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MOTIVATIONAL AND INFORMATIONAL CONSEQUENCES OF ERRORS IN EARLY SKILL ACQUISITION: THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TRAINING STRATEGY ON PERCEPTIONS OF NEGATIVE FEEDBACK

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MOTIVATIONAL AND INFORMATIONAL CONSEQUENCES OF ERRORS IN EARLY SKILL ACQUISITION: THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TRAINING STRATEGY ON PERCEPTIONS OF NEGATIVE FEEDBACK

By

Kenneth Guy Brown

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ABSTRACT

MOTIVATIONAL AND INFORMATIONAL CONSEQUENCES OF ERRORS IN EARLY SKILL ACQUISITION: THE EFFECTS OF INDIVIDUAL DIFFERENCES AND TRAINING STRATEGY ON PERCEPTIONS OF NEGATIVE FEEDBACK

By

Kenneth Guy Brown

A laboratory experiment in which 110 undergraduates learned a difficult computer simulation is reported. Perceptions of the "evaluative" and "prescriptive" characteristics of feedback were found to have a number of significant effects on learning, the strongest for evaluative feedback magnitude judgments that involve internal, stable attributions for poor performance. Individuals who reported higher attributional magnitude judgments were more likely to have lower self-efficacy, lower motivation to learn, and lower knowledge test scores, regardless of their actual performance level during training. Individual difference variables significantly predicted attributional magnitude judgments, with individuals low in cognitive ability, high in performance goal orientation, and low in learning goal orientation most "at-risk" for these negative outcomes. Training strategies used in this study were generally useful, yet unable to ameliorate the influence of these attributional judgments on the learning process and learning outcomes.

To all the teachers in the world, formal and otherwise, who help others to become something better than they were before…

ACKNOWLEDGMENTS

Research is not a natural process. While curiosity and the desire to explore are, the rigor and persistence demanded by social science research do not easily follow from these more natural tendencies. Many people provided the emotional, intellectual, and lest we not forget, financial support necessary to sustain me through this difficult process.

First, I want to thank my thesis advisor, Steve Kozlowski, for all of the advice, assistance, and support he has provided over the last 3 years. He has been a tremendous influence on me. I also want to thank the other members of my committee, Kevin Ford and Rick DeShon. Each has influenced me and, whether or not they choose to admit it, created in some part my identity as a thinker and researcher. All of my classmates also deserve thanks for putting up with me over the last few years. Special thanks go to Stan, Earl, and Eleanor for providing me with an amazing introduction to teamwork at MSU. And to Dan and David, thanks go for their friendship and support, including many late night snacks, which helps make the hard work worthwhile.

Of course none of this would be possible without the love (and prodding) of an amazing family. I have been lucky to have parents who are fantastic role models, filling each and every role they hold with dedication and humor. I love them both dearly. My brother and sisters are equally amazing people, each setting the bar a little higher in their own way. And finally, to my best friend and wife, Amy. It is for her that I strive each day to better myself and the world around me. Thank you.

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INTRODUCTION

The increased rate of social and technological change in today's workplace demands that workers constantly learn new skills (Bridges, 1994; Goldstein & Gilliam, 1990; Howard, 1995). While this dynamic complexity of modern work is most obvious with computer technology, change now pervades most industries and almost all aspects of work (Howard, 1995). Employers recognize the resulting need for employees to engage in constant learning and skill updating. In a national survey of employers, the ability and desire to learn was rated among the most desirable characteristics for employees (Carnevale, Gainer, & Meltzer, 1988). In short, today's workplace will increasingly require employees to learn new, complex skills. A result of this trend is the increased need for research investigating: (1) How people react to and learn from challenging new tasks, and (2) the effectiveness of practical training strategies that can be employed to facilitate learning in these situations.

It is clear that learning new skills can be a difficult and frustrating process. Complex skills such as operating production machinery, navigating computer programs, or troubleshooting electrical equipment all require an extensive knowledge base before successful performance can be achieved. Early attempts at these skills, particularly when a trainee's knowledge-base is inadequate, are error-prone. Disappointment and confusion often result, with trainees sometimes feeling that they are not capable of gaining the necessary knowledge. Although these feelings may subside as skill increases, early stages of skill acquisition can be critical. During initial interactions with a task, trainees develop attitudes regarding their task-specific capability, the task itself, and the training enterprise. Each of these attitudes may influence subsequent motivation and behavior.

Historical approaches to training complex skills suggest that negative consequences of errors can be avoided by creating a careful program of learning where trainees are taken step-by-step through the learning process (e.g., Biehler, 1978). Dominated by behaviorism, early learning research suggested errors interfere with the acquisition of skills by distracting the trainee from proper behaviors while strengthening improper behaviors (e.g., Skinner, 1956). More recently, both the ACT* (Anderson, 1983) and QUEST (White & Frederiksen, 1986) programs of instructional research suggest that minimization of errors is the most effective manner to build expertise (Glaser, 1990; Ohlsson, 1986).

Based less on a behavioral and more on a cognitive perspective of learning, a growing literature recognizes the value of errors in promoting concept formation, rule induction, and skill acquisition (e.g., Ivancic & Hesketh, 1995). The notion that errors can aid learning is not new as it is reflected in the "discovery" side of the traditional debate over discovery learning versus programmed learning (e.g., Hermann, 1969). Recent work, perhaps driven in part by the current need for constant learning, has revived this interest in the usefulness of errors in the training context (Frese & Altmann, 1989; Frese, Brodbeck, Heinbokel, Mooser, Schleiffenbaum, & Theilmann, 1991; Ivancic & Hesketh, 1995; Nordstrom, Wendland, & Williams, 1995).

The recent research in this area has been driven largely by one specific approach. This approach, termed Error Management Training (EMT), suggests that training programs should explicitly include errors at certain stages of the learning process (e.g., develop attitudes regarding their task-specific capability, the task itself, and the training enterprise. Each of these attitudes may influence subsequent motivation and behavior.

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The recent research in this area has been driven largely by one specific approach. This approach, termed Error Management Training (EMT), suggests that training programs should explicitly include errors at certain stages of the learning process (e.g., Frese & Altmann, 1989). While studies based on EMT have demonstrated that this particular training method is effective, these studies do not address the more basic issue of how individuals learn from the difficult, early stages of skill acquisition. Furthermore, the training method suggested in these studies is impractical. EMT requires the addition of an entire training sequence. Further, this sequence is not appropriate during the early stages of skill acquisition. Thus, the question regarding what can be done to aid trainees early on in training remains.

While EMT research has pushed our understanding of how to use errors in the learning process, research is still needed on the basic process of how individuals react and learn from error-filled learning experiences. Furthermore, research should try to identify and evaluate training strategies that can be easily adopted to early training experiences. More specifically, strategies should be investigated that affect perceptions of errors so as to decrease the frustration and increase the learning that occurs as a result of their commission.

The growing literature on errors in training asserts that errors have both an informational and motivational role in learning (Ivancic & Hesketh, 1995). Errors provide information to trainees about incorrect states, procedures, and actions. This information can provide knowledge and skills that are integral to successful task performance. However, errors may lower motivation and lead trainees to disengage either mentally or physically from the task[1]. While it may be difficult to completely

[1] Errors may also increase motivation by presenting a challenge to the trainee. While this is acknowledged, the focus of this paper is on early skill acquisition where errors are frequent and argued to generate frustration and anxiety rather than increased motivation. The possibility of errors increasing motivation is addressed in greater detail in the motivation section.

disentangle motivational and informational effects, a great deal remains to be learned about the how motivation and information interact in the learning process. In the past, different training paradigms have targeted either the informational or motivational role of errors. For example, intelligent tutoring research focuses on the information from errors, including the diagnosis of why an error occurred and how that information can be used to correct trainee's knowledge (Ohlsson, 1986). Meanwhile, the motivational implications of errors are generally ignored or assumed constant across individuals and training environments. Conversely, recent training research incorporates motivational strategies aimed at decreasing the negative effects of errors while ignoring those training strategies that might enhance the information errors provide (e.g., Boyle & Klimoski, 1995; Kanfer, 1996). To my knowledge no study has investigated how training strategies influence both informational and motivational consequences of veridical feedback.

One perspective that may prove useful in an in-depth investigation of errors is an explicit recognition of errors as feedback. If an error is recognized by a trainee as having occurred, negative feedback is conveyed. Attention to this fact may provide a means to dissect the psychological experience of difficult training situations, and in turn provide a greater understanding of how errors influence the learning process, and ultimately learning outcomes.

The feedback literature (e.g., Ilgen, Fisher, & Taylor, 1979) clearly indicates that feedback confounds evaluative information (i.e., this is how well you did) with prescriptive (i.e., this is what you should have done) information. The dual meaning conveyed by feedback parallels the motivational and informational effects discussed in the errors in training literature. Thus, while an error can provide information in the form of prescriptive information, it also provides evaluative information that the trainee is doing something wrong. The prescriptive information can benefit trainees by helping them focus their attention on important, unlearned aspects of the task. The evaluative information, however, can be either beneficial or harmful, depending on whether it stimulates the recipient to work harder or to withdrawal from the task. When evaluative information leads the trainee to withdrawal, the beneficial effects of prescriptive information are ignored and learning will not occur. What leads individuals to withdrawal and ignore the attentional advantages that negative feedback from errors can provide?

The purpose of this thesis is to develop and validate a theoretical model that answers this question within the context of error-filled early skill acquisition. To distill key constructs in the learning process, a literature review was conducted. Based on this review, a process model was developed that explicates the psychological processes that result from each message -- evaluative and prescriptive -- conveyed by negative feedback. The model suggests two perceptions of feedback -- magnitude and diagnosticity -- are predominant influences on motivational (evaluative) and informational (prescriptive) learning "tracks," respectively. Although these tracks ultimately interact to determine many training outcomes, perceptions of feedback provide a means to partially disentangle the effects of the evaluative and prescriptive messages that are conveyed when errors are committed. Two easily implemented training strategies are suggested as useful ways to research this model, as they provide for differential effects on the suggested mechanisms and may be useful for improving learning outcomes from the difficult, early stages of training. An experiment conducted to evaluate the training strategies and the model underlying their development is reported.

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LITERATURE REVIEW

In order to build a process model of learning during the difficult, early stages of skill acquisition, literature on errors in training and on learning from feedback is reviewed. Further, to investigate the possible informational effects of errors, literature on attention in training and training sequencing is reviewed briefly. Then, as a way to investigate motivational issues in training, research that has explicitly incorporated motivational variables in training is reviewed, including research on mastery versus performance goals. Next, to clarify the criterion domain, a narrow survey of training evaluation research is presented, with an emphasis on the multi-dimensional perspective on training outcomes.

Errors in Early Skill Acquisition

An error is defined by Frese and Altmann (1989) as the result of a potentially avoidable action that causes the violation of an objective rule and the non-attainment of a trainee's goal. This definition emphasizes that errors occur only if they are avoidable by alternative actions or behaviors. Further, to be considered an error, an action must prevent or delay the accomplishment of a desired goal state. Because goals are situation-specific, errors are often discussed as the result of an interaction between the situation and the individual (Fuller, 1990).

In the context of early skill acquisition, errors often occur because knowledge about a system is incorrect or inadequate (Frese & Altmann, 1989). When trainees are given free reign in unfamiliar situations or with unfamiliar systems, errors are a natural result of the inadequacy of their knowledge base. The alternative to errorful training is error-free training, in which the trainee's behaviors are guided and controlled in order to avoid incorrect actions. While there are other forms of errors and more advanced forms of error-filled training, the focus of this research is on errors that result from the interaction between the trainee as a novice and the situation of early skill acquisition.

There is little research to identify how errors in training may facilitate or inhibit the learning process. Most literature on errors emphasizes the explanation or prediction of human error (e.g., Norman, 1984; Rasmussen, 1990). However, in the training literature, there are two theoretical papers that directly address the potential usefulness of errors in training -- Frese and Altmann (1989) and Ivancic and Hesketh (1995). The work of these authors is reviewed for their perspective on the positive and negative effects of errors in training. Then empirical work regarding these ideas is reviewed, with a note on limitations and avenues for future research.

Learning from Errors

Frese and Altmann (1989) present arguments for and against the usefulness of errors in training. According to these authors, researchers have identified three potential negative consequences of errors for learning. First, Skinner and other behaviorists argue that errors are akin to punishment. While an individual may learn to avoid the particular behavior or action that led to the error (or punishment), the individual does not learn the correct behavior. In order for the trainee to learn the correct sequence of actions, positive reinforcement must be provided to the trainee upon commission of the correct behaviors, a process often called "shaping" (Skinner, 1956, 1968). Thus, errors are merely aversive stimuli with no benefit to the instructional process. Second, there are also behaviorist arguments that when an incorrect action is performed, it is learned to some degree. That is, the very commission of a behavior makes that behavior more likely in the future, so incorrect actions should never be allowed to occur in the first place. Third, a more humanistic perspective dictates that errors arouse anxiety and frustration. If it is possible to avoid these negative states, a trainer or teacher should help do so (Frese & Altmann, 1989).

On the positive side, Frese and colleagues take a more cognitive perspective and suggest errors increase knowledge about a system. Frese et al. (1991) note that "mental models" of a system are enhanced when a person makes an error, both by indicating that an area is not known well and by encompassing pitfalls and error-prone areas into the trainee's mental model. Although the term mental model has been differentiated from the general term knowledge (e.g., Rouse & Morris, 1986), Frese and colleagues use the term loosely to indicate all forms of knowledge about a system (e.g., Frese & Altmann, 1989, p. 66).

Frese et al. (1991) also note that trainers restrict the kinds of strategies used by trainees if they try to eliminate errors from training. Errors can spur exploration and creative strategies that would not have been employed in a more restricted training environment. There is growing evidence that allowing the use of exploration strategies can improve learning, particularly with adult learners (Carroll & Mack, 1984; Frese et al., 1988).

The notion of exploration as beneficial to learning marks the theme of a number of studies on discovery learning (Andrews, 1984; Hermann, 1969; McDaniel & Schlager, 1990; Prather, 1971; Singer & Pease, 1974). Each of these studies suggests that active exploration of a novel system provides advantages over more programmed or static learning environments. Most of this research, however, is concerned with the issue of transfer to tasks that differ in significant ways from the trained task (i.e., McDaniel & Schlager, 1990; Singer & Pease, 1976). Furthermore, these studies do not focus on errors per se, but on exploration and hypothesis-testing that may involve errors. For the purposes of this study, the research on discovery learning provides ambiguous information about how individuals react or learn from errors. The discovery research investigates instructional techniques that involve errors without ever equating subjects on the degree or amount of exploration and comparing the perceptions, reactions, and consequences of error commission.

Each of the positives of error commission discussed above involves increases in knowledge that may come as a result of a behavioral reaction to errors, not necessarily as a result of error commission itself. In other words, error commission does not necessarily provide new knowledge merely by its commission. Error commission can provide a signal to the learner that something should be thought about, paid attention to, or studied more. It is this "signal" provided by errors that initiates a learning process. It is the behavioral manifestations of this process, or the trainee's reaction to the error, that ultimately cause changes in knowledge. In the discovery learning studies, it is often the commission of an error that leads to exploration of a system and its capabilities. Again, however, these studies investigate this phenomena by encouraging or limiting exploration following error commission, not by observing and measuring reactions to errors. To investigate the reactions and consequences of error commission during early skill acquisition, exploration and other behavioral reactions to errors should be measured, not manipulated. Note that this suggests a somewhat different research approach than that employed by traditional research on errors in training.

The Frese and Altmann (1989) work implies three important preconditions for learning to occur from errors: (1) Errors must be noticed, (2) errors must be interpreted correctly, and (3) errors must be used to guide attention in order for learning effects to occur. Some of these pre-conditions are made explicit by Frese and Altmann (1989). For example, they emphasize the importance of the interpretation of feedback generated from errors in the following quote: "Errors provide feedback to the person. However, feedback is only useful when the trainee is able to perceive and interpret the feedback..." (Frese & Altmann, 1989, p. 76). Unfortunately, their research does not look at perceptions of errors. Nor do they consider explicitly the role of the behavioral outcomes of these perceptions, other than ultimate learning outcomes. Instead, the focus of their work is explicating Error Management Training which combines error commission, emotional and informational strategies to deal with the errors, and active exploration. As a result, the process of learning from errors is hard to disentangle from their empirical results. An interesting future direction for their research would be to investigate how trainees use errors to guide their learning efforts during skill acquisition. This research would provide a clearer indication of which aspects of EMT are integral to generating positive learning effects.

Ivancic and Hesketh (1995) also discuss the positive and negative effects of errors in training. These authors note three benefits errors have in promoting learning. First, the commission of errors provokes controlled or conscious processing of information. When trainees become more conscious of their activities, a task is actively thought about and practiced longer than it would be if the trainee judged the task well-learned and focused on new activities. This statement provides the emphasis on attention and behavioral reaction that seems missing in the work by Frese and Altmann (1989). The important statement derived from this argument is that the longer something is thought about or practiced, the better learned it is likely to become (e.g., Ericsson, Krampe, & Tesch-Romer, 1993).

Second, echoing the comments of Frese and colleagues, Ivancic and Hesketh (1995) suggest that errors help trainees develop accurate mental models. This is accomplished by initiating hypothesis testing and problem solving activities which can provide greater information about a system and even reveal faulty assumptions. Similarly, an error provides information that a particular strategy or activity is inappropriate and must be adapted or modified. So errors can narrow the range of possible alternatives for achieving a goal. Again, Ivancic and Hesketh (1995) are noting the importance of behavioral reactions to errors in order for learning to occur.

Third, errors or failures can be useful as reminders of analogous problems. In essence, an error can serve as a way to cue up memories of successful and unsuccessful strategies. A particular error may help an individual recall relevant examples of past performance. As the preceding paragraphs indicate, the positive effects of errors are generally informational in that they can provide knowledge about the target activity.

Ivancic and Hesketh (1995) suggest that motivational effects of errors are mostly negative. The authors note that errors can induce learned helpless reactions. Learned helplessness is a well-researched phenomena that involves motivational deficits following repeated exposure to failure (e.g., Dweck, 1986; Mikulincer, 1989). Learned helpless-like reactions involve reducing effort and/or withdrawing from a task. This reduction in effort can undermine training efforts in error-filled programs. If a trainee reduces effort, withdrawing in some way from the training exercises, it is unlikely that the trainee will learn.

Empirical Evidence for Errors. Over the last 5 years there have been a few studies that tested the effects of errors in the training context. Frese, Brodbeck, Heinbokel, Mooser, Schleiffenbaum, and Thiemann (1991) conducted one of the most straightforward empirical tests of the ideas discussed above. With 24 German volunteers, the experimenters tested two different training approaches for learning word processing. One group received error-avoidant training where they were guided through word processing tasks during the six hour training phase. The training materials in this condition outlined the precise steps necessary to complete each task. When subjects in this condition committed errors, the experimenter corrected the problem immediately with no explanation.

The error training group was not provided with specific lists of operations and was allowed to make errors. Subjects were encouraged to correct their own errors, and were allowed three minutes to do so before having the situation corrected by the experimenter without explanation. Trainees in this condition were told that errors are opportunities and that they should try to learn from them. A list of learning "heuristics" were displayed using an overhead projector urging trainees to pay attention to the screen and keep trying to learn from confusing or difficult situations. This type of training has been labeled error management training (EMT).

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Testing conducted after all training was complete indicated that the EMT subjects performed better on a free recall test and better at difficult competence tests (although error-free did just as well on easy and moderate competence tests). There were no differences in transfer to non-trained tasks. While this study offers preliminary evidence for the usefulness of errors, it provides a complex explanation for why the EMT subjects outperformed the error-avoidant subjects.

First, subjects in the EMT condition were exhorted to think of errors as beneficial to the learning process. EMT subjects were told that errors and mistakes help the training situation. This first aspect of EMT should reduce the detrimental motivational effects of errors, attenuating frustration, anxiety, and thoughts of task withdrawal. The study offers some evidence in support of this explanation. Second, subjects were told to try to learn from the errors they committed. EMT subjects were told to pay attention to the screen and actively seek a way to correct an error situation. This second aspect of EMT should increase the attention of trainees on task, particularly when errors occur. With increased attention to the error states, the actions that lead to them, and the strategies to resolve them, EMT subjects should gain more information from a given error situation than error-avoidant trainees. Third, EMT trainees were forced to explore to a greater degree than control subjects, because they were not provided with a list of how tasks should be completed. While EMT was beneficial overall, this study offers no hint as to whether the difference in learning outcomes over the error-avoidant group was due to changes in motivation, information, or a combination of these effects. A first step in explaining the effects of EMT would involve a more elaborate theoretical model of the psychological and behavioral process factors that are triggered by errors. As of yet, such a model has not been presented.

Further limitations of the Frese et al. (1991) study involve the sample, which comprises 24 German citizens. This sample size was small and the results may differ from a United States sample because German culture has a stronger emphasis on perfection. The commission of errors and mistakes may be interpreted more severely by Germans (Nordstrom, Wendland, & Williams, 1995).

In part to address the limitations in the sample, a more recent error training study was conducted by Nordstrom and colleagues (1995). These experimenters evaluated EMT training with a larger American sample. The results were similar to the Frese et al. (1991) study because EMT improved task knowledge. However, as with the Frese et al. (1990) study, there was little indication as to whether the EMT training helped maintain motivation, improved the acquisition of important information, or both of these. In addition, the explicit reactions of trainees to errors in these situations was not assessed, making it difficult to ascertain whether the training affected error perceptions or some other psychological variable. More research is clearly needed to determine how trainees react to errors and how these errors affect motivation and information acquisition. In accomplishing this task, researchers must first build theory by identifying how errors affect learning. Then training strategies can be developed that directly influence this process.

Empirical Evidence Against Errors. While the studies reviewed above support the use of error training, there is some literature that indicates that limiting the commission of errors can improve learning. In particular, Carroll and Carrithers (1984) used a "training-wheels" system of a commercial word processing program. The term "training wheels" is used to indicate that the word processor was modified so that certain commands were shut off from the user. Commands that often create errors for novices were blocked out of the menus in order to avoid having the new users make errors. The rationale for creating this system was that introductory users often end up ignoring manuals and exploring irrelevant parts of the program.

In an experiment to test the training wheels system, 12 temporary workers with little or no computer experience were split into training wheels and complete system conditions. For both conditions, the task was to become familiar with the word processing program, then type in and print a letter. After two hours on task, only 2 complete system subjects had typed in the letter, neither had printed it out. In the training wheels system, all subjects had typed the letter and 4 were able to print it out. Trainees in the training wheels task actually spent less time on task (overall) but generated significantly higher comprehension and task satisfaction scores. Error rates were not different across conditions, but error recovery times were different, with training wheels subjects spending less time recovering from errors.

One of the major conclusions from this paper is that training wheels designs provide useful limits on user options. While hypothesis testing and discovery can be a significant means to improve learning, drastically unfamiliar situations can make errors so distracting that is precludes learning. Delimiting the learning situation makes the situation manageable for the learner, so she or he can engage in effective hypothesis testing. This is the same goal of discovery learning studies that provide some guidance or structure to the exploratory behavior of trainees.

An issue that was not considered by Carroll and Carrithers (1984), but is raised by Frese and Altmann (1989) is the issue of avoiding the negative motivational consequences of error commission. While subjects in both conditions of the Carroll and Carrithers study had similar error rates, the errors committed by complete systems subjects took longer to handle. It is likely that these subjects experienced greater distress over their errors, resulting in decreased motivation to engage in the task. No data is available from the Carroll and Carrithers study, however, to indicate how trainees viewed their errors. Future research would benefit from looking at the perceptions of errors, so that researchers can estimate the motivational impact of error commission.

In summary, the Carroll and Carrithers (1984) work suggests that limiting the focus of trainees may be useful for lowering the overwhelming amount of information presented during early stages of learning a new skill. However, the use of a modified task makes the "training wheels" approach unfeasible in many situations. There may be less costly and less time consuming ways to restrict the trainees' attention in order to avoid an overload of information.

The research studies discussed above involve attempts to improve learning outcomes in situations that involve many errors. While Frese and colleagues and Carroll and Carrithers arrived at different solutions, each group of researchers was attempting to avoid the potentially detrimental motivational effects of errors. However, neither group provides for a full theoretical account for why their respective training strategies improve learning. In all of the studies above, motivational and informational effects of errors are combined in both the creation and evaluation of their training manipulations. In order to disentangle these issues, the next section considers the role of errors as feedback. A substantial literature exists regarding learning from feedback. To the extent that errors provide feedback, this literature may provide a means to specify the motivational and informational effects of errors.

Learning from Feedback

Errors influence learning via the feedback that they convey to a trainee. This is the informational result of errors that can provide for learning advantages over trainees that do not receive or pay attention to error feedback. Unfortunately, the literature on feedback is divided across disciplines and paradigms. There have been a number of different reviews covering research in these different areas. Balzer, Doherty, and O'Connor (1989) have reviewed feedback research from the multiple-cue probability learning (MCPL) paradigm, an inductive reasoning task based on the Brunswik Lens Model. Ilgen, Fisher, and Taylor (1979) and Taylor, Fisher, and Ilgen (1984) reviewed literature on feedback from a performance appraisal perspective. Kluger and DeNisi (1996) recently reviewed literature on feedback as augmentation or intervention. In other words, Kluger and DeNisi excluded those forms of feedback that are derived solely from the task itself, which is the form of feedback of most interest in this thesis. While none of these reviews deal explicitly with the issue of learning from errors, they do offer information about the characteristics of feedback that may influence individual reactions to it.

First, however, its important to note that these reviews identified a series of studies that show people do not learn from outcome feedback on complex tasks (Azuma & Cronbach, 1966; Hammond & Summer, 1972; Schmitt, Coyle, & Saari, 1977; for a recent review see Balzer et al., 1989). Similarly, Jacoby, Mazursky, Troutman, and Kuss

(1984) found that seeking outcome feedback was negatively associated with performance. However, this work has been completed under the MCPL paradigm where learning is a completely inductive process. Much learning today is both inductive and deductive. For example, learning a word processor involves generating, testing, and verifying hypotheses. However, this process can be done either by trial-and-error or by reference to an information source. Hypotheses regarding task rules do not have to be tested solely by interacting with the environment in an iterative trial-and-error learning process. Rather than being implicit or hidden within the structure of the task, rules that govern systems are often available in manuals, on-line documentation, or from expert advice.

In environments where learning can be both inductive and deductive, feedback may serve to cue the trainee about when and where attention should be focused at reference materials. In the words of Ivancic and Hesketh (1995), errors focus attention. For example, if someone always has trouble with changing margins on their word processor (an event that is salient to the author right now), that person can look up margins in the software manual. More generally, if the screen on the computer always becomes incomprehensible after a particular command is executed, the user has been provided with information necessary to refer to a manual or expert regarding the use of that command. Ordinarily, individuals do not have to rely on testing hypotheses over and over again to uncover "latent" rules as they do in the MCPL paradigm. The rules are, at least in part, laid out in manuals or by reference experts; these resources can be sought when error feedback is perceived. This discussion serves to indicate that error feedback on complex tasks can be useful for learning. The remainder of this section explores some of the issues involved in translating error feedback into action that improves learning outcomes. However, the idea that feedback can generate action requires a more in-depth discussion of the characteristics of feedback.

Ilgen et al. (1979) present a conceptualization of feedback as a special case of the general communication process where a sender conveys a message to a recipient. While this is the definition adopted in this thesis, there are a number of boundary conditions around the type of feedback under investigation here. These boundary conditions are noted as each of the three components of feedback are discussed.

Sender. First, while characteristics of the sender can affect individual reactions, these are not the focus of the current study. In the training context, the sender is often either the trainer/instructor or the task itself. When feedback is provided by an external agent like a trainer or supervisor, characteristics of the source such as power over rewards, credibility (Ilgen et al., 1979), and trust (Earley, 1988) become important variables to consider in determining an individual's reaction to feedback. Furthermore, there is evidence that feedback presented by external agents has little effect on performance, and can even have negative effects (Kluger & DeNisi, in press).

The focus of this review is on objective feedback conveyed directly from the task. As a result, the sender is constant across subjects and is assumed to provide potentially useful and trustworthy feedback. This has been shown to be the case for self-generated or computer-generated feedback (Earley, 1988). The questions of usefulness and trust would become more important if feedback was "yoked" or false, neither of which is the case in the current study.

Receiver. Second, characteristics of the receiver provide important clues in determining the effects of a feedback message. Three characteristics seem important to isolate: Goal orientation, negative affectivity, and general cognitive ability. First, recent research in educational psychology has indicated that learning orientation, or the degree to which an individual values challenge and learning, significantly affects how individuals approach difficult tasks (Bouffard, Boisvert, Vezeau, & Larouche, 1995; Dweck, 1986, 1989; Elliot & Dweck, 1988). Similarly, performance orientation, or the degree to which an individual values performance and achievement, significantly affects how individuals react to failure in achievement situations. While learning oriented individuals view errors as challenge and show increased effort and persistence in the face of adversity, performance oriented individuals are focused on demonstrating competence and disengage from activities that are difficult and hard to learn (Dweck, 1986, 1989). This form of disengagement is similar to the well-researched phenomena of learned helplessness, in which individuals withdraw a task after repeated negative feedback (Dweck, 1986; Mikulincer, 1994).

Applying the notion of goal orientation to adult workplace learning has been the topic of a number of recent studies. Boyle and Klimoski (1995) and Kozlowski, Gully, Smith, Nason, and Brown (1995) have conducted empirical tests to demonstrate the usefulness of the goal orientation constructs in predicting training outcomes. Boyle and Klimoski (1995), in a study on learning from a computer tutorial, demonstrated that learning orientation was correlated positively with learning outcomes. Similarly, Kozlowski and colleagues (1995) found that learning orientation facilitated the acquisition of knowledge structure and self-efficacy. High levels of performance orientation were found to inhibit these learning outcomes. Similar results were found by

Ford et al. (1995) who reported that performance orientation was negatively related to self-efficacy in training.

Although this perspective of goal orientation is dispositional, situational influences have also been proposed. Kozlowski et al. (1995) used sequenced mastery goal interventions to improve knowledge structure and self-efficacy. This intervention improved knowledge structure and self-efficacy to a greater extent than performance goals, even though performance goals appeared to facilitate basic task performance. These situational manipulation effects were found independent of effects for individual differences. Having measured learning and performance orientation as dispositions prior to training, Kozlowski and colleagues demonstrated that traits were indeed relevant. Furthermore, training with performance or mastery goals had independent, additive effects beyond the effect of natural trait tendencies (Kozlowski et al., 1995).

However, the studies reviewed above do not provide direct evidence that the adoption of learning or performance goals involves a different perspective on or interpretation of the errors committed. Particularly in the study by Kozlowski and colleagues, it is difficult to ascertain whether it was the mastery focus created by the mastery goals, the sequence of goals, or the combination of the two that initiated the differences in learning between the mastery and performance subjects. Disentangling the motivational focus issue from the sequencing manipulation would provide a clearer picture of how individuals react to error-filled training experiences.

Furthermore, direct evidence should be collected as to whether goal orientation directly affects the perception of errors, as suggested by Dweck's work. If this is indeed the case, then it is clear that the process by which mastery or learning goals affect

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Furthermore, direct evidence should be collected as to whether goal orientation directly affects the perception of errors, as suggested by Dweck's work. If this is indeed the case, then it is clear that the process by which mastery or learning goals affect learning outcomes involves feedback perception and interpretation. Ivancic and Hesketh (1995) note, "Research in applied contexts is needed to determine if manipulating goal orientation is an effective strategy for managing errors" (p. 144).

In short, both disposition and situational influences should be considered in future research. The prediction from Dweck's work would be that negative feedback for learning oriented individuals is less demotivating. The opposite is expected for performance oriented individuals. Yet, future research is needed both to manipulate goal orientation without confounding other variables, and to measure the perceptions of errors directly in order to ascertain whether this receiver characteristic affects the learning process.

The second characteristic of the recipient that should be considered is the propensity for negative thoughts and anxiety. Research has demonstrated that a primary reason errors cause learning and performance decrements is through the creation of anxiety and frustration (e.g., Ivancic & Hesketh, 1995; Mikulincer, 1989). Certain individuals have been shown to experience events as more negative, and consequently exhibit greater anxiety from them. These individuals have been labeled as having high negative affectivity (NA, Watson, Clark, & Tellegen, 1988). Individuals high in NA have been shown to view the world more negatively and to experience greater levels of anxiety and stress following negative feedback. As a result, these individuals may respond differently to errors than individuals low in negative affectivity. This characteristic of the recipient should also be measured in identifying the effects of errors in early skill acquisition.

The third characteristic of the trainee that may affect feedback perceptions is general cognitive ability. One would expect that cognitive ability would have an effect on the ability of trainees to use information. Cognitive ability has been demonstrated as an important influence on training outcomes (e.g., Ree & Earles, 1991, 1992) and one cause for this may be the ability to utilize feedback during the learning process. There is evidence that the effects of general cognitive ability on work samples at the end of training occur through the acquisition of job knowledge (Ree, Carretta, & Teachout, 1995). Thus, individuals who have lower levels of general cognitive ability may have more difficulty interpreting feedback and consequently gain less information from feedback. This process may at least partially explain the differences in acquisition of job knowledge noted by Ree and colleagues (1995). Thus it seems likely that individuals high in general cognitive ability would perceive feedback as more important and more useful.

Message. Finally, the message of the feedback is an important determinant of an individual's reaction to it. Ilgen et al. (1979) mention three critical characteristics of message: timing, frequency, and sign. In many training environments, the timing and frequency of feedback is constant. All individuals receive their feedback around the same time throughout the training. Consequently, the current focus is not on timing and frequency. The notion of feedback sign, however, is germane to the topic of errors. While one might assume that all errors convey only negative feedback, it is important to consider that the sign of feedback depends on both the message and the receiver (Ilgen et al., 1979; Kluger & DeNisi, in press). Two characteristics of feedback message are noted below for their potential usefulness in studying the effects of feedback on learning. Brief comments about how the individual differences reviewed above may affect perceptions of these feedback characteristics are also provided below.

One of the criticisms leveled against current theories of feedback by Kluger and DeNisi (in press) is the lack of an *a priori* means to identify the sign of feedback. The reason for this is quite simple. The message conveyed by feedback about the "goodness" or "badness" of performance depends on the goal of the recipient. In the current work, the goal of the recipient is assumed to be this -- to lower the number of errors committed on the task. In early skill acquisition, errors provide a clear indication that the trainee has not learned the task yet. The goal of any trainee then is to demonstrate that they are learning and performing well by lowering the number of errors they commit. Even given this assumption, Kluger and DeNisi raise an important issue about the relativity of any feedback message. As discussed below, this relativity can be assessed by directly measuring perceived characteristics of the feedback.

The first perception of the feedback message that is relevant here is the extent to which a feedback message is positive or negative. The "magnitude" of the feedback depends on the number of errors, certainly, but also on the characteristics of the recipient as noted earlier. Unfortunately, little research has attempted to directly ascertain how different individuals gauge or scale feedback in terms of positivity or negativity. In other words, researchers have not stopped to ask learners with different characteristics, "What did you think about that feedback? How good/bad do you think you did based on the feedback you just received."

There are at least two benefits to this direct measurement approach for the research process. First, instead of looking at feedback as dichotomous, positive or negative, feedback is viewed along a continuum. Second, the psychological interpretation of feedback is not left to *a priori* theoretical conjecture. By asking about the perception of the magnitude of the feedback in terms of how good or how bad, the researcher gains access to a construct that can be used model both the antecedents and consequences of perceived feedback. In a learning situation it is the psychological interpretation of the feedback message that dictates subsequent behaviors. In a sense, the assessment of positivity provides a direct psychological assessment of goal--performance discrepancy, which has been shown to have important consequences in learning and performance environments (Thomas & Mathieu, 1994). In summary, perceptions of the feedback message can and should be measured in order to model the effects of feedback on behavior. In the previous discussion, the "magnitude" or extent to which error feedback is seen as negative is an important characteristic of the feedback message.

Characteristics of the recipient that may influence the judgment of negativity are learning and performance orientation. As noted earlier, individuals who are more learning oriented are hypothesized to experience negative feedback as less demotivating and more challenging. Although learning and performance orientations tend to be uncorrelated (e.g., Kozlowski et al., 1995), a similar result is expected for individuals with a low performance orientation. One explanation for this finding would be that high learning oriented individuals and low performance oriented individuals view a given episode of negative feedback as less negative others. As a result of this possibility, the effects of goal orientation should be considered when measuring perceptions of feedback magnitude. Furthermore, training should manipulate goal orientation in order to reduce the perceived negativity of error feedback.

Another characteristic of the recipient that may influence the interpretation of feedback negativity is negative affectivity. Individuals high in NA have been shown to experience greater levels of anxiety and rumination following exposure to negative feedback (Watson, Clark, & Tellegen, 1988). One explanation for this finding is that individuals high in NA are more likely to view a given episode of feedback as more negative than individuals low in NA. Given the likelihood of such differences, it would be worthwhile to consider differences in NA when measuring perceptions of the magnitude of negative feedback.

Another important characteristic of the feedback message is its information value (Ilgen et al., 1979). Ilgen et al. (1979) note that feedback is only information. The usefulness of the information depends on both the nature of the feedback and on the recipient. If all trainees are given a similar form and similar quantity of feedback, the meaning of that feedback is ascertained solely by the trainee. A trainee's ability and past experience with the task influences how useful the trainee judges the feedback.

General cognitive ability, as noted earlier, should influence the extent to which feedback is judged as useful. Individuals with higher levels of cognitive ability have been shown to learn more from given training episodes, and at least one reason for this may be their perception of the importance of feedback. Having judged feedback as useful, higher cognitive ability should allow a trainee to assimilate more information from a given feedback message (Ackerman, 1988).

Similarly, the more a trainee's attention is focused, the less likely she is to become overloaded with information. That is, individuals who only focus on a single facet of a task, and the feedback relevant to that facet, should be able to interpret that feedback more easily. Within a limited time frame, one individual can only perceive and interpret a finite amount of information -- this is the basic argument of attentional resource capacity (e.g., Kanfer & Ackerman, 1989). Similarly, Goldstein (1993) and Ilgen et al. (1979) both note that too much feedback can be confusing. One way instructors or trainers prevent information from becoming overwhelming is to ask trainees to attend to only portions of the task information that is available. This is the approach advocated by training wheels strategies (Carroll & Carrithers, 1984) and discovery learning advocates who include sequencing or guidance (e.g., Singer & Pease, 1976). To study the effectiveness of these strategies, though, cognitive ability should be assessed as it likely affects the usefulness of feedback for self-diagnosis of learning and performance.

As with the magnitude, the perception of the usefulness of feedback can and should be measured in order to ascertain how each individual perceives the feedback received. In the current study, feedback that is useful is termed "diagnostic" because that term captures the notion that feedback can be used to diagnosis problems in learning and direct attention to fix those problems. Thus diagnosticity, when trainees are given similar amounts of information as feedback, depends largely on the ability and current focus of the trainee. As a result, perceptions of diagnosticity may provide clues into whether or not feedback messages are attended to and used to guide effort and attention during the training process.

This discussion still leaves unanswered how negative feedback influences learning. From an informational perspective, trainees must allocate attention to those aspects of the task that have not been well-learned. This means perceiving, interpreting, feedback more easily. Within a limited time frame, one individual can only perceive and interpret a finite amount of information -- this is the basic argument of attentional resource capacity (e.g., Kanfer & Ackerman, 1989). Similarly, Goldstein (1993) and Ilgen et al. (1979) both note that too much feedback can be confusing. One way instructors or trainers prevent information from becoming overwhelming is to ask trainees to attend to only portions of the task information that is available. This is the approach advocated by training wheels strategies (Carroll & Carrithers, 1984) and discovery learning advocates who include sequencing or guidance (e.g., Singer & Pease, 1976). To study the effectiveness of these strategies, though, cognitive ability should be assessed as it likely affects the usefulness of feedback for self-diagnosis of learning and performance.

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From a motivational perspective, people who receive negative feedback know that they are not performing the task well. Thus, these individuals have to decide whether to exert more or less effort as a reaction to this feedback. The perception of feedback magnitude would seem to be an important antecedent to the decision of whether to engage in effortful thinking about the task. In general, it would seem that greater levels of negative feedback (i.e., higher magnitude of negative feedback) would lead trainees to disengage from their learning attempts and apply less effort. Each of these processes are discussed in greater detail in the next sessions.

Attentional Focus in Training

The notion of attention is not well defined in the training literature. The most common notion of attention is that presented by Gagne et al. (1992). In their 9 events of instruction, Gagne and colleagues list "gaining attention" as the first event. Gaining attention involves appealing to the learner's interests or using rapidly changing stimuli. The notion of attention, however, goes beyond a one-time event of attracting the trainee's mental focus to the task at hand.

Attentional focus is simply the information about which trainees are currently thinking. A rough, but useful, distinction made in much of the literature is between on-task and off-task cognitions (e.g., Fisher, 1995; Kanfer & Ackerman, 1989). On-task cognitions involves attentional focus on material that is directly relevant to the to-be-learned material. Off-task cognitions are thoughts and concerns that have no immediate relevance to the task at hand. In general, one would expect that focusing attention on-task should provide for the greatest learning benefits. This has been demonstrated in a number of studies (Fisher, 1995; Kanfer & Ackerman, 1989).

The purpose of training sequencing is to narrow the attention of the trainee more specifically. Sequencing involves narrowing trainees' attention on specific portions or facets of task relevant information. Generally defined, sequencing is the organization of subunits in a training program (Gagne et al., 1992). Reviews of instructional sequencing (Reiguluth & Curtis, 1987; Reiguluth & Stein, 1983) have indicated that almost all sequencing involves a movement of trainee focus from simple to more complex material.

Different traditions provide different dimensions on which to judge task complexity. For example Anderson's ACT* model suggests that verbal or declarative knowledge should (and must) proceed the presentation (and acquisition) of procedural or action-based knowledge (Anderson, 1983). Simple facts, terms, and ideas must be understood before an individual can use those ideas to generate action. Elaboration theory (Reiguluth & Curtis, 1987) suggests that the most basic unit of action or knowledge should be presented first. From this core, elaborations or different permutations are presented in succession. In other words, elaboration theory suggests that a simple foundation should be built before exceptions, counter-examples, or differentiating complexities are explored. In general then, sequencing is simply a means of focusing attention to different areas of study with the ultimate goal of accomplishing the training objective.

In order to accomplish the final training objectives, pre-requisite capabilities must be built through-out the course of instruction. That is, the goal of sequencing is to build the basic skills (i.e., simple skills) necessary to move on to the more complex skills for which training is attempting to build proficiency. For example, for a person to learn how to understand and solve a calculus problem, that person must both understand the principles of calculus and be able to utilize basic algebra skills to solve simple equations. Learning how to solve simple algebra equations such as $3x + 5 = 14$ requires previously acquired skills in basic math functions like subtraction and division. Pre-requisite knowledge must be built by focusing trainee attention on simple math skills before moving to more complex skills like how derive an integral.

Sequencing, then, is the traditional training solution to the same problem addressed by Carroll and Carrithers (1988) "training wheels" system. Carroll and Carrithers were trying to limit the focus of trainee's attention in order to prevent information overload and consequent withdrawal from the learning attempt. They modified a system so trainees could only focus on those aspects of the task that were most relevant to the to-be-learned task. As noted earlier, however, modifying the task is a costly solution, one that involves time and money. Furthermore, there is the possible danger of the trainee missing out on important information or skills because the task has been modified.

This focusing of attention via sequencing should directly affect the perception of feedback received. As noted earlier, limiting the attention of trainees should allow for unambiguous interpretation of the feedback. If trainee's attention is focused on all aspects of the task, there will simply be too much feedback presented for it to be

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While sequencing should help trainees judge feedback as more diagnostic, it does not necessarily have any effect on the level of on- and off-task attention. Sequencing is designed to move a trainee from subject x to subject y and finally to subject z. What this movement does not demand is greater on-task attention than someone who is provided with training that is not sequenced. Simply because a trainee is told to focus on different information does not suggest that the focus will last longer or will be less susceptible to interference from off-task cognitions. However, sequencing may improve on-task attention indirectly.

Feedback that is highly diagnostic provides trainees with unambiguous information about their skills. This information can be used to focus their attention on improving the shortcomings with their skills. So trainees who perceive their error feedback as diagnostic are more likely to use that information to attend to on-task information about how to remedy the problem identified by the feedback. On the other hand, trainees presented with information that is perceived to be useless or ambiguous should have no specific focus for their follow-up study efforts. These trainees consequently spend less time using information resources in follow-up study time. As a result of these different reactions to diagnosticity of feedback, research should find that sequencing affects feedback perceptions directly, but only affects on-task attentional focus indirectly, via those feedback perceptions.

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Motivation in Training

Some research suggests that individuals who receive negative feedback are likely to exert more effort than those who receive positive feedback because positive feedback indicates that the status quo can be maintained or that further effort is unnecessary (Anderson & Rodin, 1989; Podsakoff & Farh, 1989; Waldersee & Luthans, 1994). Other research suggests that exposure to negative feedback can result in a reduction of motivation and on-task effort (Mikulincer, 1994). How can these contradictory results be remedied in order to render a prediction in the current paradigm?

Kluger and DeNisi (1996) suggest four strategies that people use to address negative feedback, based on a cybernetic model of discrepancy reduction: 1) Increase effort, 2) abandon the standard, 3) change the standard, 4) reject the feedback message. From an operational perspective, the last three strategies manifest themselves with very similar behaviors. Individuals who abandon, change, or reject the standard and/or the feedback generally decrease their effort on the task in question. The similarity of the behavioral manifestation of these three outcomes makes it difficult to evaluate the conceptual distinctiveness of each of these strategies. Thus, the key theoretical question, and practical issue for trainers, is whether individuals work harder after being provided negative feedback.

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In the current paradigm, the most common reaction is likely to be to a reduction of effort via one of the three mechanisms above. At the early stages of skill acquisition, individuals are faced with a novel, difficult task. The feedback received is almost entirely negative, indicating serious problems with the individuals capability to learn and perform the task. Because the individual has not had prior exposure to this task, early time-on-task provides one of the best means to judge capability.

If low levels of perceived capability result from error feedback, then individuals see little benefit in continuing efforts to learn the task. The question for an individual then becomes whether the negative feedback is judged as something the individual feels he or she is capable of transcending. A traditional approach to understanding this issue is to measure attributions of causation, controllability, or stability (e.g., Thomas & Mathieu, 1994; Weiner, 1985, 1986). An alternative approach involves capturing how negative the perception of feedback appears. Individuals who perceive high levels of negative feedback are more likely to judge that feedback is indicating lower levels of capability.

However, because of the evidence supporting attribution theory, an attempt should be made to ascertain whether attributional processes are affecting how individuals interpret their feedback. This can be accomplished within this theoretical framework by construing magnitude of negative feedback in two distinct ways. First, magnitude can be purely descriptive, as suggested above. This would indicate the extent to which feedback is highly positive or highly negative. Second, magnitude can be assessed from an attributional perspective. This would indicate the extent to which feedback is highly positive or highly negative and reflects stable, internal factors. Although this perspective combines across dimensions of attribution noted by Weiner (1986), it provides a simple

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However, because of the evidence supporting attribution theory, an attempt should be made to ascertain whether attributional processes are affecting how individuals interpret their feedback. This can be accomplished within this theoretical framework by construing magnitude of negative feedback in two distinct ways. First, magnitude can be purely descriptive, as suggested above. This would indicate the extent to which feedback is highly positive or highly negative. Second, magnitude can be assessed from an attributional perspective. This would indicate the extent to which feedback is highly positive or highly negative and reflects stable, internal factors. Although this perspective combines across dimensions of attribution noted by Weiner (1986), it provides a simple means of assessing whether causal judgments affect perceptions of magnitude. Further the combination of internality and stability provides an indicator of whether trainees feel that current performance could improve with time and effort. Thus, this study distinguishes between attributional magnitude of negative feedback and descriptive magnitude of negative feedback. Both of these magnitude constructs are expected to influence perceptions of task capability.

Perceived task capability has been measured in a number of ways, but most recently the focus has been on self-efficacy judgments. Self-efficacy is the overall assessment an individual makes about his or her task-relevant capability (Bandura, 1986, 1991; Gist & Mitchell, 1992). As one form of expectancy (e.g., Schunk, 1991), self-efficacy serves as an indication of whether the individual feels capable of performing the task. Perceptions of capability in the form of self-efficacy have been linked to persistence, effort, and strategy use (Bandura, 1977, 1986, 1991; Latham & Locke, 1991; Schunk, 1991). Thus, high levels of self-efficacy would be beneficial in eliciting and maintaining high levels of motivation during training. Very high levels of negative feedback, such as those encountered during initial attempts at learning a new task, should lead to low perceptions of self-efficacy. A goal of training interventions in early stages of skill acquisition should then be to lower the perceived magnitude of negative feedback in order to avoid lowering self-efficacy. Self-efficacy, in turn should affect the overall motivation level of trainees. More specifically, higher levels of capability on a task may influence the extent to which individuals value learning about that task.

Interest in the effects of motivation has become very popular in the training literature in recent years (Campbell, 1988; 1989; Goldstein, 1993). Although a number means of assessing whether causal judgments affect perceptions of magnitude. Further the combination of internality and stability provides an indicator of whether trainees feel that current performance could improve with time and effort. Thus, this study distinguishes between attributional magnitude of negative feedback and descriptive magnitude of negative feedback. Both of these magnitude constructs are expected to influence perceptions of task capability.

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Interest in the effects of motivation has become very popular in the training literature in recent years (Campbell, 1988; 1989; Goldstein, 1993). Although a number of different techniques for conceptualizing and measuring motivation are available, recent work has concentrated on the construct of motivation to learn. Early definitions of motivation to learn, posed by Noe (1986) and Noe and Schmitt (1986), suggest that it is the degree to which an individual desires to learn from training. The definition used here reflects this early tradition, with motivation to learn defined as the extent to which an individual wants to learn about the task. In the terms of expectancy theory, motivation to learn reflects the value placed on learning the task in question. This definition suggests that individuals who are high in motivation to learn are more likely to spend time attending to those activities that lead to changes in internal knowledge states as opposed to activities that satisfy external task demands. This concept is distinct from on- and off-task attention as it implies greater effort for a similar level of on-task attention and the use of learning strategies such as mnemonics and rehearsal that are commonly used to learn new material.

A number of recent studies have studied the effects of motivation on learning outcomes. Hicks and Klimoski (1987) used overall measures of motivation but found little effect for motivation on a final role play and test performance. Their study, however, showed few significant predictors of these criteria, indicating possible contamination problems. Similarly, Tannenbaum, Mathieu, Salas, and Cannon-Bowers (1991) tested the effects of various training characteristics on attitudinal outcomes of training. While it was not the focus of their study, they did find significant relationships between training motivation and 3 of 5 training outcome variables. One of these was in negative direction, opposite what one might predict. The variables that were not predicted well were honors and demerits, outcomes that likely have significant influences

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Mathieu and Martineau (in press) note that different criteria might be predicted differently by different measures of motivation. In particular, they note that some motivational variables have direct effects on learning outcomes while others will have indirect effects. More specifically, these authors note that self-efficacy measures are likely to affect pre-training motivation measures, while expectancy based motivation measures, similar to the definition espoused here, will predict work outcomes. In other words, self-efficacy predicts overall motivation level and it is this motivating force that predicts performance.

Martocchio (1994) suggests this relationship exists in the computer training when he states, “Self-efficacy beliefs are expected to directly influence motivation...” (p.820). His results suggest this effect, although motivation is not a measured variable. Martocchio found differences in declarative knowledge test performance were related to efficacy levels. Other studies, however, have indicated a non-significant effect of self-efficacy on learning (Thomas & Mathieu, 1994).

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The contradiction in these findings seems to be due to a difference in the variables included in the studies. Studies that do not show direct effects for self-efficacy control for self-set or personal goals (e.g., Thomas & Mathieu, 1994). Personal goals, like motivation to learn, provide a measure of motivation for subsequent on-task behavior. Thus these studies suggest that self-efficacy influences are mediated by the motivation level (whether ascertained as self-set goal or as motivation level) which itself is the primary determinant of learning outcomes. Martocchio (1994) found a direct effect for self-efficacy because, while he controlled for expectancies, he did not control for a global assessment of motivation. Motivation captures the desire to mobilize the capability assessment inherent in self-efficacy judgments. Why should an individual who is capable always perform better than an individual who is less capable? Capability may result in a desire to learn, but it does not directly imply a change in learning outcomes.

Motivation to learn, in turn, should influence the cognitive and skill-based learning outcomes through an interaction with attentional focus. The combination of high levels of motivation to engage in learning activities and high levels of attention on task should increase learning over individuals who possess neither. Motivation to learn should directly influence affective learning outcomes. If a trainee is motivated to learn, task satisfaction and task withdrawal should be directly affected by this attitude. While changes in knowledge and skill require the mobilization of effort via a motivating force, a change in attitudes can result directly from a desire to do so.

Training Outcomes

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Training Outcomes

On the criterion side, recent work has emphasized that learning outcomes are multi-dimensional. Most recently, Kraiger, Ford, and Salas (1993) suggest three primary categories for training evaluation: Cognitive, skill-based, and affectively-based outcomes.

Cognitive learning outcomes refer to variables that represent the quantity and type of knowledge available to the trainee. The traditional tests of cognitive learning are achievement tests of verbal knowledge. While tests of verbal knowledge have been criticized for being unable to discriminate among learners at higher levels of development, they are appropriate for early stages of skill acquisition (Kraiger et al., 1993). Measures of verbal knowledge can be taken using traditional pencil-and-paper questions. Other cognitive outcomes include knowledge organization and cognitive strategies. Both of these outcomes, however, are more likely to develop in later stages of the skill acquisition process.

Skill-based learning outcomes also tend to reflect later stages of learning. According to Kraiger et al. (1993) the two major components of skill-based outcomes are compilation and automization. Compilation involves the combination of discrete behaviors into domain-specific routines that are relatively fast and efficient. During this stage errors are reduced, verbal rehearsal is eliminated, and behavior is more task-focused. During early stages of skill acquisition this may take place and be ascertained by observations of performance. Similarly, task outputs of products or performance can be examined for evidence that compilation is beginning to occur -- fewer errors and faster production or reaction time.

Automaticity, on the other hand, involves an even greater level of skill. Automaticity implies that tasks or portions of task can be handled without conscious monitoring. The lack of monitoring frees cognitive resources to engage in other categories for training evaluation: Cognitive, skill-based, and affectively-based outcomes.

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Automaticity, on the other hand, involves an even greater level of skill. Automaticity implies that tasks or portions of task can be handled without conscious monitoring. The lack of monitoring frees cognitive resources to engage in other activities. No subjects are expected to engage in this level of skill during initial studies of learning.

The third learning outcome suggested by Kraiger and colleagues are affectively-based. These outcomes reflect a class of variables such as attitudes and motivation that are relevant to the purpose of training. Attitudinal outcomes include outcomes that are specific to the training, such as appreciation for diversity in a diversity training course. In the context of early skill acquisition, there are several affectively-based outcomes that should be considered. The early stages of training provide the first exposure of trainees to a task that require many hours of practice to master. The attitude trainees hold toward the task and toward the training are important outcomes of training (Tannenbaum et al., 1991). It is possible that trainees who feel negatively about their early experiences, regardless of their ability or skill, will disengage from later training efforts. As a result, attitudes such as task satisfaction and task withdrawal should be considered as important outcomes of early training experiences. These are attitudinal outcomes that can be affected by training and are potentially important indicators of future performance.

Motivational outcomes are somewhat distinct from attitudinal outcomes, but they nonetheless represent important outcomes of the training process. In particular, self-efficacy has received a great deal of research attention for its impact on individual's willingness to use newly acquired skills in new situations. Baldwin and Ford (1988), in their review of transfer of training, note the importance of self-efficacy in determining whether learned skills are employed back on the job. As a result, self-efficacy is important as both a process and as an outcome variable of any training effort.

The study by Kozlowski et al. (1995) noted earlier measured verbal knowledge, metacognitive knowledge structure, self-efficacy, and final training performance as a skill indicator. All four of these variables were found to affect the generalization of learning. Therefore each represents an important outcome of training. Although that study did not investigate task specific attitudes like satisfaction and withdrawal, those constructs were noted as potential future research directions. Particularly in the context of early stages of skill acquisition, these attitudes may affect future effort in the training.

To conclude, to evaluate the effects of errors and feedback on learning, it is important that a number of different learning outcomes are considered. Cognitive, skill-based, and affectively-based outcomes are all important outcomes of training, as each contributes to the use of acquired knowledge at a later time. Furthermore, in the context of early skill acquisition, variables from each category are likely to have significant effects on subsequent behavior and performance in the training environment. If trainees disengage from the task after the first hour of a week long program, the effects of that first hour affect the remaining training.

INTEGRATION AND HYPOTHESES

To understand the effects of errors on learning during early skill acquisition, an integrative model is needed that identifies the major psychological mechanisms through which negative feedback affects learning outcomes. Thus far, little research has been conducted to identify the psychological processes that result from feedback. Theoretical and practical progress in the area of training design also calls for an understanding of how errors during early stages of learning a novel, complex task may affect learning. To aid in the design of training programs, instructional techniques should be investigated that directly affect the theoretically relevant mechanisms. The literature reviewed above is integrated in Figures 1 and 2.

As noted earlier, the literature on negative feedback indicates that both negative feedback and errors have informational and motivational consequences. The perceived descriptive and attributional magnitude and diagnosticity of feedback were noted as important dimensions of feedback that may affect the learning process. Each perception can be manipulated via training strategies, has individual differences that likely affect it, and is causally antecedent to psychological variables that may facilitate or impair learning. Thus each of these perceptions is modeled as both a dependent variable of training strategies and individual differences and as an independent variable influencing the learning process.

The basic processes involved in early stages of learning include both motivation variables like self-efficacy and motivation to learn and information variables such as

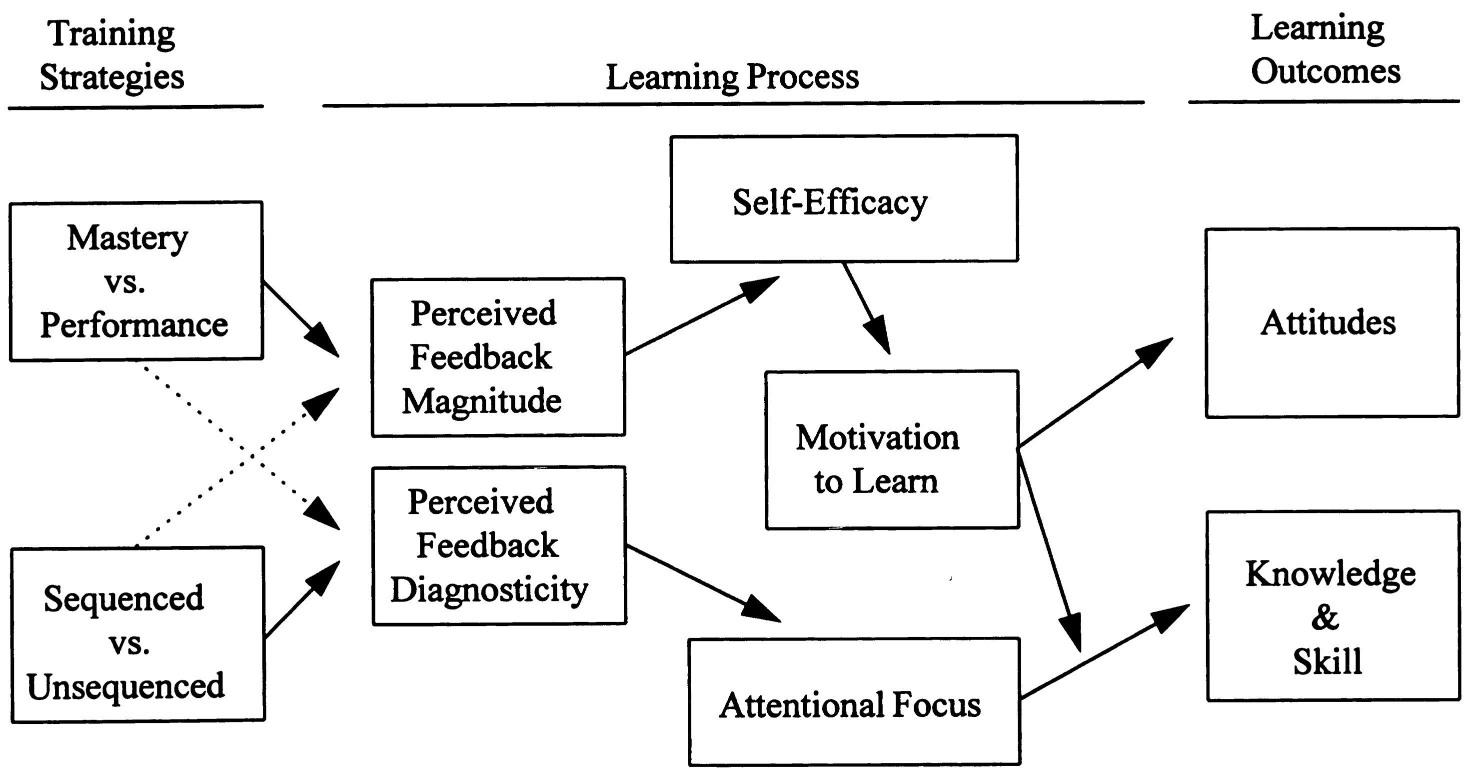

Figure 1. Manipulation research model.

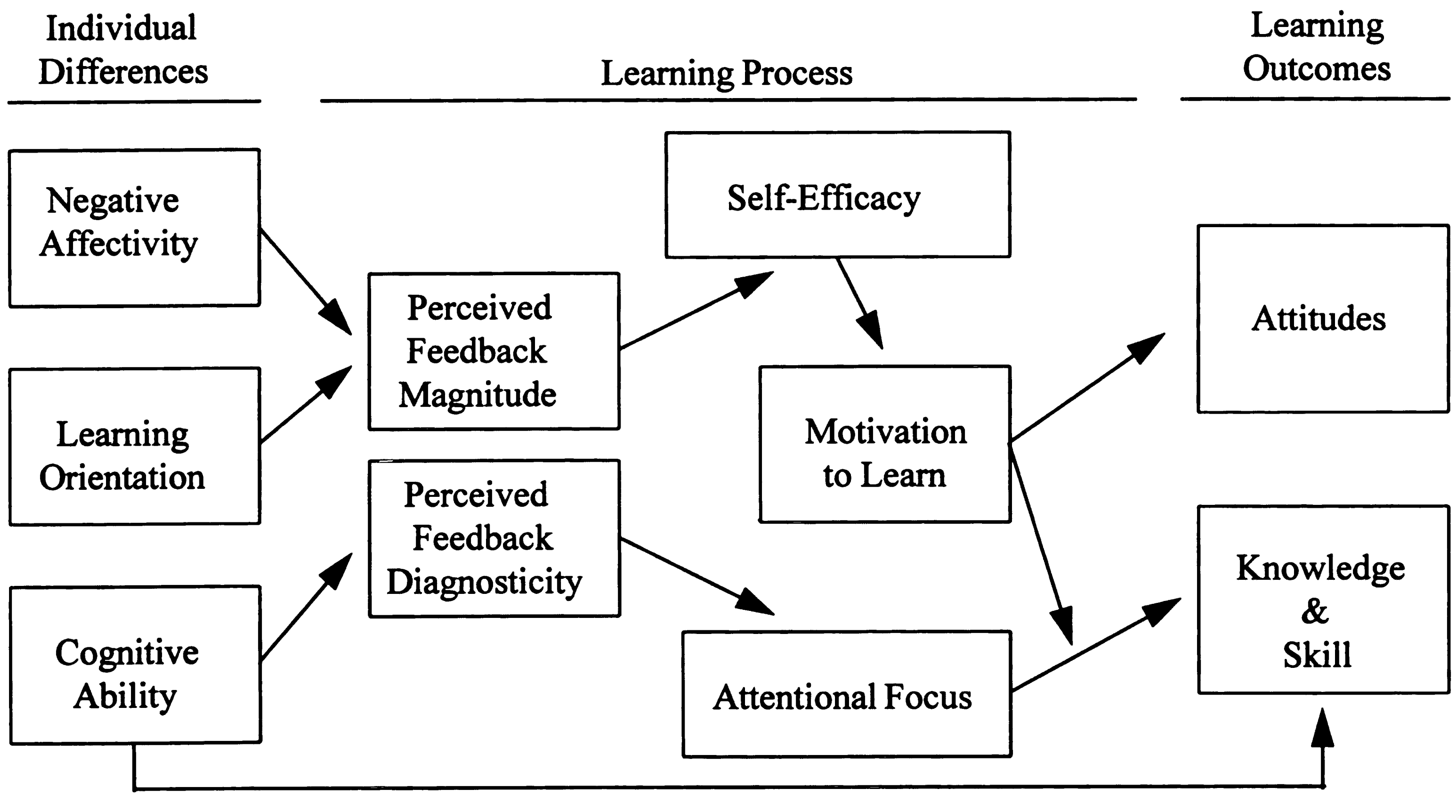

Figure 2. Individual differences research model.

attentional focus. The motivational variables directly determine attitudinal or affective outcomes, as those outcomes do not require substantial attention or practice in order to change. Attentional focus interacts with motivation to determine knowledge and skill outcomes. Feedback perceptions initiate these two learning processes.

During the early stages of skill acquisition in error-filled training, all trainees receive large quantities of negative feedback. Each of the training strategies affects feedback perceptions in a way that ultimately improve learning. Sequencing can provide a means to increase the usefulness or diagnosticity of feedback, pushing trainees to focus their attention on task. Compared to performance focused training, mastery focus decreases the magnitude of negative feedback so that self-efficacy is not so damaged by the error-filled environment. As noted earlier, past research has tied goal focus and sequencing together (Kozlowski et al., 1995). To disentangle the effects of these strategies and examine the process by which they affect learning in error-filled training, each strategy is portrayed separately in the model. The effects of these two training strategies are explained in more detail below.

The first strategy is mastery focus, a training strategy that calls for trainers and training materials to emphasize the learning and mastery of content over the performance of training content in comparison to others. Performance or mastery focus is expected to have a direct effect on the perceived magnitude of negative feedback. Trainees who de-emphasize performance and consider progress more important should consider errors to be less negative than trainees who seek high levels of performance. Trainees who consider performance of paramount importance should construe errors as conveying more negative information. As noted earlier, there are two different ways to construe feedback magnitude, as purely descriptive or as attributional. Both of these perceptions should be affected by mastery framing.

Hypothesis #1: Trainees in the mastery condition will perceive lower attributional and descriptive magnitude of negative feedback than trainees in the performance condition (controlling for the actual performance feedback).

The second training strategy, sequencing, involves changing the focus of trainees' attention over time. Sequencing focuses attention on particular aspects of the task at different times. In terms of the feedback constructs, sequencing should directly affect the perceived diagnosticity of different feedback information by limiting the amount of information to which the trainee attends. Trainees who are asked to focus on particular aspects of the task attend more closely to the feedback about those task aspects and consequently judge that feedback as useful for diagnosing their performance. Over time, the focus on specific aspects of the task provides the trainee with the necessary skills to interpret and use the feedback relevant to that task dimension.

Hypothesis #2a: Trainees in the sequenced condition will perceive greater diagnosticity of feedback than trainees in the no sequence condition (controlling for the actual performance feedback).

As all trainees become more familiar with the task, there should also be a general trend for feedback to be more diagnostic. Trainees who have greater knowledge about the task should be better able to interpret feedback messages.

Hypothesis #2b: Over time all trainees will perceive greater diagnosticity of feedback.

In addition to this global effect, differences in diagnosticity of specific forms of feedback should result from the sequencing. When a trainee is asked to focus on a particular subtask, then feedback regarding that aspect of the task should be more diagnostic than for other topics. This effect should occur because the individual is paying closer attention to behavior relevant to that topic, because the individual is gaining experience with that topic relative to other topics, and because the individual is concentrating on the meaning of that feedback. The result is greater diagnosticity of sequenced materials over material that has not been sequenced. In addition, subjects who are not in the sequenced condition should have lower diagnosticity for that specific topic compared to subjects in the sequenced condition. The latter hypothesis, #2d below, is similar to #2a but is concerned with specific topic area feedback, not with overall feedback.

Hypothesis #2c: Trainees in the sequenced condition should perceive greater diagnosticity for feedback relevant to the material that is currently the focus of the sequence than for material that has yet to be brought to focus by the sequence.

Hypothesis #2d: Trainees in the sequenced condition should perceive greater diagnosticity of feedback relevant to the material that is currently the focus of the sequence than trainees that are in the unsequenced condition.

In addition to the main training strategy and developmental effects, each training strategy is expected to have secondary effects on the remaining feedback construct. These secondary effects result in interactions between mastery and sequencing to determine the feedback perceptions. Figures 3 and 4 portray these interactions.

The first interaction involves sequencing and mastery effects on perceived magnitude of negative feedback. Sequencing is predicted to affect perceived magnitude directly by lowering the magnitude of negative feedback. In the mastery condition, however, this effect should only be minor as trainees already are influenced to view the feedback less negatively. In other words, both mastery and sequencing affect magnitude, but mastery has a more primary effect that makes the sequencing effect redundant.

Hypothesis #3a: There will be an interaction between sequencing and goal frame such that trainees in the sequenced condition will perceive lower descriptive and attributional magnitude of negative feedback in the performance condition, but there will be no difference in descriptive and attributional magnitude between the sequenced and non-sequenced condition in the mastery condition.

The second interaction involves sequencing and mastery effects on perceived diagnosticity. Mastery is predicted to affect perceived diagnosticity directly by raising the trainee's ability to attend to the negative feedback. In the sequenced condition, however, this effect should only be minor because diagnosticity should have already approached high levels. In other words, both mastery and sequencing affect diagnosticity, but sequencing has a more primary effect that makes the mastery effect almost redundant. These interactions account for the usual statement that it is difficult to disentangle motivational from informational consequences of feedback (Frese & Altmann, 1989; Goldstein, 1993).

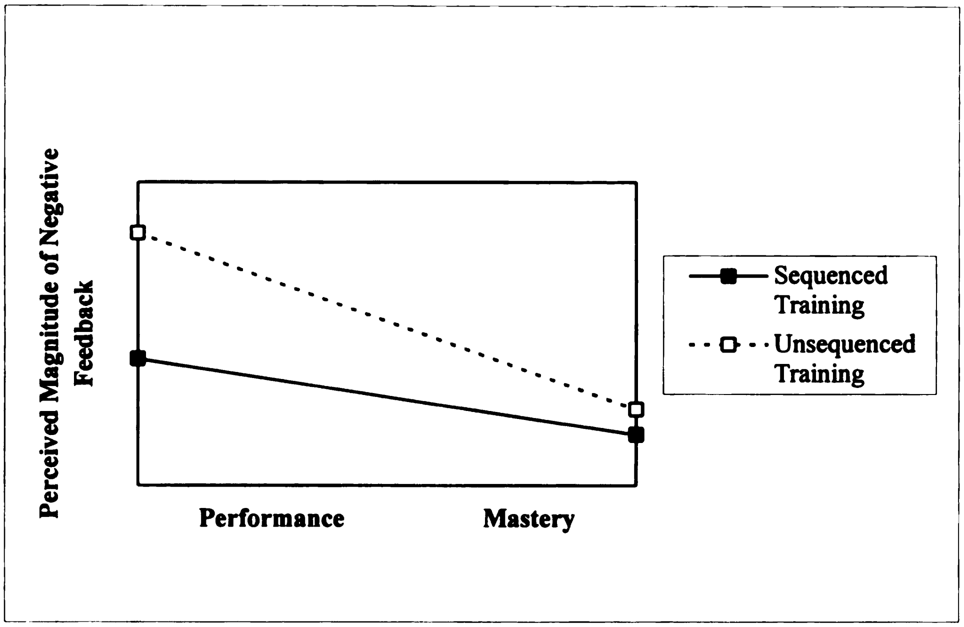

Figure 3. Hypothesized magnitude perception interaction by training strategy.

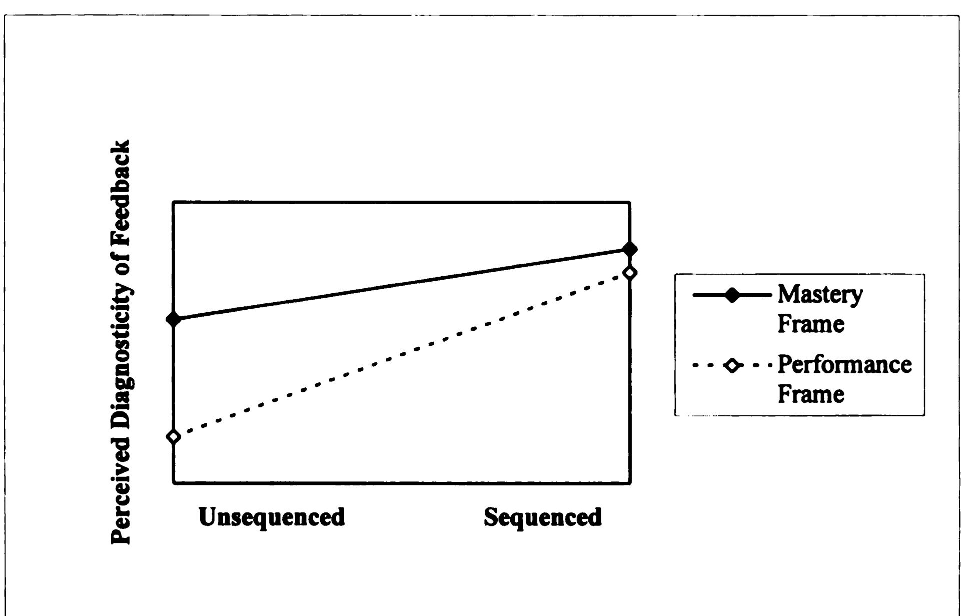

Figure 4. Hypothesized diagnosticity perception interaction by training strategy condition.

Hypothesis #3b: There will be an interaction between sequencing and goal frame such that trainees in the mastery condition will perceived greater diagnosticity of feedback than trainees in the no sequence condition, but there will be no difference in diagnosticity between mastery and performance conditions in the sequence condition.

A number of individual differences also affect feedback perceptions. Figure 2 portrays these variables and their effects. First, cognitive ability should increase the diagnosticity of feedback. The more an individual can rely on working memory and processing speed, two variables associated with general cognitive ability, the more quickly the individual can learn the task. The ability to learn quickly does not imply that attitudinal and motivational variables are directly affected. Affective and cognitive learning outcomes, while related, are influenced by different mechanisms (Kraiger et al., 1993). However, the more a trainee knows, the easier the interpretation and utilization of feedback. As a result, diagnosticity of feedback may be affected by cognitive ability. Thus there are two hypotheses about cognitive ability, about both final learning outcomes and perceived diagnosticity.

Hypothesis #4a: Trainees with higher levels of cognitive ability will perceive higher levels of feedback diagnosticity than trainees with lower levels of cognitive ability.

Hypothesis #4b: Trainees with higher levels of cognitive ability will have perform better on cognitive and skill learning outcomes than trainees with lower levels of cognitive ability.

In addition to cognitive ability, negative affectivity was mentioned as a dispositional personality variable that influences feedback perceptions. Individuals high in NA tend to experience more anxiety and depression that individuals low in NA. This tendency results in more negative interpretations of even neutral stimuli. The effects of NA on negative feedback should be more pronounced.

Hypothesis #4c: Trainees high in negative affectivity will perceive higher magnitudes of negative feedback than trainees with low levels of negative affectivity.

Learning-oriented individuals view negative feedback as informative or challenging, without viewing it as a threat to their sense of skill or ability. Conversely, performance-oriented individuals should view negative feedback as more threatening. As a result, learning-oriented individuals are likely to judge their feedback as less negative than individuals who are low on this trait while performance-oriented individuals should display the opposite pattern. Research by Dweck and colleagues also suggests that these individual differences are related to attributional style (Eliott & Dweck, 1988). Thus, these hypotheses are expected to hold for both descriptive and attributional magnitude descriptions.

Hypothesis #4d: Trainees high in learning orientation will perceive lower attributional and descriptive magnitudes of negative feedback than trainees with low levels of learning orientation.

Hypothesis #4e: Trainees high in performance orientation will perceive higher attributional and descriptive magnitudes of negative feedback than trainees with low levels of performance orientation.

Each of the feedback constructs is predicted to affect the learning activities of trainees. The effects of each feedback dimension is discussed separately below. The first feedback perception discussed is the perceived diagnosticity of feedback. Diagnosticity is predicted to affect the study efforts of the trainee on later trials. In essence, negative feedback, if interpreted as diagnostic, signals to the trainee that a particular aspect of the task is not well learned and should be studied (Ivancic & Hesketh, 1995). As with the general notion of usefulness, the diagnosticity of feedback is an interaction of the feedback stimulus (e.g., how much information does it convey, how clearly presented is it) and the person perceiving it (e.g., how much do they know about the task, what past experience do they have with the task). Even with this complexity it is possible to identify, from the trainee's perspective, the diagnosticity of a feedback message and to measure the consequences that perception. Feedback that is judged as diagnostic should push trainees to focus on the task in order to rectify the problems the feedback has indicated. In other words, diagnostic feedback helps trainees focus their attention to specific aspects of the task, decreasing off-task attention.

Hypothesis #5: Trainees who judge their feedback as more diagnostic will have greater attentional focus to relevant study material than trainees who judge their feedback as less diagnostic.

The second feedback dimension involves the perceived magnitude of negative feedback. Both forms of this perception should affect the self-efficacy of trainees. In essence, people who judge their performance to be very negative lack confidence in their ability to perform the task. Although the model does not depict expectations or goals directly, the presumption is that all trainees are attempting to minimize if not eliminate errors from their performance. With number of errors noted explicitly in the feedback, trainees should be dissatisfied with error-filled performance and lower their perceptions of capability. The extent of this lowering of self-efficacy varies across individuals, however. In order to ensure that differences across individuals are perceptual and not a result of actual differences in the nature of the feedback received, the actual amount of feedback should be statistically controlled.

Hypothesis #6: Trainees who perceive the attributional and descriptive magnitudes of negative feedback to be greater will produce lower self-efficacy judgments than trainees who perceive the magnitude of negative feedback to be smaller (controlling for the actual level of negative feedback).

Self-efficacy judgments have been shown to affect trainees' motivation level in the form of self-set goals (Latham & Locke, 1991). The perspective of this study is that a global assessment of motivation, rather than self-set goals only, results from self-efficacy. After-all, self-set goals are only one means by which highly motivated individuals direct their efforts. Trainees who judge themselves as more capable on the task should be more willing to invest energy into the task, as measured by the more global measure of motivation to learn. In training situations where a lot of negative feedback is conveyed, low levels of self-efficacy seem likely. These low levels should lower self-assessed motivation.

Hypothesis #7: Trainees with lower levels of self-efficacy will be less motivated to learn the task.

Motivation to learn, as an indicator of the effort trainees are willing to exert during training, is expected to moderate the relationship between attentional focus and learning outcomes. In essence, this variable serves as an indicator of the quality of the energy focused on learning the simulation. In addition, individuals who are motivated to learn likely develop more positive attitudes toward the task. As a result, motivation to learn should also have a direct effect on affective learning outcome measures, such as attitudes towards to the task and training.

Hypothesis #8a: Trainees with high motivation to learn will learn more from their attentional focus than trainees with low motivation to learn.

Hypothesis #8b: Trainees with high motivation to learn will have more positive affective learning outcomes (attitudes toward the task) than trainees with low motivation to learn.

Overall tests of the model are also conducted. Of particular interest is the extent to which two different tracks can be identified -- an informational and a motivational -- as the pathways through which errors influence the learning process. Ultimately these paths intersect to determine many outcomes, but whether they can be distinguished is a question fundamental to the issue of learning from errors during early skill acquisition.

METHOD AND MEASURES

Participants

There were 115 participants in this study drawn from introductory and advanced summer courses in psychology, communication, and business at Michigan State University. From this sample, 4 participants did not follow directions and their data was discarded. One additional student asked to terminate the experimental session, and was dismissed without penalty. The final sample size was 110. There is no missing data.

Nine subjects were left handed (8.2%). All subjects who asked to modify the position of the computer mouse were allowed to do so. Eighty-two subjects (75%) were female. Sixty-six subjects (60%) were aged 22 or older, while only 3 subjects (2.7%) were age 19 years or younger.

Although participation in this particular study was voluntary, most participants fulfilled class requirements by participating. A few students participated for extra credit and two people who were not taking summer classes volunteered to participate with no direct form of compensation.

All participants were informed of possible awards for highest performance and learning scores. Six small monetary awards were offered, three for each different outcome. The first three awards were noted as final performance awards, with the three individuals who perform the best on the final scenario receiving the awards. The second three awards were noted as final knowledge awards, with the three individuals who perform the best of the final knowledge test receiving the awards. The award information was contained on the consent form, was mentioned at the beginning of training, and was contained in the final instructions provide just prior to taking the knowledge test and conducting the final scenario.

Task Selection and Description

The task for this experiment was selected based on a number of criteria. First, the experimental task should be relatively complex such that individuals can make progress but not master it during a 2 hour laboratory session. Second, the task should be governed by a finite number of deterministic rules. These rules should be summarized and explained in written material that trainees can reference. Third, the task should be relatively engaging so trainees are at least initially interested in the activity. Fourth, the task should allow for standardization, control, and unambiguous evaluation of performance. Generally speaking, tactical and strategic computer simulations meet all of these criteria. They offer controlled performance environments for which finite numbers of veridical rules must be learned before effective performance can be achieved.

Recent research has demonstrated that the TANDEM computer simulation is an effective means to test the effects of training strategies on learning (Ford et al., 1995; Kozlowski et al., 1995; Kozlowski et al., 1996; Nason, Brown, Gully, & Kozlowski, 1995). Further, this simulation offers an interesting game-like task with rules that can be modified to vary the complexity of the task. As a result of these characteristics, the experimental task chosen for this study is a recently modified version of the TANDEM simulation initially programmed by the Naval Air Warfare Center, Human Factors Division. Under the guidance of a research team at Michigan State, the program was significantly modified. The latest collaborative version, TANDEM 8.1f, has been renamed TEAMS/TANDEM in recognition of the significant differences in experimenter control provided by the latest version.

TEAMS/TANDEM is a computer simulation that can be run on personal computers. The simulation graphically emulates a simple radar terminal, with the computer screen portraying a series of blips or "contacts" that the user classifies using pull-down menus. On-screen displays include time remaining in the current scenario, the current range of sensors, and a number identifying the current contact that is highlighted or "hooked" by the user. Hooking contacts involves clicking on a contact on the screen; in this way users indicate to the simulation that they wish to collect information about that particular contact. Information is collected by pulling down menus using the mouse. As the current experiment involves a number of changes from the basic setup used in these earlier studies, I explain how the task is designed below. As a result of the difference between this configuration and past configurations, I refer to this experimental configuration as RADAROP.

RADAROP has three relatively independent performance dimensions: Labeling, engaging, and prioritizing. Trainees start the game by clicking on a menu and then selecting or "hooking" a particular contact. Once selected, information regarding the nature of the vessel can be obtained.

The first performance dimension is labeling. Three pieces of information must be considered prior to making a label decision. Altitude and communication time information is collected from menus to determine whether the contact is an air or surface vessel. While the altitude operates as a simple classification rule, communication time forms an exception rule, with values within a certain range completely determining the air or surface nature of the vessel while values outside of that range have no impact on the label decision. The third piece of information is maneuvering pattern and this provides a contact's civilian or military status. Based on this information, the trainee must render a label decision by selecting the proper identifying label (i.e., air civilian, air military, surface civilian, or surface military) from a decision menu. Trainees are informed that contacts can appear as any of these combinations, and an equal number of each appear in the training scenarios.

Once this decision is made, subjects can begin the second performance dimension of the task, engaging. Engaging involves making a decision about what should be done about the contact. This decision involves collecting three pieces of information: Threat level, response intent, and missile lock. Correct engage decisions depend on an interaction of the level of threat level and response intent, rendering this decision more complex than the label decision. As with the label decision, the third cue provides an exception rule. There are 4 possible engage decisions, including clear, monitor, warn, and shoot.

The third performance dimension is somewhat different from the two above. Prioritizing involves deciding which contacts to process using the above procedure. In short, it involves making executive decisions about whether to clear a contact from the screen using the procedure above. Prioritization decisions are based on features of the game that include defensive perimeters, speed, course, and range of contacts on the screen, so this decision is even more complex than the previous two. Although individuals can choose to focus on some decisions over others, effective overall performance involves operating all three components of the task in rapid succession.

Feedback automatically appears on the computer screen after a trial is completed. This feedback is actually created by an add-on program entitled "FASTBACK" designed and developed at Michigan State University. This program reads the data files from RADAROP and displays performance information on the computer screen. In this experiment, four pieces of feedback information are presented. The first piece of information is a global indicator of performance, called score. Score is generated by the following formula:

$$SCORE = [(50 * a) - (50 * (A - a))] + [(50 * b) - (50 * (B - b))] + 100 * C$$

where A is total label actions, a is total labels correct, B is total engage actions, b is total engages correct, and C is the total number of prioritization errors. This provides 50 points to trainees for performing each label and engage action correctly, for a total of 100 points for correctly handling a contact. This formula subtracts 50 points for every incorrect decision. Thus, if one of those decisions is made incorrectly, the sum score is zero; if both decisions are rendered incorrectly the sum score is -100. The total of 100 also reflects the penalty for making prioritization errors. This formula places a heavy emphasis on avoiding errors, in line with the study focus.

The numbers used to generate the score were based on pilot work which demonstrated that most trainees continue to receive negative scores throughout most of the experiment. Furthermore, the task was designed such that no individual could attain error-free performance levels in the time allotted, although error-free performance is attainable given further practice. It is important to note that, while scores were intended to be negative, no comparative information was provided to trainees. Thus, feedback was suggested to be negative by the score, but trainees had to rely on their personal

interpretations of the meaning of negative scores and errors to decide how well they were performing.

The next three pieces of feedback information presented are the labeling, engaging, and prioritizing statistics used to compute the overall score. As the focus of the current study is on negative feedback, the data presented on the screen provides feedback about the number of errors committed along each dimension of the task. A sample feedback screen for labeling appears as follows:

5 ERRORS on 6 LABEL actions!

Press any key to continue

This would represent feedback for the labeling 6 contacts, but only labeling one correctly.

As RADAROP requires a good deal of task knowledge, past experiments have used paper manuals to explain the characteristics of the task and the rules of engagement. In the current experiment the manual is computerized. Computerization allows the manual to accurately reflect on-line documentation, an increasingly popular means of providing information to computer system users as well as to provide general instruction. Further, computerization allows for data collection about what information the user has displayed on the screen. The time spent on each page is automatically recorded by the manual program and written to a separate data file. This data allows the experimenter to ascertain the exact amount of time the trainee spends looking at different types of material (represented by the content of pages).

Design

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a result, the experiment employs a 2 (mastery goal versus performance goal) x 2 (sequencing versus control) between-subjects design. There is also a block within-subject factor consisting of 3 different performance segments. The total on task time is 30 minutes, constant across all conditions. This time is divided into 3 blocks of trials, with trials 1 to 3 composing block 1, trials 4 to 6 composing block 2, and trials 7 to 9 composing block 3. The final on-task trial, trial 10, is used as a final measure of skill. Study time lasts 21 minutes, divided into 7 sessions of 3 minutes between on-task trials.

Training Strategy Manipulations

As each manipulation involves a different approach to structuring and running the first stage of a training program, each involves different instructions throughout the experiment. These instructions were handed out to trainees while the instructor read them aloud. The experiment was conducted by one experimenter, the principal investigator, and the manipulations and all interaction with trainees were tightly scripted. The manipulations are presented in Appendix A and summarized below.

Mastery versus Performance. As noted earlier, a mastery frame involves presenting the training in terms of learning and progress. Conversely, performance presents the goal of training as high scores (few errors) and end-states. The instructions provided to trainees about the purpose of the experiment, the emphasis of the training, and the way to interpret their progress, vary across each condition. To provide a quick summary, mastery subjects receive the following training instructions:

> Your purpose during this study is to learn and understand RADAR-OP. You will go through 3 blocks of trials to give you and opportunity to learn, practice, and explore the game. Pursuing knowledge about the game is the key to gaining skill with this simulation.

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> Your purpose during this study is to learn and understand RADAR-OP. You will go through 3 blocks of trials to give you and opportunity to learn, practice, and explore the game. Pursuing knowledge about the game is the key to gaining skill with this simulation.

In contrast, the performance goal instructions are as follows:

> Your purpose during this study is to perform at your maximum on RADAR-OP. You will go through 3 blocks of trials to give you an opportunity to maximize your performance. Your level of performance, as measured by the overall score, is critical to demonstrating your skill at this game.

In summary, in the mastery condition the purpose of the experiment is presented as trying to discover how people go about learning and mastering skills like those contained in this task. In the performance condition, the purpose is stated as testing to determine who can perform the task best and how quickly they can perform at the highest levels on the task. Performance conditions emphasize the score and the number of errors as indicators of how well the trainee can perform while the mastery condition emphasizes this feedback as essential to learning. Mastery condition subjects are encouraged to use the feedback to learn more about the task, as feedback provides valuable information. Manipulation reminders are provided once during each block and at the beginning of the remaining blocks.

Sequencing versus Unsequenced. Sequencing is initiated via instructions to the trainee just prior to beginning the task for the first time. The purpose of the sequencing is to focus trainees attention on particular aspects of the task in an order that helps subjects learn parts of the task separately. As there are three primary dimensions of performance on the RADAROP task, each is be covered separately, in a part-task approach to sequencing. Following the ACT* model (Anderson, 1982), sequencing begins with the declarative aspects of task performance. As labeling requires the most memorizing and involves the simplest aspect of task performance, subjects are asked to focus on this aspect of the task for the first block of trials. This focus is mentioned before the block and repeated before every trial within the block, as follows:

> Our suggestion is that you limit your attention to certain parts of the simulation for each block. Instead of working on all parts of the program, the best way to approach this task is to concentrate your effort. So, before each block of trials we will give you a set of skills to focus on during that block. When you are practicing and studying RADAR-OP during that block, you should focus on the part of the task that we suggest.
>
> For this first block, we suggest that you focus on LABELING. Although there is more to the simulation than just this one skill, LABELING is integral to all subsequent skills and actions with the task. So concentrate your efforts of LABELING....

Trainees still have control over what they choose to focus on; however, these instructions are paraphrased once during each block.

For the second block, trainees are asked to focus on engaging contacts. Engaging also involves memorization of information about contact characteristics, but it entails a more complex relationship between the information provided and the decision to be made. Finally, trainees are told to focus on prioritizing contacts for the third block of trials. Prioritizing is a superordinate skill, requiring performance of the preceding two skill components. Following Anderson's model, it involve a heavier procedural component than the previous two performance dimension, in addition to a few additional declarative requirements. In the unsequenced condition, no mention of sequencing is made. Subjects are told to engage the task with no specific instructions on how to focus their attention.

Manipulation checks were conducted with 10 questions for the mastery/performance induction and 2 questions for the sequencing induction. The mastery/performance manipulation check involves two sets of 5 questions ascertaining the level of mastery and performance state goal orientation of trainees, based on scales developed by Boyle (1995). The sequencing manipulation check consists of two items assessing whether trainees felt that the training suggested they focus their attention on specific aspects of the simulation over others. These questions are presented to trainees just after the manipulations, but before the trainee begins the first block of trials.

Procedure

Table 1 outlines the procedure for experiment. The experiment is basically divided into four sections. In the first section the experiment is explained and informed consent is obtained. In the second, individual differences measures are collected. This is done before the manipulations are enacted, in order to avoid contaminating the measures. Third, a demonstration and training is provided. This part of the experiment begins with a guided tour of the RADAROP simulation, the feedback screen, and the manual program. After this demonstration, trainees are given 3 minutes to become familiar with the manual program. This allows trainees time to get comfortable with how to collect relevant information from the manual and time to read the first few introductory pages

Table 1. Outline of experimental procedure.

Individual Differences Measures and Introductory Training	
+5 Min	Explanation/Purpose/Consent
+10 Min	Individual differences measures
+30 Min	Introduction training with demonstration
+35 Min	Introduction read on manual (3 minutes)
Block 1	
+40 Min	Manipulations-- frame (mast or perf), sequenced focus labeling (or none)
+44 Min	On-task + feedback (3 minutes)
+47 Min	Measure--feedback perceptions
+52 Min	Study (3 minutes)--measure attentional focus
+55 Min	Manipulation reminder + on-task + feedback (3 minutes)
+58 Min	Study (3 minutes)--measure attentional focus
+61 Min	On-task + feedback (3 minutes)
+64 Min	Measure--mediating constructs
+70 Min	Break (3-4 minutes)
Block 2	
+74 Min	Manipulation reminder with sequenced focus on engaging (or none)
+75 Min	On-task + feedback (3 minutes)
+78 Min	Measure--feedback perceptions
+83 Min	Study (3 minutes)--measure attentional focus
+86 Min	Manipulation reminder + on-task + feedback (3 minutes)
+89 Min	Study (3 minutes)--measure attentional focus
+92 Min	On-task + feedback (3 minutes)
+95 Min	Measure--mediating constructs
+100 Min	Break (3-4 minutes)
Block 3	
+104 Min	Manipulation reminder with sequenced focus on prioritizing (or none)
+105 Min	On-task + feedback (3 minutes)
+108 Min	Measure--feedback perceptions
+114 Min	Study (3 minutes)--measure attentional focus
+117 Min	Manipulation reminder + on-task + feedback (3 minutes)
+120 Min	Study (3 minutes)--measure attentional focus
+123 Min	On-task + feedback (3 minutes)
+132 Min	Measure--mediating constructs and learning (knowledge, attitudes)
+145 Min	Final block on-task (3 minutes)--performance measure
+150 Min	End of experiment, debrief and dismiss

without becoming familiar with the major rules that govern the simulation. This ensures that all trainees begin the first task trial with little substantive knowledge about the simulation, but the ability to collect such information in the future.

The fourth part is the core of the experiment when subjects actually receive the manipulations. Following the reading of the manipulations, trainees answer manipulation check questions. Then the main part of the experiment begins with subjects practicing the task for 1 trial of 3 minutes and receiving feedback. Following that the program automatically asks the trainees to answer feedback perception questions on bubble sheets. Following these questions, trainees are allowed 3 minutes to study the manual. After the 3 minutes study period is up, subjects are taken back into the task to perform another time 3 minutes trial. Trainees then study and practice again, for a total of 3 on-task trials and 2 study sessions per block. At the end of the block trainees answer the mediating construct questions. This is one block of the experiment. Two more blocks follow this one, each providing a different focus in the sequencing condition or simply more opportunity to perform in the control condition. Between blocks subjects are given a 3 to 5 minute break. After the second block no mediating construct questions are asked, simply to prevent trainees from becoming bored with answering too many questions. As a result, analyses for mediating constructs only have 2 levels of the within-subjects factor.

When all three blocks are complete, subjects complete the cognitive and affective learning outcome measures. Then, a final task scenario is played to provide skill learning outcomes measures. Finally, subjects are debriefed and provided with class credit slips.

Measures

Measures employed in this study are presented in Appendices B, C, and D. These are presented as they appeared to trainees, with one exception. Item codes are presented after each item so readers can reference item numbers to the later analyses.

Learning outcomes. To capture the multi-dimensional nature of learning, three different learning outcomes are measured, each measuring a different component of complex cognitive skill. Questionnaire items, when employed, are presented in Appendix B as they appeared to trainees. As noted earlier, cognitive, skill-based, and affective learning outcomes are all possible outcomes of training (Kraiger et al., 1993). Each category of training outcome is measured in a number of ways. Knowledge or cognitive outcomes are assessed via an 21-item multiple choice paper-and-pencil measure. Knowledge items were developed to tap into all three of the primary dimensions of task performance--labeling, engaging, and prioritizing. Seven items were written for each content area, so each performance dimension is weighted evenly. Items were written to reflect both declarative knowledge, such as what does altitude of 10 nautical miles mean, and the utilization of that knowledge in standard performance settings. An example of this latter question type is, "Given a target with altitude of 10 N.M., a maneuvering pattern of Code_Foxtrot, and a communication time of 30 seconds, which is the correct label action?" All questions are presented with 5 multiple choice alternatives. Total number of correct answers, ranging from a possible low of 0 to a high of 21, serves as the indicator of knowledge.

Skill is operationalized as behaviors performed correctly to complete portions of the task. This measure is taken from a final training scenario for which all subjects (i.e., regardless of condition) are given performance instructions. That is, all trainees are told to perform at their maximum for the final scenario. There are a number of different measures of skill, including indicators for each of the primary dimensions of task performance and a global score.

For labeling, the number of label actions and the number of label errors is used. For engaging, the number of engage actions and the number of engage errors is used. For prioritizing, the number of contacts that cross defensive perimeters is used. A global score is also used as a dependent variable, based on the scoring algorithm presented to trainees. Although there are no specific hypotheses about different skill outcomes, results may differ depending on the criterion used. Exploratory analyses determine whether the manipulations and subsequent learning process differentially affect these training outcomes.

Affect is operationalized with two self-report questionnaires. Task withdrawal and task satisfaction are measured using paper-and-pencil surveys. Task withdrawal is assessed using a 6-item scale used by Gilliland (1992). Task satisfaction is measured using a 4-item scale developed by Carsten (1987). All but one of these questions is answered with respondents indicating their agreement to statements using a 5-point Likert scale with "Strongly Agree" to "Strongly Disagree" anchors. The final question of the withdrawal scale using a different format, with individuals selecting the alternative statement that most reflects their attitude. As these scales are expected to be highly related, a composite index is formed to reflect the overall affective reaction to the task.

<u>Feedback Constructs</u>. All feedback and mediating construct questionnaire items are presented in Appendix C, exactly as they appeared to trainees. The questions are

statements for which respondents indicate their agreement using a 5-point Likert scale with "Strongly Agree" to "Strongly Disagree" anchors.

Descriptive magnitude of negative feedback, the first feedback construct, is a descriptive judgment by the trainee of the degree to which feedback received is negative. The 4 items tapping this construct ask how poorly the trainee feels s/he did based on this feedback. The second feedback construct, attributional magnitude of negative feedback, is also measured using a 4-item scale. This combines a description of magnitude with the assertion that this magnitude is caused by internal, stable factors. While this is a non-traditional way of measuring attributions, it offers a way to capture magnitude judgments that are viewed as more serious in their implications.

The third feedback construct is the perceived diagnosticity of feedback. This construct taps the individual's perception of the utility of feedback for improving future learning and performance on the task. A 4-item diagnosticity scale provides for the global assessment of utility. Furthermore, to obtain measures of diagnosticity for specific feedback on labeling, engaging, and prioritizing, three pairs of items are used. Each pair asks about diagnosticity specifically relating to a single dimension of performance. All feedback constructs are measured 3 times throughout the experiment.

Mediating Constructs. The following scales are all measured using 5-point Likert scales with "Strongly Agree" to "Strongly Disagree" anchors. These scales are answered twice during the course of the experiment.

Self-efficacy is measured using a 5-item shortened version of the questionnaire employed by Kozlowski et al. (1995; 1996). These items were developed for a similar experimental task using the same simulation and has demonstrated sufficient reliability. Motivation to learn is measured using a 5-item, modified version of the scale used by Noe and Schmitt (1986) and Quiñones (1995). Noe and Schmitt used a longer scale composite and found alpha reliabilities of .98 for pre-training motivation and .95 for post-training motivation. Quiñones (1995) used a 10-item scale more similar to the one employed in this study and reported an alpha of .93.

Attentional focus is measured in two ways. First, a shortened version of the scale developed by Fisher (1995) is used to assess how much attention was spent on-task. The scale has demonstrated sufficient reliability and validity in predicting learning outcomes. Six items are used with a few wording changes to reflect differences in experimental tasks. Second, a time measure is calculated based on time spent studying content pages in the manual. The sum of time spent reading pages that contain information relevant to simulation performance is used for this measure. Of nineteen total pages in the manual, 3 pages provide procedural information about the 3 performance components of the task. For each dimension, two more pages provide specific information about the rules which govern the task. Thus, a total of 9 pages provide the core information to successfully run the simulation. The other 9 pages provide either: (1) Information that is redundant with the introductory training, or (2) information that is irrelevant to task performance.

Individual Differences. Individual difference questions are located in Appendix D, reproduced in the form used in the experiment. To test for individual differences in learning and performance trait orientation, scales from Button, Mathieu, and Zajac (in press) are employed to measure learning and performance orientation. These measures are 5-point Likert scale statements divided into two 8-item scales. Both scales were employed in 3 different validation studies reported by Mathieu et al. (in press). Reported alpha reliabilities were .79, .85, .82 and .76, .77, .81 for learning and performance trait orientation, respectively. Boyle and Klimoski (1995) and Kozlowski et al. (1995; 1996) used the same scales and reported similar reliabilities.

To ascertain whether propensity for negative thoughts and anxiety have an effect of perceptions of feedback, negative affectivity (NA) is measured. The 10-item measure of negative affectivity from the PANAS scale, developed by Watson, Clark, and Tellegen (1988), is used. In order to tap the overall propensity to experience negative mood states, the items are worded to general or average feelings, the traditional way the scale is used to tap stable individual differences. Watson et al. (1988) reported alpha reliabilities of .87 for this scale and 8 week test-retest reliabilities of .71. Watson et al. (1988) note that this latter reliability suggests this scale is stable enough to be used to measure traits.

Cognitive ability is also assessed, as noted above, using the 12 minute Wonderlic Personnel Test. Test-retest reliability for this test has ranged from .82 to .94 and correlations of odd and even items range from .88 to .94 (Wonderlic Personnel Test and Scholastic Level Exam Users Manual, 1992). For the purpose of this experiment, the reliability of the test is assumed approximately equal to .88, the lower bound for typical internal consistency reliabilities. Two different forms were used during the experiment, and adjustments were made for form difficulty according to the User's Manual.

RESULTS

Reliability Analyses

Before testing the hypotheses, the quality of the self-report data was investigated. First, factor analyses were run on all self-report data collected at the same point in time. These analyses help determine whether trainees were able to effectively discriminate between different constructs measured at the same time. Method or response bias may result in a single factor representing the general response tendency. Recovering the latent structure provides some evidence against the response bias explanation for observed correlations between self-reported constructs. Further, this analysis can be used to assess the homogeneity of scales. Recognizing that the solutions obtained may vary depending on technique (e.g., Ford, MacCallum, & Tait, 1986), the following analyses were computed with both principal component and principal axis factor analytic techniques. As the solutions were nearly identical, all reports are for principal components solutions only. Varimax rotation is employed, as it can aid the psychological meaningfulness, reliability, and reproducibility of factor solutions (Ford et al., 1986).

Exploratory factor analyses of the individual differences data results in 9 factors using the Kaiser eigenvalue criterion. Eigenvalues for these factors were 6.7, 5.3, 3.3, 1.9, 1.8, 1.3, 1.2, 1.1, 1.0. However, the scree plot of these eigenvalues indicates a clear break occurs between the fifth and sixth factors. Tucker, Koopman, and Linn (1969) have noted that the scree criterion, while somewhat subjective, generally performs more effectively than the "eigenvalue over one" rule. The five factor solution from the scree test results in performance orientation, learning orientation, positive affectivity[2], and 2 negative affectivity factors. Given the extensive amount of research on negative affectivity and the limited number of hypotheses employing it in this study, it was determined that there was little conceptual clarity to be gained from dividing the scale into two subscales. Forcing a four factor solution results in a more parsimonious description of the data and a description that follows theoretical assertions regarding the structure of affect.

Table 2 presents the forced 4 factor solution for the individual differences data. Aside from one positive affectivity item loading on the learning orientation scale, the latent factor structure of the data was recovered. As a whole the positive affectivity and learning orientation scales had a number of items with moderate cross-loadings, implying that these latent constructs are correlated. Given the consistency of loadings both within and across scales, it is concluded that these scales are sufficiently homogeneous.

Table 3 presents the exploratory factor analysis solution for the two magnitude and one diagnosticity scale collected at the beginning of each block. Eigenvalues for the three factors were 4.5, 2.6, and 1.5 for block 1; 6.8, 1.6, 1.3 for block 2; 6.3, 1.7, 1.4 for block 3. Once again, the latent structure of the data was successfully recovered, aside from one attributional magnitude item which loaded evenly on the descriptive and attributional scales. However, this only occurred one of the three times data was collected. As a result, this item was maintained in future analyses.

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[2] The results for positive affectivity are not explored in the thesis, but the factor analysis results are presented with this scale because the data was collected at the same point in time.

Table 2. Factor solution for individual differences scales.

	Factor 1	Factor 2	Factor 3	Factor 4
NA2	.76080	-.08952	-.06355	.15546
NA6	.74714	.19920	-.21515	.06205
NA9	.70786	.09099	-.24891	.08213
NA5	.68560	.16480	-.22537	.01475
NA7	.67129	-.05439	.11801	.05560
NA8	.65241	-.01304	.09547	.06551
NA4	.63536	-.24334	.16165	.11927
NA3	.62938	-.06160	.10752	.01828
NA10	.62895	.06759	-.06436	-.06980
NA1	.58894	.08593	-.08215	.18378
L5	-.05469	.68460	.23645	.03111
L8	-.10963	.67725	.25379	-.03454
L6	.12242	.65533	.25978	.11631
L4	.06038	.63434	.27421	-.17382
L3	.08353	.61828	.33826	.06711
L1	-.02594	.61823	.09052	-.05930
L7	.00763	.60934	.09114	.09897
L2	.09223	.51474	.13125	-.04172
PA2	-.02202	.48559	.38183	-.00794
PA3	.00613	.42509	.67530	.02402
PA5	-.04293	.29475	.67297	-.06504
PA8	-.27297	.00901	.66083	.00148
PA9	-.09986	.06302	.64774	.05195
PA1	.03792	.22154	.63346	-.05031
PA7	-.09365	.25461	.61275	-.07211
PA10	-.03289	.37452	.59100	-.05506
PA4	.16356	.20573	.57057	.00966
PA6	.00661	.22006	.45781	.02351
P7	.09570	-.16687	.01117	.79610
P4	.08260	-.17198	.00004	.77130
P5	.11461	.15027	-.01211	.67156
P3	.03415	.22026	-.09437	.66262
P1	-.00579	-.22681	.14526	.64280
P8	.09219	-.03612	-.12300	.63207
P2	-.02659	.03691	.08761	.59294
P6	.25716	.17063	-.11929	.58718

Note. L = learning orientation, P = performance orientation, NA = negative affectivity, and PA = positive affectivity. Numbers represent item numbers. Solution obtained forcing 4 factors with a principal components analysis with Varimax rotation.

Table 3. Factor solution for feedback constructs.

TIME 1	Factor 1	Factor 2	Factor 3
AMAG4	.88085	.08210	-.23711
AMAG2	.86840	.08173	-.21420
AMAG3	.84971	.09510	-.22527
AMAG1	.69547	.27519	-.05995
DMAG2	.12985	.90841	-.04072
DMAG1	.16053	.89680	-.00694
DMAG3	.11567	.76553	-.12441
DMAG4	.04127	.70708	.05309
DIAG3	-.07177	-.05081	.90525
DIAG2	-.27748	.04302	.82501
DIAG4	-.10676	-.15294	.78964
DIAG1	-.39948	.08771	.69182

TIME 2	Factor 1	Factor 2	Factor 3
DMAG2	.86994	-.12119	.28405
DMAG1	.86676	-.21922	.22178
DMAG4	.81461	-.22092	.33258
DMAG3	.79008	-.37564	.09782
AMAG1	.58361	-.34406	.56080
DIAG3	-.19507	.85751	-.09342
DIAG2	-.21410	.84549	-.19610
DIAG1	-.17000	.83507	-.21702
DIAG4	-.33113	.69504	-.31843
AMAG4	.19880	-.18992	.90390
AMAG3	.28133	-.18205	.88779
AMAG2	.23948	-.22633	.80700

TIME 3	Factor 1	Factor 2	Factor 3
AMAG4	.90785	.18623	-.14502
AMAG3	.90014	.28204	-.15936
AMAG2	.88011	.24501	-.22383
AMAG1	.77746	.33039	-.28693
DMAG2	.26954	.87907	-.12604
DMAG1	.39113	.82854	-.14929
DMAG3	.01711	.76183	-.32816
DMAG4	.40073	.73650	-.11210
DIAG2	-.01515	-.20157	.83089
DIAG3	-.13724	-.19969	.81745
DIAG1	-.30587	-.15893	.79734
DIAG4	-.41112	-.05518	.64251

Note. AMAG = attributional magnitude, DMAG = descriptive magnitude, and DIAG = diagnosticity. Numbers represent item numbers. Solution obtained with an exploratory principal components factor analysis using the Kaiser criterion for extraction.

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Note. AMAG = attributional magnitude, DMAG = descriptive magnitude, and DIAG = diagnosticity. Numbers represent item numbers. Solution obtained with an exploratory principal components factor analysis using the Kaiser criterion for extraction.

The diagnosticity couplets targeted towards specific performance dimensions were run through a separate series of factor analyses. For data collected at both block 1 and 3, only 1 factor (eigenvalues of 4.0 and 4.3, respectively) was recovered using the Kaiser criterion. At time 2, two factors were recovered (eigenvalues of 3.5 and 1.1). As the perceptions of diagnosticity were expected to change over time, the factor structures and intercorrelations of the latent constructs represented in these items may change over time. The third block data is used to check item quality, as trainees have the most knowledge about the simulation and the feedback at this point. Even though only one factor was extracted in the exploratory analyses, a forced three factor solution was tested to ascertain whether the latent structure could be recovered. Table 4 indicates that the latent structure of this data was well-recovered except for one item. The second item of the labeling scale has a larger loading on the engaging scale than on the labeling scale. To maintain homogeneity of the labeling and engaging scales, this item was removed from further analysis. Moderate cross-loadings suggest that the latent constructs are correlated; this accounts for the difficulty in recovering the three factor solution in exploratory analyses.

Table 5 presents exploratory factor analysis results for the mediating constructs of motivation to learn, attentional focus, and self-efficacy. Eigenvalues for these factors were 8.1, 2.3, and 1.1 at the end of block 1, and 7.7, 3.0, and 1.1 at the end of block 2. These analyses support the proposed latent structure. At each time, a self-efficacy item cross-loaded with the motivation to learn factor, but the pattern of loadings between these factors suggests the cross-loading reflects a moderate latent correlation between scales. All other items loaded on the correct factors. Thus, no items were discarded.

Table 4. Factor solution for diagnosticity item couplets.

TIME 1	Factor 1	Factor 2	Factor 3
DIPRI1	.89589	.03086	.24490
DIENG2	.80893	.38484	.15598
DIPRI2	.79833	.32932	.25805
DIENG1	.66059	.59773	.10657
DILAB2	.19729	.84149	.39099
DILAB1	.27565	.30813	.89436
TIME 2	**Factor 1**	**Factor 2**	**Factor 3**
DIENG1	.83568	.30218	.22322
DIENG2	.82228	.28593	.24040
DILAB2	.78758	.17540	.43252
DIPRI1	.14508	.93722	.15063
DIPRI2	.42788	.82122	-.01177
DILAB1	.36957	.07979	.91480
TIME 3	**Factor 1**	**Factor 2**	**Factor 3**
DIENG2	.86752	.27889	.23501
DILAB2	.83776	.29563	.29419
DIENG1	.80205	.30515	.36866
DIPRI1	.21373	.92776	.17853
DIPRI2	.38240	.85908	.17719
DILAB1	.46351	.25081	.84682

Note. DILAB = diagnosticity for labeling, DIENG = diagnosticity for engaging, and DIPRI = diagnosticity for prioritizing. Numbers represent item numbers. Solutions obtained forcing 3 factors with a principal components analysis and Varimax rotation.

Exploratory factor analysis of the task attitudes of satisfaction and withdrawal result in one factor with eigenvalue of 5.5 using the Kaiser criterion. A forced two-factor solution, reported in Table 6, further supports the earlier assertion that these two constructs are highly related. Both the task satisfaction and withdrawal scales split, with items loading on two factors which do not represent one factor or the other. These two factors appear to be correlated, as indicated by the moderate cross-loadings of most items.

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Table 5. Factor solution for mediating constructs.

TIME 1	Factor 1	Factor 2	Factor 3
MOTLN5	.83024	-.15222	.13088
MOTLN1	.77913	-.32611	.24277
MOTLN4	.76823	-.29392	.32029
MOTLN2	.74385	-.20525	.17587
MOTLN3	.66752	-.29934	.26571
SELFEF3	.57280	-.12467	.50063
ATTNTN5	-.13121	.89612	-.01194
ATTNTN1	-.09175	.80168	-.06938
ATTNTN4	-.34394	.75326	.12643
ATTNTN2	-.31962	.74736	-.21178
ATTNTN3	-.43464	.70084	-.04496
ATTNTN6	-.05993	.58738	-.34933
SELFEF4	.00204	-.02445	.76734
SELFEF5	.45546	.04202	.67078
SELFEF1	.36844	-.15537	.66622
SELFEF2	.34710	-.13685	.60681

TIME 3	Factor 1	Factor 2	Factor 3
ATTNTN1	.92785	-.13099	-.02133
ATTNTN3	.89716	-.21206	-.07578
ATTNTN5	.88187	-.26418	-.02435
ATTNTN4	.85073	-.23969	-.10017
ATTNTN2	.80116	-.05628	-.12063
ATTNTN6	.74177	-.28005	-.09531
MOTLN2	-.16901	.83923	.17588
MOTLN1	-.30030	.77803	.24387
MOTLN5	-.34164	.77025	.27998
MOTLN4	-.32443	.76380	.29769
MOTLN3	-.46449	.67168	.25772
SELFEF4	.18324	.51038	.49922
SELFEF3	-.01083	.38489	.79535
SELFEF1	-.16780	.24954	.79249
SELFEF5	-.12968	.40006	.73914
SELFEF2	-.09813	.02304	.73058

Note. ATTNTN = attentional focus, MOTLN = motivation to learn, and SELFEF = self-efficacy. Numbers represent item numbers. Solution obtained with an exploratory principal components factor analysis using the Kaiser criterion.

Based on these findings, one scale is created, with all items reflected to represent task satisfaction.

The second way in which the quality of the self-report data was investigated was by generating internal consistency reliabilities. Having established scale homogeneity, Cronbach's alpha provides a meaningful estimate of internal consistency reliability. Reliabilities are reported in the diagonal of Table 7, along with means and standard deviations of the variables used in the majority of analyses. Reliability for self-report scales was generally quite good, ranging from .92 to .77.

Cronbach's alpha is not a meaningful indicator of internal consistency reliability for the multi-dimensional task knowledge test. The items in this test were designed to systematically assess knowledge of different task rules. As a result, split-half reliability based on odd and even items offers a more reasonable indicator of internal consistency. Because of the organization of test items, this process results in two subtests with parallel content. The correlation between odd and even test scores is .68. Corrected to the full-length of the test using the Spearman-Brown prophecy formula, the reliability of this test is .81. Item difficulties of test items range from .92 to .15 (M = .56, SD = .27), indicating the test items generally provide good discrimination.

Manipulation checks

The first manipulation check was for the effectiveness of the sequencing manipulation. As noted earlier, a two-item scale was employed to assess whether trainees recognized that their training was designed to focus attention on certain aspects of the task. The correlation between these items was .40, resulting in an alpha of .57. Trainees

Table 6. Factor solution for attitude training outcomes.

	Factor 1	Factor 2
TSAT3	-.83308	-.28291
WTHD6	.78038	.05750
TSAT2	-.74885	-.26979
WTHD3	.68278	.41613
WTHD2	.65951	.45445
WTHD5	.64704	.43521
WTHD4	.62619	.57773
TSAT1	-.14565	-.77702
WTHD1	.21117	.74754
TSAT4	-.40530	-.61486

Note. TSAT = task satisfaction and WTHD = task withdrawal. Numbers represent item numbers. Solution obtained forcing 2 factors with a principal components analysis and Varimax rotation.

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in the sequenced group (M = 4.10, SD = .72) reported their training was significantly more focused than trainees in the unsequenced group (M = 3.70, SD = .74), $t(108) = 2.93$, $p < .01$, $d = .54$. No significant difference between goal framing groups was found on this manipulation check, $t(108) = .95$, n.s., $d = .17$.

To further verify that the sequencing training strategy was effective, the relative time trainees spent reviewing various pages of the manual was investigated. In the first block, sequenced trainees were told to focus on labeling. Trainees in the sequenced group (M = 131.50, SD = 82.01) spent significantly greater time in the first block studying material relevant to labeling than trainees in the unsequenced condition (M =

Table 7. Descriptive statistics and intercorrelations of study variables.

Variable	Mean	Sd	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Goal	.50	.50	--													
2.Seqn	.49	.50	.00	--												
3.GoalxSeq	.25	.43	.57	.58	--											
4.CogAb	23.71	5.73	-.08	-.08	-.14	(.88)										
5.NegAff	1.94	.61	.01	-.04	.01	-.12	(.87)									
6.LrnOrn	4.04	.46	-.02	.03	-.03	.08	.02	(.82)								
7.PrfOrn	3.79	.55	-.15	-.04	-.12	-12	.21	-.01	(.82)							
8.Dmag1	4.16	.88	-.14	-.25	-.19	.06	.08	-.04	.18	(.85)						
9.Dmag2	3.37	1.03	-.12	-.10	-.14	-.31	.12	-.09	.07	.05	(.92)					
10.Dmag3	3.40	.93	-.02	-.14	-.09	-.26	.15	-.10	.13	.02	.46	(.89)				
11.Amag1	2.44	.94	-.12	-.10	-.07	-.24	.11	-.29	.29	.29	.34	.32	(.87)			
12.Amag2	2.42	.95	-.01	-.13	-.08	-.40	.15	-.27	.22	.08	.63	.52	.69	(.91)		
13.Amag3	2.47	1.08	-.02	-.12	-.08	-.34	.20	-.23	.30	.07	.50	.61	.63	.85	(.89)	
14.Diag1	2.85	1.00	-.06	.03	-.00	.16	.10	.26	-.14	-.09	-.20	-.16	-.45	-.29	-.22	(.86)
15.Diag2	3.20	1.01	.08	.10	.13	.23	.02	.23	-.14	-.02	-.55	-.38	-.33	-.55	-.47	.43
16.Diag3	3.03	.94	.07	.03	.07	.19	.01	.13	-.14	-.02	-.46	-.46	-.26	-.51	-.50	.36
17.Attn-sr1	3.25	.74	.09	.04	.13	.28	-.10	.16	-.15	.16	-.26	-.39	-.18	-.41	-.44	.03
18.Attn-sr2	2.84	.96	.16	.17	.25	-.06	-.07	.22	-.04	.01	.01	-.10	-.21	-.31	-.28	.02
19.Attn-tm1	240.25	96.31	-.34	.03	-.20	.44	-.04	-.01	-.04	.05	-.27	-.20	-.09	-.32	-.32	.12
20.Attn-tm2	292.36	75.73	-.06	.31	.16	.02	-.25	.10	-.13	-.07	-.07	-.14	-.10	-.23	-.26	-.01
21.Attn-tm3	265.35	98.81	.11	.27	.31	-.19	-.02	.16	-.08	-.22	.02	-.01	-.11	-.14	-.16	-.00
22.MotLn1	3.51	.87	.08	.05	.16	.21	.09	-.12	-.12	.09	-.37	-.31	-.44	-.61	-.52	.32
23.MotLn2	3.24	1.00	.06	.10	.17	.17	.10	.38	-.12	.04	-.25	-.31	-.36	-.54	-.50	.25
24.SelfEf1	3.29	.73	.01	.15	.13	.29	.02	.37	-.06	-.01	-.51	-.46	-.48	-.67	-.58	.46
25.SelfEf2	3.31	.78	.02	.11	.08	.26	-.04	.34	-.18	.04	-.46	-.50	-.48	-.63	-.62	.33
26.TaskSat	2.87	.76	-.07	.06	-.06	.27	.03	.30	-.13	.06	-.33	-.35	-.47	-.63	-.61	.27
27.Knowtst	11.75	3.72	-.07	-.04	-.04	.60	-.14	.01	-.34	.02	-.37	-.27	-.34	-.52	-.50	.13
28.Score1	-627.27	125.37	.08	.11	.13	.24	-.02	.04	-.14	-.31	-.16	-.05	-.14	-.14	-.09	.24
29.Score4	-303.63	356.31	-.04	.09	.02	.49	-.01	.03	-.04	.14	-.69	-.28	-.23	-.47	-.39	.24
30.Score7	-274.09	321.46	-.02	.03	. 02	.44	-.10	-.08	-.14	.10	-.46	-.56	-.23	-.47	-.46	.20
31.Score10	-363.00	355.85	-.06	-.04	-.08	.43	-.14	-.06	-.10	.09	-.39	-.41	-.18	-.39	-.36	.16

Note. Correlations .19 or greater are significant at $p < .05$.

Table 7 (cont'd).

Variable	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
15.Diag2	(.89)																
16.Diag3	.77	(.84)															
17.Attn-sr1	.38	.45	(.88)														
18.Attn-sr2	.32	.30	.64	(.94)													
19.Attn-tm1	.30	.30	.24	-.07	--												
20.Attn-tm2	.24	.30	.19	.28	.27	--											
21Attn-tm3	.18	.14	.23	.45	.01	.54	--										
22.MotLn1	.56	.48	.55	.51	.21	.16	.27	(.90)									
23.MotLn2	.52	.51	.54	.55	.20	.21	.25	.88	(.92)								
24.SelfEf1	.72	.68	.34	.29	.29	.26	.18	.66	.58	(.82)							
25.SelfEf2	.60	.57	.34	.22	.14	.16	.01	.62	.62	.76	(.84)						
26.TaskSat	.50	.50	.42	.41	.33	.16	.15	.77	.76	.65	.70	(.91)					
27.Knowtest	.33	.33	.39	.13	.47	.23	.07	.35	.31	.41	.41	.41	(.81)				
28.Score1	.13	.14	-.01	-.11	.07	-.19	-.23	.00	.01	.12	.11	.03	.13	--			
29.Score4	.47	.40	.35	-.00	.59	.03	-.19	.40	.32	.44	.42	.43	.56	.28	--		
30.Score7	.38	.47	.37	.05	.53	.09	-.15	.34	.29	.45	.48	.45	.56	.17	.70	--	
31.Score10	.26	.31	.18	-.08	.41	.15	-.20	.15	.15	.35	.41	.32	.45	.12	.54	.73	--

92.62, SD = 55.93), $t(93) = 2.89$[3], $p < .01$. Following the sequence directions, trainees in the sequence condition (M = 184.74, SD = 95.05) spent more time in the second block reviewing engage information than trainees in the unsequenced condition (M = 75.61, SD = 48.75), $t(78) = 7.54$[4], $p < .01$. Finally, following sequencing instructions in the third block, trainees in sequence condition (M = 245.78, SD = 108.89) reviewed prioritization information to a greater extent than trainees in the unsequenced condition (M = 120.79, SD = 92.74), $t(108) = 6.49$, $p < .01$.

The second manipulation check was for the effectiveness of the mastery and performance manipulations. Five items were used to assess each state goal orientation. Cronbach's alpha for mastery and performance state orientation scales were .61 and .78, respectively. An independent groups t-test indicates that trainees in mastery-framed training (M = 3.56, SD = .49) did not report higher levels of mastery state orientation than trainees in the performance-framed training (M = 3.59 , SD = .47), $t(108) = -.36$, n.s., $d = -.07$. No significant difference in mastery state emerged between the sequenced and unsequenced conditions, $t(108) = .69$, n.s., $d = .12$.

The performance manipulation did create a significant difference in performance state orientation for performance trainees (M = 3.64, SD = .61) compared to the mastery trainees (M = 3.28, SD = .70), $t(108) = 2.95$, $p < .01$, $d = .54$). No significant differences in performance state emerged between the sequenced and unsequenced conditions, $t(108)$

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[3] The homogeneity of variance assumption was violated for this test, as indicated by a significant Levene's F-test. While t-tests performed on samples with different variances can be misleading, this effect is minor when samples are large and of equivalent size (Hays, 1988, p. 304). None-the-less, to provide a conservative test, the t value reported here is based on degrees of freedom adjusted for the use of two variance estimates in calculating t,as opposed to the pooled estimate that is ordinarily employed.

[4] As above, the reported t value is based on corrected degrees of freedom.

= -.16, n.s., d = .03. These results suggest that the performance manipulation was successful in eliciting a performance-oriented state, but the mastery manipulation was not successful in eliciting a mastery-oriented state.

Although the current study utilized random assignment of subjects, it is possible that differences in dispositional goal orientation are the underlying cause for the manipulation effects reported above. Research has indicated that dispositional and state orientation are related (Boyle & Klimoski, 1995). In this study, the zero-order correlation between performance orientation and performance state was .40 ($p < .05$), between learning orientation and mastery state was .46 ($p < .05$). To investigate the possibility that randomization was not effective, independent group t-tests were run on goal framing groups for both learning, $t(108) = .23$, n.s., d = .04, and performance orientation, $t(108) =$ 1.55, n.s., d = .29. Neither of these analyses indicated significant differences in goal orientation by condition.

As a final step in preparing the data for analysis, the relationship between the two attentional focus measures was investigated. While the correlation between self-report measures for block 1 and block 3 was .64 ($p < .01$), the correlation between self-report measures and time-based measures was generally much lower. The most relevant relationships are those between measures that correspond to similar time periods. The correlation between block 1 self-report and block 1 study time was .24 ($p < .01$). The correlation between block 3 self-report and block 3 study time was .45 ($p < .01$). Because these correlations do not suggest these measures are tapping the same construct, both measures are tested. Thus, analyses with attentional focus will be tested twice, once with the self-report measure and once with the time-based measure.

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Training Strategy Effects

Hypothesis 1 suggests both descriptive and attributional measures of negative feedback are lower in the mastery goal condition than in the performance goal condition. Similarly, hypothesis 3a suggests that sequencing and goal framing should interact in determining magnitude judgments, controlling for actual performance. To control for performance, the scores obtained at the first trial in each block are entered as a varying covariate. This procedure tests how training strategies affect perceptions of negative feedback independent of their effect on actual performance.

Table 8 presents the RM-ANOVA for the manipulation effects on descriptive magnitude of negative feedback. The results show significant between and within subjects covariate effects, indicating that, as expected, score values had an effect on the magnitude judgments. The goal effect was marginal, $F(1,105) = 3.15$, $MS_E = .82$, $p < .10$, $\eta^2 = .03$), providing some support for hypothesis 1. Trainees in the mastery framed training tended to perceive their feedback as less negative regardless of the actual score values. This effect is depicted in Figure 5. The graph indicates that while mastery training lowered perceptions of descriptive magnitude for blocks 1 and 2, this effect disappeared for block 3.

While the sequencing main effect noted in Table 8 was significant, the interaction between goal and sequencing was not. These results do not support the interaction hypothesis presented in 3a. The main effect for sequencing on descriptive magnitude was

Table 8. Repeated measures analysis of variance (RM-ANOVA) of training strategy on descriptive magnitude of negative feedback.

Effect	df	F	η^2
Between Subjects			
Covariates[a]	1	36.83*	.26
Sequencing	1	5.72*	.05
Goal	1	3.15†	.03
Seq. by Goal	1	.10	.00
Within-group Error	105	(.82)	
Within Subjects			
Covariates[a]	1	143.63*	.40
Block	2	.77	.01
Seq. by Block	2	1.57	.02
Goal by Block	2	.93	.01
Seq. by Goal by Block	2	.69	.01
Within-Group Error	211	(.45)	

[a]Covariates include performance scores for trials 1, 4, and 7.

* $p < .05$
† $p < .10$

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somewhat unexpected, but it does provide general support for the secondary effects (i.e., sequencing to magnitude; goal frame to diagnosticity perceptions) that provide the foundation for hypothesis 3a. This effect is depicted in Figure 6. As the graph indicates, compared to trainees in the unsequenced condition, trainees in the sequenced condition reported lower descriptive magnitudes of negative feedback throughout the experiment.

Table 9 presents the RM-ANOVA results for the attributional magnitude of negative feedback. While this analysis indicates significant effects for score covariates

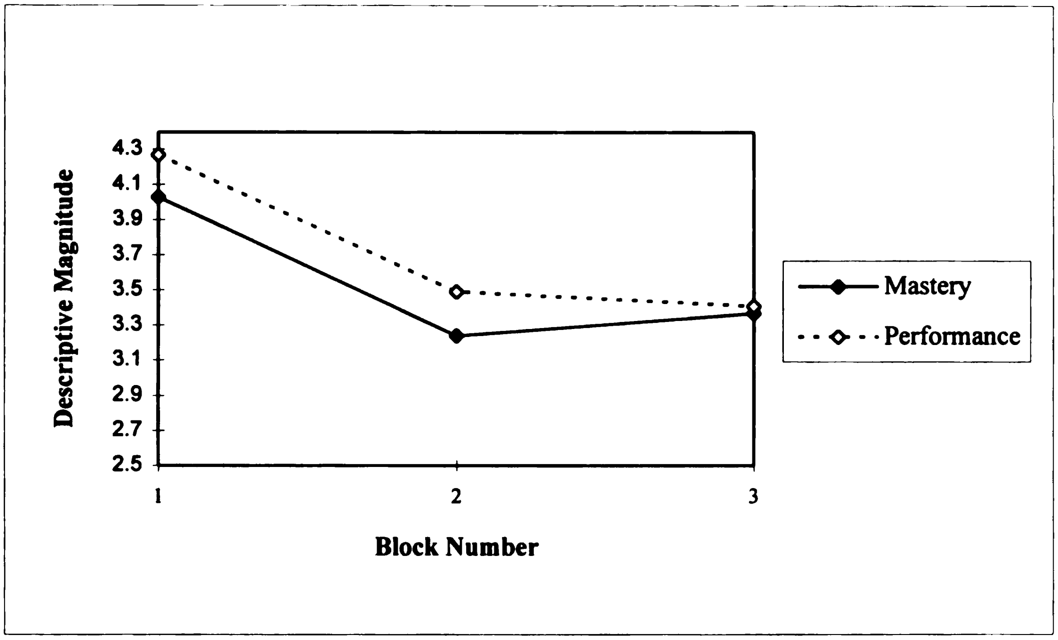

Figure 5. Descriptive magnitude of negative feedback by goal condition.

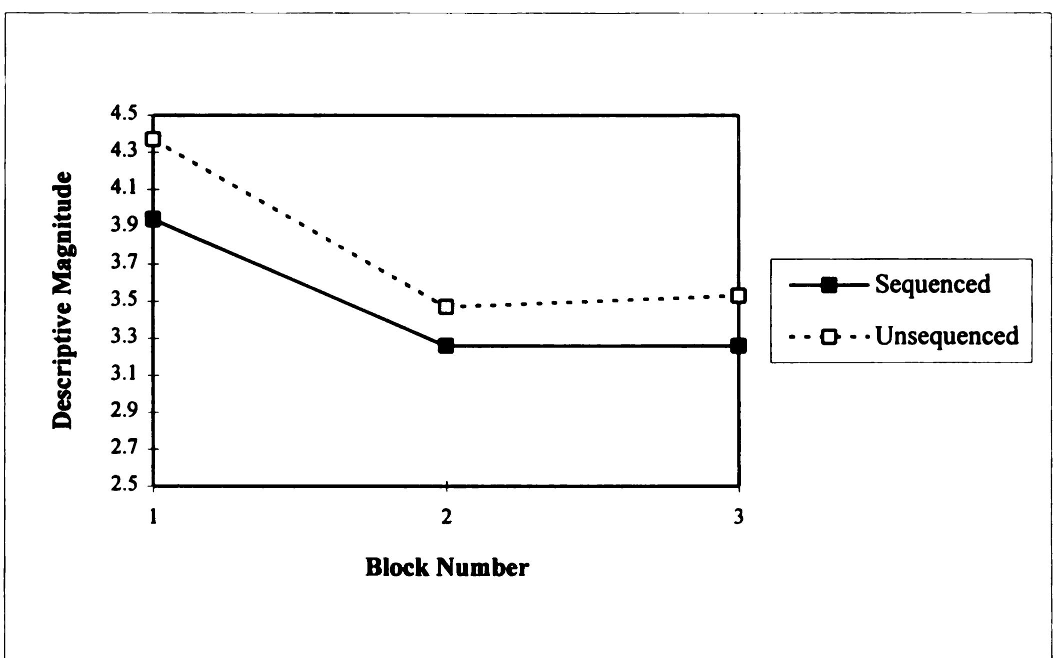

Figure 6. Descriptive magnitude of negative feedback by sequencing condition.

Table 9. Repeated measures analysis of variance (RM-ANOVA) of training strategy on attributional magnitude of negative feedback.

Effect	df	F	η^2
Between Subjects			
Covariates[a]	1	25.94*	.20
Sequencing	1	1.07	.01
Goal	1	.48	.00
Seq. by Goal	1	.42	.00
Within-group Error	105	(1.96)	
Within Subjects			
Covariates[a]	1	21.33*	.09
Block	2	5.46*	.05
Seq. by Block	2	.11	.00
Goal by Block	2	.98	.01
Seq by Goal by Block	2	1.12	.01
Within-Group Error	211	(.25)	

[a]Covariates include performance scores for trials 1, 4, and 7.

* $p < .05$

and block, the effect for goal framing is not significant, $F(1,105) = .48$, $MS_E = 1.96$, n.s., $\eta^2 = .00$). Similarly, the sequencing main and interaction effects are not significant. Thus, for attributional magnitude of perceptions, neither hypothesis 1 nor 3a were supported.

Hypothesis 2a suggests that the diagnosticity judgments should be enhanced by the sequencing manipulation. Hypothesis 3b predicts that goal frame and sequencing interact to affect diagnosticity judgments. Table 10 presents the RM-ANOVA results for diagnosticity of feedback. This table indicates that, while covariates had a significant

Table 10. Repeated measures analysis of variance (RM-ANOVA) of training strategy on diagnosticity of feedback.

Effect	df	F	η^2
Between Subjects			
Covariates[a]	1	31.51*	.23
Sequencing	1	.07	.00
Goal	1	.29	.00
Seq. by Goal	1	.13	.00
Within-group Error	105	(1.56)	
Within Subjects			
Covariates[a]	1	16.32*	.07
Block	2	2.51†	.02
Seq. by Block	2	.23	.00
Goal by Block	2	1.94	.01
Seq. by Goal by Block	2	.13	.00
Within-Group Error	211	(.44)	

[a]Covariates include performance scores for trials 1, 4, and 7.

* $p < .05$
† $p < .10$

effect, none of the manipulations or interactions had a significant effect on these judgments. Thus, no support was obtained for hypothesis 2a or 3b.

Hypothesis 2b suggests that over time diagnosticity judgments should increase. The block effect obtained in the within-subjects analysis provides marginal support for this hypothesis, $F(2,211) = 2.51$, $MS_E = .44$, $p < .10$, $\eta^2 = .03$). The trend for diagnosticity indicates that diagnosticity judgments rose from the first to the second block, but fell again in the third ($M = 2.85$, $SD = 1.00$ for block 1; $M = 3.20$, $SD = 1.01$ for block 2; $M =$

3.03, SD = .94). This trend may reflect the difficulty of the more complex aspects of the task which become the focus in later trials.

Hypothesis 2c suggests that trainees in the sequenced condition perceive greater diagnosticity of feedback for material that is currently the focus of sequencing than for material that has yet to be focused. This hypothesis suggests that diagnosticity for labeling, which is the focus of the first block in the sequence condition, should be greater than diagnosticity for both engaging and prioritizing in block 1. In block 2, this hypothesis suggests that engaging diagnosticity should be greater than prioritization diagnosticity. Paired sample t-tests run on only the trainees in the sequenced condition indicate that the diagnosticity for labeling ($M = 3.13$, $SD = 1.03$) is greater than both the diagnosticity for engaging ($M = 2.70$, $SD = .98$), $t(53) = 3.14$, $p < .01$, $r = .51$, and the diagnosticity for prioritizing ($M = 2.74$, $SD = .90$), $t(53) = 2.80$, $p < .01$, $r = .45$ for the first trial block. For the second block, the diagnosticity for engaging ($M = 3.38$, $SD = 1.04$) is greater than the diagnosticity for prioritizing ($M = 2.60$, $SD = .96$), $t(53) = 5.62$, $p < .01$, $r = .48$. These analyses support hypothesis 2c. However, post-hoc analyses indicate that some of these diagnosticity trends are also obtained for trainees in the unsequenced condition.

For trainees in the unsequenced condition, diagnosticity of labeling ($M = 2.73$, $SD = 1.15$) is not significantly different than diagnosticity of engaging in the first block ($M = 2.54$, $SD = 1.04$), $t(55) = 1.47$, n.s., $r = .56$. Diagnosticity of labeling is, however, greater than diagnosticity of prioritizing feedback ($M = 2.37$, $SD = .98$), $t(55) = 2.70$, $p < .01$, $r = .54$ in the first block. Further, engaging diagnosticity ($M = 2.92$, $SD = 1.09$) is greater than diagnosticity of prioritizing feedback ($M = 2.46$, $SD = .90$) in the second block, $t(55$

$= 4.24$, $p < .01$, $r = .58$. Therefore, prioritization diagnosticity seems to have the lowest diagnosticity for all trainees, regardless of sequencing condition. This effect likely results from the difficulty of that task component. And, because sequencing involves only one ordering, the manipulation effect cannot be disentagled from effects of task component difficulty. The sequencing manipulation was designed to start with the most simple task component and move towards the more complex. Thus, while hypothesis 2c is supported, this effect may reflect in part the nature of the task and the design of the sequence manipulation.

Hypothesis 2d requires a direct comparison of sequenced and unsequenced trainees. This hypothesis predicts that for a particular block, trainees in the sequenced condition should judge feedback relevant to the sequenced topic more diagnostic than trainees who are not in the sequenced condition. Thus, to test this hypothesis, diagnosticity should be compared between sequenced and unsequenced groups for labeling in block 1, engaging at block 2, and prioritizing at block 3. These comparisons follow the focus of sequencing. Although this analysis procedure conducts 3 separate tests where one omnibus test could be used, these tests should be considered "protected" from type I error inflation because they directly reflect the *a priori* hypothesis.

For the first block, trainees in the sequenced condition ($M = 3.13$, $SD = 1.03$) reported labeling diagnosticity that was marginally higher than trainees in the unsequenced condition ($M = 2.73$, $SD = 1.15$), $t(108) = 1.91$, $p < .10$, $d = .36$. For the second block, trainees in the sequenced condition ($M = 3.38$, $SD = 1.04$) reported significantly higher diagnosticity for engaging feedback than trainees in the unsequenced condition ($M = 2.92$, $SD = 1.09$), $t(108) = 2.26$, $p < .05$, $d = .46$. For the third block, trainees in the sequenced condition (M = 2.72, SD = 1.08) and the unsequenced condition (M = 2.44, SD = 1.07) reported similar levels of prioritization diagnosticity, t(108) = 1.38, n.s., d = .26. These analyses provide partial support for hypothesis 2d. More specifically, it appears that while the sequencing training strategy enhanced diagnosticity for labeling and engaging, the diagnosticity of prioritization was unaffected. This finding may again reflect the difficulty of the prioritization activity and resulting ambiguity of feedback for that dimension of performance. Again, however, because the sequencing involves only one ordering, the sequencing effect cannot be disentagled from effects of task component difficulty.

Individual Difference Effects

In order to provide a complete test of individual differences effects, learning orientation, performance orientation, negative affectivity, and cognitive ability are entered simultaneously into a regression predicting the dependent variables suggested by each hypothesis. As these variables are relatively uncorrelated, simultaneous entry should not alter the derived beta-weights estimates and, consequently, the conclusions drawn. For this analysis, individual difference variables were assessed using a hierarchical regression strategy, controlling for manipulation effects and actual performance on the trial just prior to the collection of the relevant dependent variable. Actual differences in performance may result from these factors, but performance differences are controlled in order to test how different individuals react to similar performance levels.

First, hypothesis 4a suggests that cognitive ability raises diagnosticity judgments. Table 11 displays the regression results relevant to this hypothesis. The only significant predictors of this dependent variable are actual score and learning orientation. The effect for learning orientation was not hypothesized, but it reflects a trend for individuals high in learning orientation to view their feedback as more diagnostic.

As diagnosticity data was collected at three points in time, change analyses were conducted to determine if individual differences affected the change in diagnosticity over time. These tests were conducted by controlling for previous diagnosticity judgments in a hierarchical regression. Table 12 indicates that initial diagnosticity judgment and score are significant predictors of diagnosticity judgment made at the beginning of the second block. Learning orientation had a marginal effect on this change, with individuals high in learning orientation exhibiting more positive change in diagnosticity. Table 13 displays this analysis for the change from block 2 to block 3. As the table depicts, early diagnosticity judgments and performance level predict the change in diagnosticity, but individual differences do not. More specifically, cognitive ability did not predict initial diagnosticity judgments or the change in diagnosticity judgments over time. These results do not support hypothesis 4a.

Cognitive ability was also hypothesized to influence final knowledge and skill outcomes, as stated in hypothesis 4b. Tables 14 and 15 contain the regression results for each of these dependent variables. In both tables, the effects of cognitive ability are

Table 11. Individual difference regression equation for initial diagnosticity of feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.00	2	-.-	--	
Goal					-.06
Seq.					.03
2: Strategy Interaction	.00	3	.00	1	
Goal x Seq.					.04
3: Performance	.06	4	.06*	1	
Score (T1)					.24*
4: Individual Differences	.16*	8	.10*	4	
Cognitive Ab.					.09
Learning Orn.					.24*
Perform. Orn.					-.14
Negative Aff.					.14

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

positive and significant, indicating that individuals with higher levels of cognitive ability learned more and performed better at the end of the experiment. These results support hypothesis 4b. Table 14 also indicates that performance orientation is a significant predictor of knowledge test scores. The sign of the beta-weight indicates that final knowledge was significantly lower for individuals with high performance orientations.

Table 11. Individual difference regression equation for initial diagnosticity of feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.00	2	-.-	--	
Goal					-.06
Seq.					.03
2: Strategy Interaction	.00	3	.00	1	
Goal x Seq.					.04
3: Performance	.06	4	.06*	1	
Score (T1)					.24*
4: Individual Differences	.16*	8	.10*	4	
Cognitive Ab.					.09
Learning Orn.					.24*
Perform. Orn.					-.14
Negative Aff.					.14

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

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Table 11. Individual difference regression equation for initial diagnosticity of feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.00	2	-.-	--	
Goal					-.06
Seq.					.03
2: Strategy Interaction	.00	3	.00	1	
Goal x Seq.					.04
3: Performance	.06	4	.06*	1	
Score (T1)					.24*
4: Individual Differences	.16*	8	.10*	4	
Cognitive Ab.					.09
Learning Orn.					.24*
Perform. Orn.					-.14
Negative Aff.					.14

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

positive and significant, indicating that individuals with higher levels of cognitive ability learned more and performed better at the end of the experiment. These results support hypothesis 4b. Table 14 also indicates that performance orientation is a significant predictor of knowledge test scores. The sign of the beta-weight indicates that final knowledge was significantly lower for individuals with high performance orientations.

Table 12. Individual difference regression equation for first change in diagnosticity of feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.02	2	-.-	--	
Goal					.08
Seq.					.10
2: Strategy Interaction	.02	3	.00	1	
Goal x Seq.					.08
3: Previous Perception	.21*	4	.19*	1	
Diagnosticity (B1)					.43*
4: Performance	.34*	5	.14*	1	
Score (T4)					.39*
5: Individual Differences	.37*	9	.02*	4	
Cognitive Ab.					-.01
Learning Orn.					.14†
Perform. Orn.					-.06
Negative Aff.					-.00

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$
† $p < .10$

As noted in the discussion of task characteristics, the final performance score is composed of a number of skill indicators including label actions, label errors, engage actions, engage errors, and prioritization errors. The regression results predicting these components of final score, not reported in tabular form here, suggest that no individual differences significantly predict label actions, label errors, and engage actions. Cognitive

Table 13. Individual difference regression equation for second change in diagnosticity of feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					.03
Seq.					.14
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.03
3: Previous Perception	.60*	4	.59*	1	
Diagnosticity (B2)					.77*
4: Performance	.63*	5	.04*	1	
Score (T7)					.21*
5: Individual Differences	.64*	9	.01	4	
Cognitive Ab.					-.08
Learning Orn.					.00
Perform. Orn.					-.02
Negative Aff.					.02

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

ability does, however, predict the number of engagement ($\beta = -.27$, $p < .01$) and prioritization errors ($\beta = -.46$, $p < .01$) in the final trial, controlling for training strategy manipulations and the other individual differences variables. The effects of cognitive ability on these two performance components suggests that the overall effect of cognitive ability on performance is a result of a reduction in engagement and prioritization errors.

Table 14. Individual difference regression equation for knowledge test.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					-.07
Seq.					-.04
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.07
3: Individual Differences	.45*	7	.44*	4	
Cognitive Ab.					.57*
Learning Orn.					-.05
Perform. Orn.					-.28*
Negative Aff.					-.01

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

As the rules for engaging and prioritizing are the most complex, this finding is not surprising.

Next, individual differences variables were tested for their influence on magnitude judgments. Hypothesis 4c suggests individuals higher in negative affectivity perceive higher levels of negative feedback. Tables 16 to 21 present the regression of attributional and descriptive magnitude on individual differences. These analyses indicate that the negative affectivity hypothesis was not supported either for initial magnitude estimates or for change in these estimates.

Table 15. Individual difference regression equation for final performance score.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.00	2	-.-	--	
Goal					-.06
Seq.					-.04
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					-.08
3: Individual Differences	.20*	7	.20*	4	
Cognitive Ab.					.42*
Learning Orn.					-.09
Perform. Orn.					-.04
Negative Aff.					-.08

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

Hypothesis 4d and 4e predict that learning and performance orientation traits influence magnitudes judgments. Table 16 indicates that initial attributional magnitude judgments support both of these hypotheses. The effect for cognitive ability, learning and performance orientation are all significant in predicting attributional magnitude. The effect for individuals with higher levels of cognitive ability to note lower levels of attributional magnitude was unexpected.

Table 16. Individual difference regression equation for initial attributional magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.02	2	-.-	--	
Goal					-.12
Seq.					-.10
2: Strategy Interaction	.03	3	.01	1	
Goal x Seq.					.16
3: Performance	.05	4	.02	1	
Score (T1)					-.13
4: Individual Differences	.23*	8	.18*	4	
Cognitive Ab.					-.18*
Learning Orn.					-.27*
Perform. Orn.					.23*
Negative Aff.					.04

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

Tables 17 and 18 present change analyses for attributional magnitude judgments. For the second judgment the only significant predictor was the judgment in the first block. In the third block both the previous judgment and performance orientation were positively associated with the attributional magnitude judgment. Thus, while attributional magnitude is initially determined by performance level, cognitive ability and goal orientation, this judgment remains relatively stable throughout the training. The only significant predictor of change was performance goal orientation.

Table 16. Individual difference regression equation for initial attributional magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.02	2	-.-	--	
Goal					-.12
Seq.					-.10
2: Strategy Interaction	.03	3	.01	1	
Goal x Seq.					.16
3: Performance	.05	4	.02	1	
Score (T1)					-.13
4: Individual Differences	.23*	8	.18*	4	
Cognitive Ab.					-.18*
Learning Orn.					-.27*
Perform. Orn.					.23*
Negative Aff.					.04

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

Tables 17 and 18 present change analyses for attributional magnitude judgments. For the second judgment the only significant predictor was the judgment in the first block. In the third block both the previous judgment and performance orientation were positively associated with the attributional magnitude judgment. Thus, while attributional magnitude is initially determined by performance level, cognitive ability and goal orientation, this judgment remains relatively stable throughout the training. The only significant predictor of change was performance goal orientation.

Table 17. Individual difference regression equation for first change in attributional magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.02	2	-.-	--	
Goal					-.02
Seq.					-.13
2: Strategy Interaction	.02	3	.00	1	
Goal x Seq.					.01
3: Previous Perception	.48*	4	.47*	1	
Att. Magnitude (B1)					.70*
4: Performance	.59*	5	.10*	1	
Score (T4)					-.33*
5: Individual Differences	.61*	9	.02	4	
Cognitive Ab.					-.11
Learning Orn.					-.08
Perform. Orn.					.02
Negative Aff.					.07

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

For descriptive magnitude judgments the only significant predictors were sequencing and score. Table 19 indicates that none of the individual differences affected initial descriptive judgments; Tables 20 and 21 indicate that these variables also did not influence changes in these judgments over time. Thus, the hypotheses regarding negative affectivity and goal orientation are not supported for descriptive judgments. In summary,

Table 18. Individual difference regression equation for second change in attributional magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					-.02
Seq.					-.12
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.00
3: Previous Perception	.73*	4	.71*	1	
Att. Magnitude (B2)					.85*
4: Performance	.73*	5	.01	1	
Score (T7)					-.09
5: Individual Differences	.75*	9	.02	4	
Cognitive Ab.					.04
Learning Orn.					-.03
Perform. Orn.					.10*
Negative Aff.					.06

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

goal orientation traits predict attributional descriptions of feedback magnitude, but not descriptive descriptions. These results provide partial support for hypotheses 4d and 4e.

Table 19. Individual difference regression equation for initial descriptive magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.08*	2	-.-	--	
Goal					-.14
Seq.					-.25*
2: Strategy Interaction	.08*	3	.00	1	
Goal x Seq.					.10
3: Performance	.16*	4	.08*	1	
Score (T1)					-.28*
4: Individual Differences	.19*	8	.03	4	
Cognitive Ab.					.14
Learning Orn.					-.03
Perform. Orn.					.12
Negative Aff.					.05

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

Process Model

In order to examine the learning process, a series of hierarchical regressions are conducted on the mediating variables of self-efficacy, motivation to learn, and attentional focus. Initial levels of these constructs are regressed on training strategy manipulations, individual differences, performance in the first trial, and the feedback perceptions. Feedback perceptions are entered separately on the last step in order to determine if these

Table 20. Individual difference regression equation for first change in descriptive magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.03	2	-.-	--	
Goal					-.10
Seq.					-.12
2: Strategy Interaction	.03	3	.00	1	
Goal x Seq.					-.04
3: Previous Perception	.03	4	.00	1	
Des. Magnitude (B1)					.01
4: Performance	.52*	5	.49*	1	
Score (T4)					-.71*
5: Individual Differences	.54*	9	.02	4	
Cognitive Ab.					.05
Learning Orn.					-.08
Perform. Orn.					-.02
Negative Aff.					.12

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

perceptions influence the learning process above and beyond the influence of individual differences and past performance. Analyses for independent steps in the regression equation are noted with small letters a, b, and c on the table. Effects for individual differences on mediating processes were not hypothesized, so these are not discussed here. Those effects are discussed later in the results section.

Table 21. Individual difference regression equation for second change in descriptive magnitude of negative feedback.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.02	2	-.-	--	
Goal					-.02
Seq.					-.14
2: Strategy Interaction	.02	3	.00	1	
Goal x Seq.					.01
3: Previous Perception	.22*	4	.20*	1	
Des. Magnitude (B2)					.45*
4: Performance	.38*	5	.15*	1	
Score (T7)					-.45*
5: Individual Differences	.40*	9	.02	4	
Cognitive Ab.					.04
Learning Orn.					-.12
Perform. Orn.					.03
Negative Aff.					.08

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

* $p < .05$

Attentional Focus. Hypothesis 5 suggests that individuals who judge their feedback to be more diagnostic have greater attentional focus on the study material. This hypothesis can be tested for block 1 and block 3 for self-report measures, and for blocks 1, 2, and 3 for time-based attentional measures.

Regression results presented in Tables 22 and 23 indicate that diagnosticity does not predict self-reported attentional focus in block 1, $\beta = -.05$, n.s., or the change in attentional focus from block 1 to block 3, $\beta = .08$, n.s.. Tables 24 to 26 present the regression results for the time based measures. For time-based attention measures, diagnosticity does not account for significant variance in attention for the initial measure or for the second change measure. However, diagnosticity does predict the change in attentional focus from block 1 to block 3, $\beta = .24$, $p < .05$. Thus, partial support was obtained for the influence of diagnosticity on attention.

An unexpected but very interesting finding is the positive effect of descriptive magnitude on initial attentional focus, $\beta = .20$, $p < .05$. This trend suggests that the higher the descriptive magnitude, the greater the on-task attention. The direction of this effect is opposite what might be hypothesized, and indicates a positive motivational effect for negative feedback. Error feedback may have resulted in a motivating force to improve performance, which is attempted by increasing on-task attention. In other words, the positive influence of descriptive magnitude may reflect a self-set goal or challenge effect whereby individuals who feel they are not doing well focus on the material in order to so.

Self-Efficacy. Hypothesis 6 suggests that magnitude feedback perceptions affect self-efficacy over and above the effects of actual performance. There are a number of possible tests of this hypothesis, including tests for block 1 and block 3, and for attributional and descriptive magnitude.

Regression results presented in Tables 22 and 23 indicate that diagnosticity does not predict self-reported attentional focus in block 1, $\beta = -.05$, n.s., or the change in attentional focus from block 1 to block 3, $\beta = .08$, n.s.. Tables 24 to 26 present the regression results for the time based measures. For time-based attention measures, diagnosticity does not account for significant variance in attention for the initial measure or for the second change measure. However, diagnosticity does predict the change in attentional focus from block 1 to block 3, $\beta = .24$, $p < .05$. Thus, partial support was obtained for the influence of diagnosticity on attention.

An unexpected but very interesting finding is the positive effect of descriptive magnitude on initial attentional focus, $\beta = .20$, $p < .05$. This trend suggests that the higher the descriptive magnitude, the greater the on-task attention. The direction of this effect is opposite what might be hypothesized, and indicates a positive motivational effect for negative feedback. Error feedback may have resulted in a motivating force to improve performance, which is attempted by increasing on-task attention. In other words, the positive influence of descriptive magnitude may reflect a self-set goal or challenge effect whereby individuals who feel they are not doing well focus on the material in order to so.

Self-Efficacy. Hypothesis 6 suggests that magnitude feedback perceptions affect self-efficacy over and above the effects of actual performance. There are a number of possible tests of this hypothesis, including tests for block 1 and block 3, and for attributional and descriptive magnitude.

Table 22. Regression equation for initial attentional focus (self-report).

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					.09
Seq.					.05
2: Strategy Interaction	.02	3	.01	1	
Goal x Seq.					.16
3: Individual Differences	.14*	7	.12*	4	
Cognitive Ab.					.27*
Learning Orn.					.15
Perform. Orn.					-.08
Negative Aff.					-.05
4: Performance	.16*	8	.02	1	
Score (T1)					-.13
5a: Diagnosticity (B1)[b]	.16*	9	.01	1	-.05
5b: Descriptive Mag. (B1)	.19*	9	.03*	1	.20*
5c: Attributional Mag. (B1)	.16*	9	.00	1	-.05

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 23. Regression equation for change in attentional focus (self-report).

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.05†	2	-.-	--	
Goal					.17†
Seq.					.16†
2: Strategy Interaction	.06†	3	.01	1	
Goal x Seq.					.17
3: Individual Differences	.13*	7	.06*	4	
Cognitive Ab.					-.06
Learning Orn.					.24*
Perform. Orn.					.01
Negative Aff.					-.09
4: Previous Judgment	.52*	8	.39*	1	
Att. Focus S-R (B1)					.67*
5: Performance	.52*	9	.01	1	
Score (T7)					-.12
6a: Diagnosticity (B3)[b]	.53*	10	.01	1	.09
6b: Descriptive Mag. (B3)	.54*	10	.02†	1	.18†
6c: Attributional Mag. (B3)	.53*	10	.00	1	-.09

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$
† $p < .10$

Table 24. Regression equation for initial attentional focus (time).

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.12*	2	-.-	--	
Goal					-.33*
Seq.					.03
2: Strategy Interaction	.12*	3	.00	1	
Goal x Seq.					-.07
3: Individual Differences	.30*	7	.18*	4	
Cognitive Ab.					.43*
Learning Orn.					-.06
Perform. Orn.					-.04
Negative Aff.					.02
4: Performance	.30*	8	.00	1	
Score (T1)					-.02
5a: Diagnosticity[b]	.30*	9	.00	1	.04
5b: Descriptive Mag.	.30*	9	.00	1	.00
5c: Attributional Mag.	.30*	9	.00	1	-.03

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 25. Regression equation for first change in attentional focus (time).

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.10*	2	-.-	--	
Goal					-.06
Seq.					.31*
2: Strategy Interaction	.10*	3	.00	1	
Goal x Seq.					.04
3: Individual Differences	.17*	7	.07†	4	
Cognitive Ab.					-.01
Learning Orn.					.10
Perform. Orn.					-.08
Negative Aff.					-.22*
4: Previous Judgment	.24*	8	.07*	1	
Att. Focus Time (B1)					.33*
5: Performance	.27*	9	.03*	1	
Score (T4)					-.23*
6a: Diagnosticity (B2)[b]	.31*	10	.04*	1	.24*
6b: Descriptive Mag. (B2)	.28*	10	.01	1	-.12
6c: Attributional Mag. (B2)	.29*	10	.02†	1	-.18†

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$
† $p < .10$

Table 26. Regression equation for second change in attentional focus (time).

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.09*	2	-.-	--	
Goal					.11
Seq.					.27*
2: Strategy Interaction	.11*	3	.02	1	
Goal x Seq.					.25
3: Individual Differences	.17*	7	.06	4	
Cognitive Ab.					-.18†
Learning Orn.					.17†
Perform. Orn.					-.07
Negative Aff.					-.03
4: Previous Judgment	.40*	8	.23*	1	
Att. Focus Time (B2)					.52*
5: Performance	.41*	9	.02	1	
Score (T7)					-.14
6a: Diagnosticity (B3)[b]	.41*	10	.00	1	.05
6b: Descriptive Mag. (B3)	.41*	10	.00	1	-.05
6c: Attributional Mag. (B3)	.43*	10	.01	1	-.15

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$
† $p < .10$

Regression results, presented in Table 27, indicate that descriptive magnitude of negative feedback had no effect on self-efficacy in block 1, $\beta = .03$, n.s.. Descriptive magnitude did have a marginal negative influence on the change in efficacy from the first to the final block, $\beta = -.13$, $p < .10$, as Table 28 indicates. These tables also indicate that attributional magnitude predicts both initial self-efficacy, $\beta = -.38$, $p < .05$, and the change in self-efficacy, $\beta = -.27$, $p < .05$ as hypothesized. This finding suggests that the interpretation of feedback as reflecting internal, stable causes significantly influences the self-efficacy judgments of trainees. Further, these results suggest that the negative effect of magnitude on self-efficacy is attenuated for descriptive, non-attributional interpretations of feedback.

An unexpected finding was that diagnosticity had a significant effect on initial self-efficacy judgments. Trainees who judged their feedback to be more diagnostic reported higher initial levels of self-efficacy, $\beta = .36$, $p < .05$. As this effect was not hypothesized, it should be interpreted with caution.

Motivation to Learn. Hypothesis 7 suggests that self-efficacy in turn influences motivation to learn. In order to test this hypothesis, a hierarchical regression analysis is run controlling for training strategies, individual differences, past performance, and feedback perceptions. Self-efficacy is entered in the last step.

Results support hypothesis 7, as Table 29 indicates, because self-efficacy significantly predicts initial motivation to learn, $\beta = .49$, $p < .05$. Change analyses, however, suggest that self-efficacy does not influence the change in motivation to learn over time. In fact, Table 30 indicates that motivation to learn is fairly stable because it is

Table 27. Regression equation for initial self-efficacy.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.02	2	-.-	--	
Goal					.01
Seq.					.14
2: Strategy Interaction	.03	3	.00	1	
Goal x Seq.					.11
3: Individual Differences	.25*	7	.22*	4	
Cognitive Ab.					.29*
Learning Orn.					.35*
Perform. Orn.					-.02
Negative Aff.					.05
4: Performance	.25*	8	.00	1	
Score (T1)					.02
5a: Diagnosticity[b]	.36*	9	.11*	1	.36*
5b: Descriptive Mag.	.25*	9	.00	1	.03
5c: Attributional Mag.	.36*	9	.11*	1	-.38*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b] Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 28. Regression equation for change in self-efficacy.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					.01
Seq.					.11
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.01
3: Individual Differences	.21*	7	.20*	4	
Cognitive Ab.					.23*
Learning Orn.					.32*
Perform. Orn.					-.15
Negative Aff.					.01
4: Previous Judgment	.60*	8	.39*	1	
Self-Efficacy (B1)					.72*
5: Performance	.63*	9	.03*	1	
Score (T7)					.21*
6a: Diagnosticity (B3)[b]	.63*	10	.00	1	.05
6b: Descriptive Mag. (B3)	.64*	10	.01†	1	-.13†
6c: Attributional Mag. (B3)	.67*	10	.04*	1	-.27*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b] Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 28. Regression equation for change in self-efficacy.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					.01
Seq.					.11
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.01
3: Individual Differences	.21*	7	.20*	4	
Cognitive Ab.					.23*
Learning Orn.					.32*
Perform. Orn.					-.15
Negative Aff.					.01
4: Previous Judgment	.60*	8	.39*	1	
Self-Efficacy (B1)					.72*
5: Performance	.63*	9	.03*	1	
Score (T7)					.21*
6a: Diagnosticity (B3)[b]	.63*	10	.00	1	.05
6b: Descriptive Mag. (B3)	.64*	10	.01†	1	-.13†
6c: Attributional Mag. (B3)	.67*	10	.04*	1	-.27*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 28. Regression equation for change in self-efficacy.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.01	2	-.-	--	
Goal					.01
Seq.					.11
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.01
3: Individual Differences	.21*	7	.20*	4	
Cognitive Ab.					.23*
Learning Orn.					.32*
Perform. Orn.					-.15
Negative Aff.					.01
4: Previous Judgment	.60*	8	.39*	1	
Self-Efficacy (B1)					.72*
5: Performance	.63*	9	.03*	1	
Score (T7)					.21*
6a: Diagnosticity (B3)[b]	.63*	10	.00	1	.05
6b: Descriptive Mag. (B3)	.64*	10	.01†	1	-.13†
6c: Attributional Mag. (B3)	.67*	10	.04*	1	-.27*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

[b]Steps a, b, and c were entered independently into the regression equation.

* $p < .05$

Table 29. Regression equation for initial motivation to learn.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.01	2	-.-	--	
Goal					.05
Seq.					.08
2: Strategy Interaction	.03	3	.02	1	
Goal x Seq.					.25
3: Individual Differences	.28*	7	.25*	4	
Cognitive Ab.					.21*
Learning Orn.					.41*
Perform. Orn.					-.10
Negative Aff.					.12
4: Performance	.29*	8	.01	1	
Score (T1)					-.10
5a: Diagnosticity[b]	.32*	9	.03*	1	.20*
5b: Descriptive Mag.	.30*	9	.01	1	.12
5c: Attributional Mag.	.37*	9	.09*	1	-.33*
6. Self-Efficacy (B1)[c]	.55*	12	.14*	1	.49*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.
[c]The final step was entered controlling for all perception variables.

* $p < .05$

Table 29. Regression equation for initial motivation to learn.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.01	2	-.-	--	
Goal					.05
Seq.					.08
2: Strategy Interaction	.03	3	.02	1	
Goal x Seq.					.25
3: Individual Differences	.28*	7	.25*	4	
Cognitive Ab.					.21*
Learning Orn.					.41*
Perform. Orn.					-.10
Negative Aff.					.12
4: Performance	.29*	8	.01	1	
Score (T1)					-.10
5a: Diagnosticity[b]	.32*	9	.03*	1	.20*
5b: Descriptive Mag.	.30*	9	.01	1	.12
5c: Attributional Mag.	.37*	9	.09*	1	-.33*
6. Self-Efficacy (B1)[c]	.55*	12	.14*	1	.49*

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.
[c]The final step was entered controlling for all perception variables.

* $p < .05$

Table 30. Regression equation for change in motivation to learn.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.01	2	-.-	--	
Goal					.06
Seq.					.10
2: Strategy Interaction	.03	3	.00	1	
Goal x Seq.					.24
3: Individual Differences	.23*	7	.19*	4	
Cognitive Ab.					.17†
Learning Orn.					.36*
Perform. Orn.					-.10
Negative Aff.					.13
4: Previous Judgment	.78*	8	.55*	1	
Mot. to Learn (B1)					.87*
5: Performance	.78*	9	.00	1	
Score (T7)					.01
6a: Diagnosticity (B3)[b]	.79*	10	.01*	1	.13*
6b: Descriptive Mag. (B3)	.78*	10	.00	1	-.06
6c: Attributional Mag. (B3)	.78*	10	.00	1	-.08
7. Self-Efficacy (B3)[c]	.79*	13	.00	1	.10

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]Steps a, b, and c were entered independently into the regression equation.
[c]The final step was entered controlling for all perception variables.

* $p < .05$
† $p < .10$

predicted by the first motivation measure, $\beta = .87$, $p < .05$ but its change is not influenced by score, feedback perceptions, or self-efficacy.

Post-hoc analyses reveal that the relationship between motivation to learn and self-efficacy may not be as simple as the hypothesis suggests. When motivation to learn is entered as a predictor of self-efficacy, the results are similar to those presented above. Using the same regression strategy, motivation to learn predicts initial self-efficacy levels, $\beta = .43$, $p < .05$, $\Delta R^2 = .43$. Furthermore, motivation to learn predicts the change in self-efficacy from block 1 to block 3, $\beta = .21$, $p < .05$, $\Delta R^2 = .02$. This finding reveals that the current method of data collection makes it difficult to ascertain the causal order of these constructs. Both constructs are measured using self-report measures at the same point in time. These two variables are highly related in both block 1, $r = .66$, $p < .01$, and block 3, $r = .62$, $p < .01$. As a result, these results reveal that either variable can serve as a significant predictor of the other.

Training Outcomes

The final hypotheses suggest that different training outcomes are affected by different learning processes. These hypotheses and related analyses are also conducted using a hierarchical regression strategy. The effects for individual differences and feedback perceptions are controlled, but they are not discussed in this section of the results.

Knowledge. Hypothesis 8a suggests individuals with high motivation to learn actually learn more from their attentional focus than trainees with low motivation to learn. This hypothesis predicts an interaction between attentional focus and motivation for the knowledge and skill training outcomes. Separate regression blocks were used to test attention with self-report and time-based attentional measures.

Regression analyses for knowledge test score are contained in Tables 31. Controlling for training strategy, score in the last block, and feedback perceptions, neither self-efficacy nor motivation to learn predicted significant variance in this knowledge outcomes. Attentional focus, measured with time, was a significant predictor of knowledge test performance. The motivation by self-report attention interaction was marginally significant, providing some support for hypothesis 8a. The graph of this interaction in Figure 7 reveals that the lowest knowledge test score occurred for individuals with low attention and low motivation to learn.

Skill. The same series of tests were conducted for final simulation score to determine if hypothesis 8a is supported for skill-based training outcomes. Table 32 shows the self-efficacy has a marginal effect on final score. The hypothesized interaction is also marginally significant. This provides some support for hypothesis 8a regarding skill outcomes. The size of this effect is very small, however, accounting for less than 2% of variance. A graph of this interaction in Figure 8 reveals that the lowest performance was obtained by individuals with low levels of attention and motivation to learn.

Attitudes. Hypothesis 8b suggests that attitudinal outcomes are directly influenced by motivation to learn. Tables 33 presents regression results for task satisfaction. These results indicate that both self-efficacy and motivation to learn

Table 31. Overall test for knowledge outcome of test score.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					-.07
Seq.					-.04
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					.07
3: Individual Differences	.45*	7	.44*	4	
Cognitive Ab.					.57*
Learning Orn.					-.04
Perform. Orn.					-.28*
Negative Aff.					-.02
4: Performance	.54*	8	.09*	1	
Score (T7)					.35*
5: Feedback Perceptions	.60*	11	.05*	3	
Diagnosticity (B3)					.04
Attributional Mag. (B3)					-.29*
Descriptive Mag. (B3)					.22*
6a: Process Variables	.60*	14	.01	3	
Self-Efficacy (B3)					.10
Mot. to Learn (B3)					-.02
Att. Focus Self Rep. (B3)					.11
6b: Process Variables[b]	.63*	14	.03*	3	
Self-Efficacy (B3)					.14
Mot. to Learn (B3)					.00
Att. Focus Time (B3)					.20*
7a: Process Interaction	.62*	15	.02†	1	
Mot. x Att Self Rep.					-.78†
7b: Process Interactions[b]	.63*	15	.00	1	
Mot x Att. Time					-.12

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]The two a steps are run together and the two b steps are run together, but a and b steps are run independently with the different measures of attention.

* $p < .05$
† $p < .10$

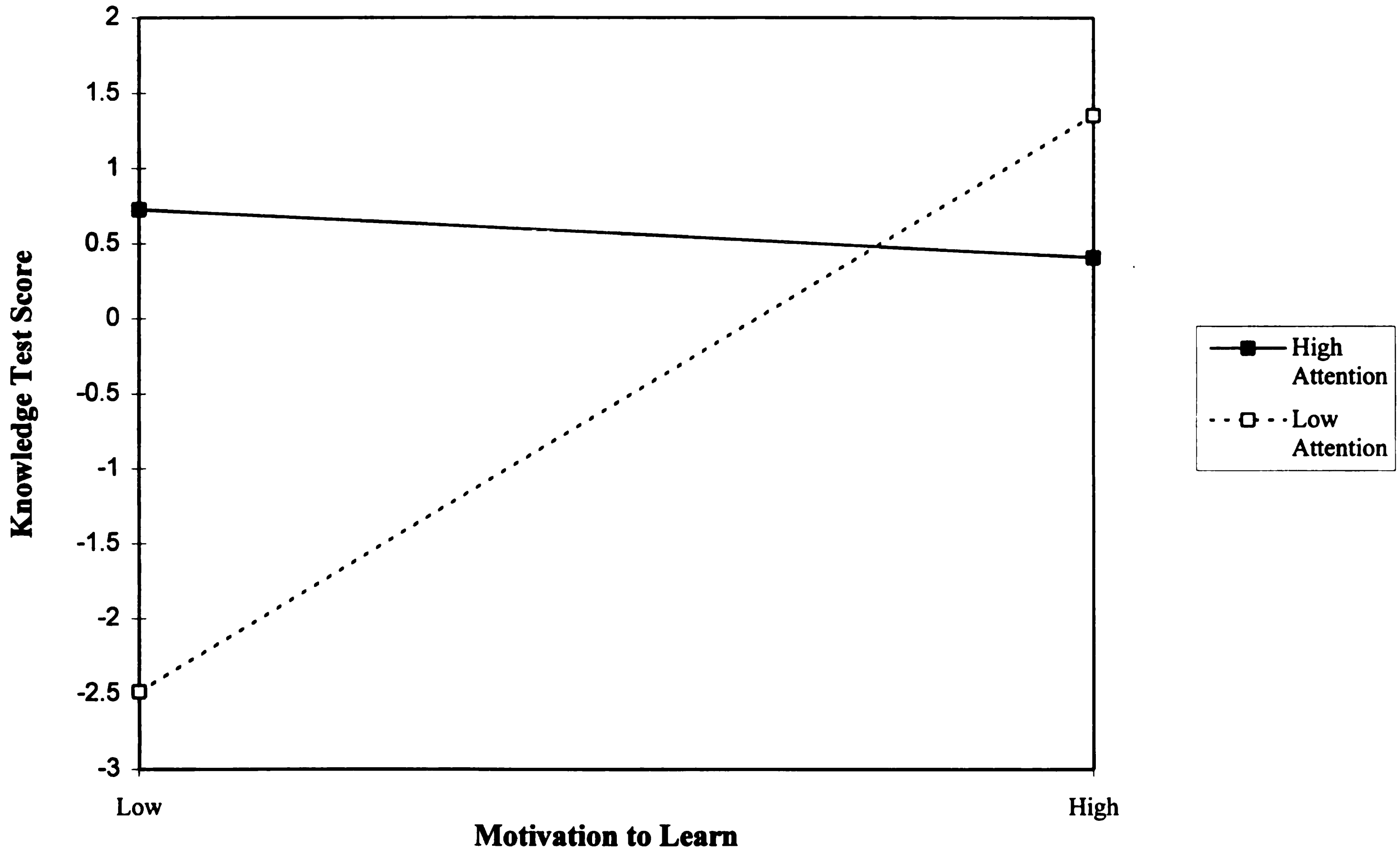

Figure 7. Self-report attention and motivation to learn interaction predicting knowledge test score.

Table 32. Overall test for skill outcome of final simulation score.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β[a]
1: Training Strategy	.00	2	-.-	--	
Goal					-.04
Seq.					-.06
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					-.08
3: Individual Differences	.20*	7	.20*	4	
Cognitive Ab.					.42*
Learning Orn.					-.10
Perform. Orn.					-.04
Negative Aff.					-.08
4: Performance	.56*	8	.36*	1	
Score (T7)					.68*
5: Feedback Perceptions	.56*	11	.00	3	
Diagnosticity (B3)					-.04
Attributional Mag. (B3)					-.02
Descriptive Mag. (B3)					-.01
6a: Process Variables	.59*	14	.02	3	
Self-Efficacy (B3)					.18†
Mot. to Learn (B3)					-.08
Att. Focus Self Rep. (B3)					-.07
6b: Process Variables[b]	.58*	14	.02	3	
Self-Efficacy (B3)					.19†
Mot. to Learn (B3)					-.12
Att. Focus Time (B3)					-.02
7a: Process Interactions	.60*	15	.01†	1	
Mot. x Att Self Rep.					-.70†
7b: Process Interactions[b]	.59*	15	.01	1	
Mot x Att. Time					-.44

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

[b]The two a steps are run together and the two b steps are run together, but a and b steps are run independently with the different measures of attention.

* $p < .05$

† $p < .10$

Table 32. Overall test for skill outcome of final simulation score.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.00	2	-.-	--	
Goal					-.04
Seq.					-.06
2: Strategy Interaction	.01	3	.00	1	
Goal x Seq.					-.08
3: Individual Differences	.20*	7	.20*	4	
Cognitive Ab.					.42*
Learning Orn.					-.10
Perform. Orn.					-.04
Negative Aff.					-.08
4: Performance	.56*	8	.36*	1	
Score (T7)					.68*
5: Feedback Perceptions	.56*	11	.00	3	
Diagnosticity (B3)					-.04
Attributional Mag. (B3)					-.02
Descriptive Mag. (B3)					-.01
6a: Process Variables	.59*	14	.02	3	
Self-Efficacy (B3)					.18†
Mot. to Learn (B3)					-.08
Att. Focus Self Rep. (B3)					-.07
6b: Process Variables[b]	.58*	14	.02	3	
Self-Efficacy (B3)					.19†
Mot. to Learn (B3)					-.12
Att. Focus Time (B3)					-.02
7a: Process Interactions	.60*	15	.01†	1	
Mot. x Att Self Rep.					-.70†
7b: Process Interactions[b]	.59*	15	.01	1	
Mot x Att. Time					-.44

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.

[b]The two a steps are run together and the two b steps are run together, but a and b steps are run independently with the different measures of attention.

* $p < .05$
† $p < .10$

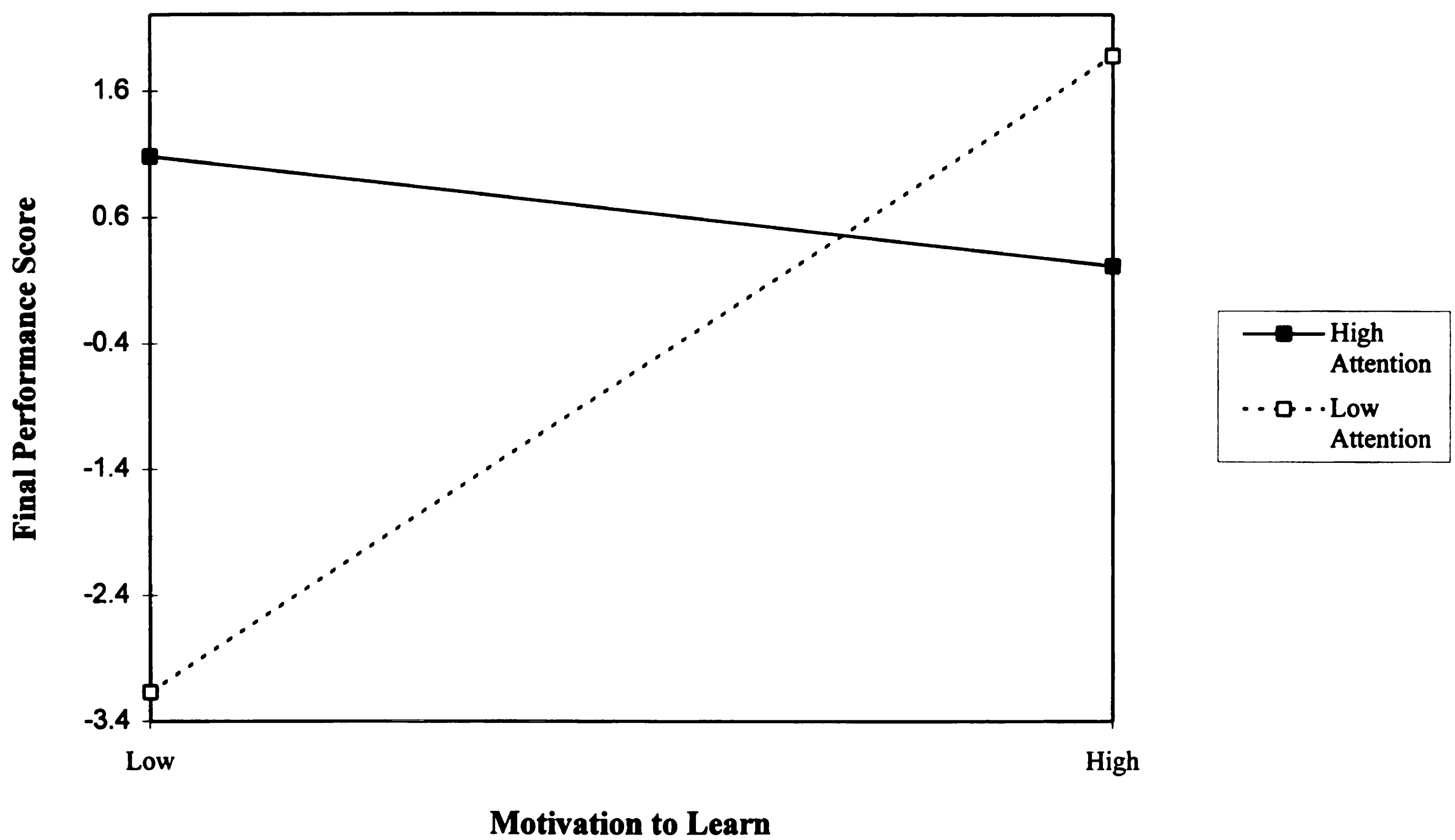

Figure 8. Self-report attention and motivation to learn interaction predicting final performance score.

Table 33. Overall test for affective training outcome of task satisfaction.

Step: Variable(s)	R^2	df	ΔR^2	Δdf	β^a
1: Training Strategy	.01	2	-.-	--	
Goal					-.07
Seq.					.06
2: Strategy Interaction	.02	3	.01	1	
Goal x Seq.					-.15
3: Individual Differences	.17*	7	.16*	4	
Cognitive Ab.					.23*
Learning Orn.					.27*
Perform. Orn.					-.13
Negative Aff.					.09
4: Performance	.34*	8	.16*	1	
Score (T7)					.45*
5: Feedback Perceptions	.52*	11	.18*	3	
Diagnosticity (B3)					.21*
Attributional Mag. (B3)					-.48*
Descriptive Mag. (B3)					.19†
6a: Process Variables	.75*	14	.23*	3	
Self-Efficacy (B3)					.25*
Mot. to Learn (B3)					.51*
Att. Focus Self Rep. (B3)					.08
6b: Process Variables[b]	.75*	14	.22*	3	
Self-Efficacy (B3)					.26*
Mot. to Learn (B3)					.54*
Att. Focus Time (B3)					.07
7a: Process Interactions	.76*	15	.00	1	
Mot. x Att Self Rep.					.22
7b: Process Interactions[b]	.76*	15	.01	1	
Mot x Att. Time					.29

[a] The β's refer to standardized regression coefficients associated with each step of the hierarchical regression.
[b]The two a steps are run together and the two b steps are run together, but a and b steps are run independently with the different measures of attention.

* $p < .05$
† $p < .10$

significantly influenced satisfaction. This supports the hypothesis 8b, but also suggests that motivation to learn is not the only predictor of satisfaction.

Mediation Analyses

The models presented in Figures 1 and 2 suggest a number of mediation effects that are not explicitly stated as hypotheses. For example, the model suggests that the effects of individual differences are mediated by the feedback perceptions of diagnosticity and magnitude. To test this relationship hierarchical regression can be used to determine if the significant individual difference effects on self-efficacy, motivation to learn, and attention focus disappear when feedback perceptions are controlled. A similar strategy can be used to test whether the effects of feedback perceptions on training outcomes are mediated by self-efficacy, motivation to learn, and attention focus. Finally, this strategy can be used to determine if individual differences have a direct or mediated effect on final training outcomes. The only direct effects that were hypothesized were for ability to final training outcomes. All other direct effects that are found should be interpreted as preliminary, the result of exploratory analyses. To limit the number of calculations and ease presentation, all of the following mediation analyses are tested with the self-report attentional focus variable in the learning process block.

Individual Differences --> Feedback Perceptions --> Learning Process. A number of significant effects were found for individual differences on the learning process. In the analyses for attentional focus, cognitive ability was found to significantly predict both initial self-report and time-based measures of attention. In all cases, cognitive ability was positively associated with attentional focus. When this regression, originally reported in Table 22, is run with cognitive ability as the final step, the predictive beta-weight and Rsquared values do not change dramatically. Entered after the manipulations, score, and feedback perceptions, the parameters for cognitive ability are still significant, $\beta = .26$, $p < .05$, $\Delta R^2 = .06$. A similar result is obtained when the regression equation for initial time-based attention focus is run with the variables reversed. The new cognitive ability parameter, $\beta = .42$, $p < .05$, $\Delta R^2 = .15$ is still significant and very similar to that shown in Table 24. These analyses suggest that the effects of cognitive ability on attentional focus are not mediated by feedback perceptions.

Other individual difference effects for attentional focus included learning orientation predicting the change in self-report attention and negative affectivity predicting the first change in attention measured with time. The reversed equations for these effects indicate that learning orientation does not predict the change in attentional focus when feedback perceptions are controlled, $\beta = .09$, n.s., $\Delta R^2 = .01$. The effect for negative affectivity does remain significant, $\beta = -.24$, $p < .05$, $\Delta R^2 = .06$. Thus, while learning orientation does not seem to have a direct effect on attentional focus, negative affectivity directly affects the change in time-based attentional focus from block 1 to block 2.

The regression results for self-efficacy suggest that both cognitive ability and learning orientation had significant effects on initial self-efficacy and the change in self-efficacy, Tables 27 and 28. In all cases, these effects served to increase the self-efficacy of trainees. Mediation analyses indicate that the effect for learning orientation remains significant, $\beta = .22$, $p < .05$, $\Delta R^2 = .04$ as does the effect for cognitive ability, $\beta = .19$, $p < .05$, $\Delta R^2 = .03$ for initial self-efficacy judgments. For changes in these judgments, learning orientation no longer predicts, $\beta = -.06$, n.s., $\Delta R^2 = .00$, and neither does ability, $\beta = -.06$, n.s., $\Delta R^2 = .00$. This suggests that while cognitive ability and learning orientation have direct effects on self-efficacy early in training, later changes in self-efficacy occur through the feedback mechanisms.

Initial levels and the change in motivation to learn were found to be influenced by cognitive ability and learning orientation. For initial levels of motivation to learn the effect for learning orientation continued to be significant in reversed order, $\beta = .31$, $p < .05$, $\Delta R^2 = .08$. For cognitive ability, the effect was significantly reduced, $\beta = .12$, n.s., $\Delta R^2 = .01$. Neither of these variables remained significant when the order was reversed in the change regressions, $\beta = -.00$, n.s., $\Delta R^2 = .00$ for learning orientation and $\beta = -.01$, n.s., $\Delta R^2 = .00$ for cognitive ability. These results indicate that only learning orientation had a direct influence on motivation to learn. This effect, however, only occurred for the initial level of motivation to learn and not for the change in motivation to learn. The effect of cognitive ability on motivation to learn was mediated by the feedback mechanisms.

Feedback Perceptions --> Learning Process --> Learning Outcomes. The only significant feedback effect for knowledge test score was for attributional magnitude of negative feedback. Table 31 notes that descriptive magnitude of negative feedback is significant, but this finding is actually a suppresser effect that occurs in the presence of the diagnosticity value. When entered separately, descriptive magnitude does not predict knowledge test score, $\beta = .08$, n.s., $\Delta R^2 = .00$.

Attributional magnitude judgments continue to account for a significant amount of variance in knowledge test score, even when entered into the regression after learning orientation no longer predicts, $\beta = -.06$, n.s., $\Delta R^2 = .00$, and neither does ability, $\beta = -.06$, n.s., $\Delta R^2 = .00$. This suggests that while cognitive ability and learning orientation have direct effects on self-efficacy early in training, later changes in self-efficacy occur through the feedback mechanisms.

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Attributional magnitude judgments continue to account for a significant amount of variance in knowledge test score, even when entered into the regression after manipulations, score, and learning process variables, $\beta = -.29$, $p < .05$, $\Delta R^2 = .04$. This suggests there is a strong, direct effect for attributional judgments on knowledge test score.

The regression for task satisfaction indicated that all three feedback perceptions were significant predictors. The effect for descriptive magnitude was entered separately to determine whether the marginal effect reported in this equation was the result of the suppression effect mentioned earlier. Separate analysis revealed that descriptive magnitude does have a significant relationship with task satisfaction, $\beta = -.28$, $p < .05$, $\Delta R^2 = .03$ controlling for manipulations, individual differences, and training score. However, none of these effects remain significant when entered after self-efficacy, motivation to learn, and attention focus, $\beta = -.14$, n.s., $\Delta R^2 = .01$ for attributional magnitude; $\beta = .07$, n.s., $\Delta R^2 = .00$ for descriptive magnitude; $\beta = -.03$, n.s., $\Delta R^2 = .00$ for diagnosticity. This suggests that all effects for feedback perceptions on satisfaction are mediated by the block of self-efficacy, motivation to learn, and attentional focus.

There were no significant feedback predictors for final performance score, so no mediation tests are conducted.

Individual Differences --> All Intervening Variables --> Learning Outcomes. The significant individual difference effects for knowledge test include both cognitive ability and performance orientation. When entered as the final step in the regression contained in Table 32, both cognitive ability, $\beta = .39$, $p < .05$, $\Delta R^2 = .11$, and performance orientation, $\beta = -.22$, $p < .05$, $\Delta R^2 = .04$, remain significant predictors of knowledge test score. Thus, both individual differences directly influence this training outcome.

For final skill score, reported in Table 32, the only significant individual difference predictor is cognitive ability. This effect does not remain significant when entered after manipulations, score, and learning process variables, $\beta = .11$, n.s., $\Delta R^2 = .01$. This suggests that final performance scores are not directly affected by cognitive ability. Instead, score during training and feedback perceptions of that score mediate the effect of cognitive ability on final performance.

For task satisfaction, Table 33 shows that cognitive ability and learning orientation are both significant predictors. Mediation tests indicate that neither of these findings remain significant when entered after the process variables, $\beta = -.01$, n.s., $\Delta R^2 = .00$ for ability; $\beta = -.02$, n.s., $\Delta R^2 = .00$ for learning orientation. Thus, the effects of ability and learning orientation on task satisfaction is mediated by self-efficacy, motivation to learn, and attentional focus.

Summary of Results and Overall Test of Model

Using LISREL, path analyses were conducted to provide overall assessments of model fit. First, the hypothesized model depicted in Figures 1 and 2 is tested. The manipulation effects are not tested because dichotomous variables violate the normality assumption in structural equation modeling. This same issue creates problems modeling interaction. More specifically, interaction terms violate normality assumptions because they are not normally distributed. While this does not affect the maximum-likelihood solutions, the chi-square and coefficient tests can be invalid (Bollen, 1989, p. 406). Because of these problems, and because the interaction and manipulation effects were largely marginal, the manipulations and the interaction term of motivation and attention are not included. The actual model tested is presented in Figure 9. Following this assessment, a revised model is tested based on the results of the hypotheses above. For all of these analyses, no measurement model was tested; all variables are entered as manifest variables.

For the following tests, specific variables needed to be selected to represent each construct in the model. As the theoretical model was designed to predict training outcomes, variables were selected based on their conceptual appropriateness for this task. Initial performance was operationalized by the total score obtained in the first block of trials. This provides a measure of performance for the first nine minutes of task exposure. Feedback perceptions were taken from the second block so they follow performance but are antecedent to the other self-report variables. The other self-reports, self-efficacy, motivation to learn, and self-efficacy, were all operationalized by the values obtained near the end of training (Block 3 values). The self-report attentional variable was employed in these analyses, rather than the time-based measure, to simplify the analyses. Skill was operationalized by the score obtained in the tenth and final trial. Both task knowledge and task satisfaction, labeled attitudes on the figure, were operationalized as they were in the regression analyses. Initial performance and final skill were standardized in order to create variance terms comparable with other variables in the analyses.

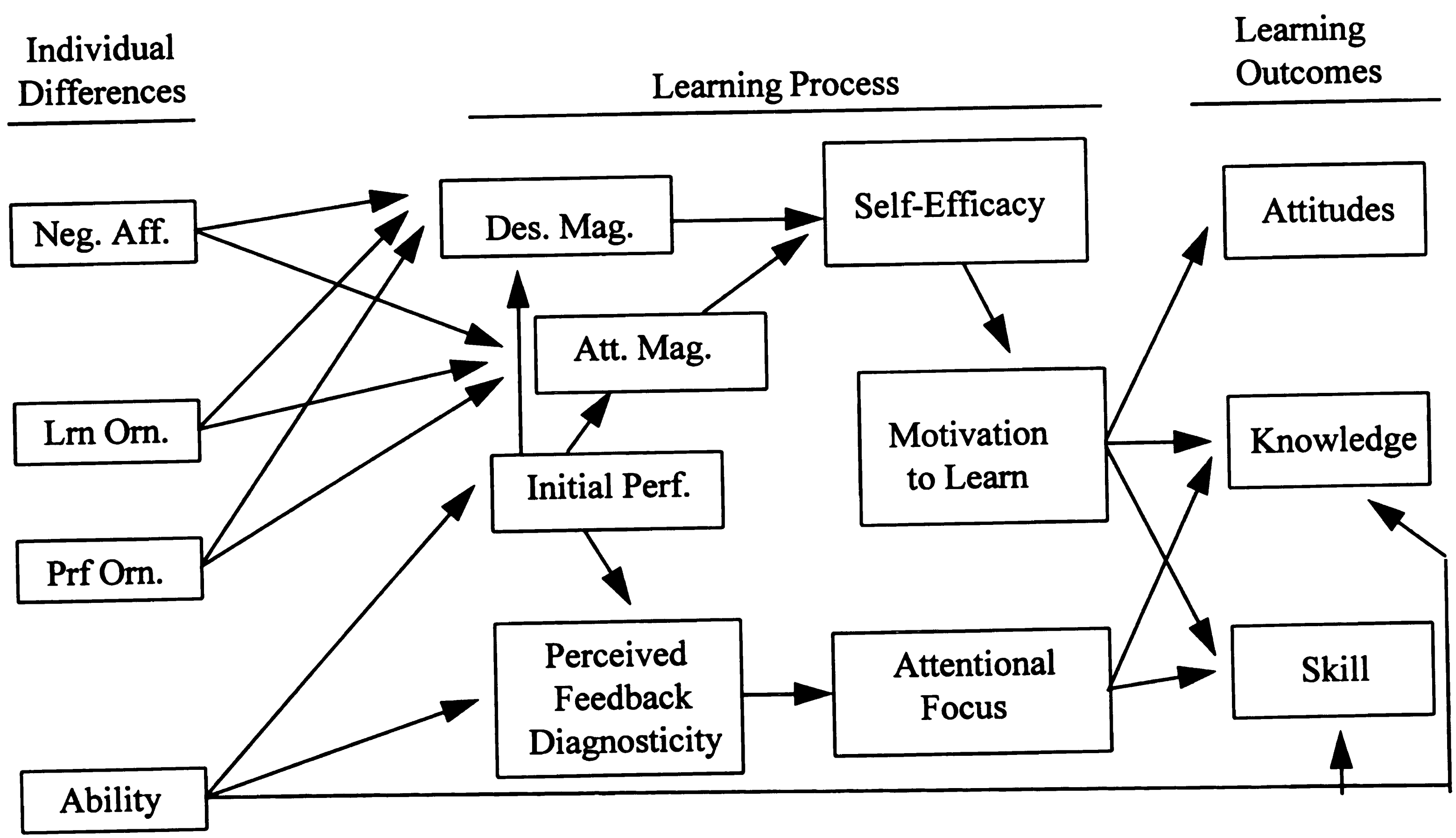

Figure 9. Path diagram for learning from negative feedback.

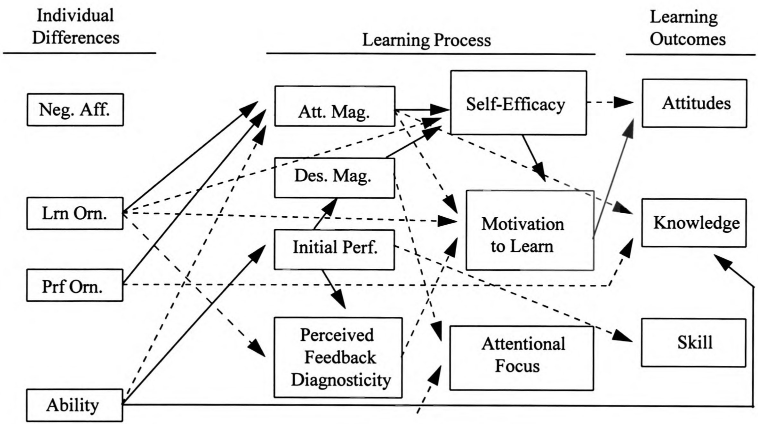

Figure 10. Summary of Significant Results.

First, the hypothesized process model was tested using path analysis. The fitted covariance matrix was a poor fit of the data, as indicated by a number of the fit indices, $\chi^2(63, N=110) = 233.84$, $p < .00$, RMSEA = .16, AGFI = .63, NNFI = -.10. None of these values suggest the model even comes close to effectively capturing the covariance pattern in the data.

Second, based on the results above a number of paths were modified. For example, the paths between diagnosticity and attentional focus were dropped because of a lack of support for this hypothesis. Diagnosticity did, however, predict self-efficacy so this link was added. The paths between self-report attentional focus and skill and attentional focus and knowledge were dropped because those effects were not significant. Direct effects for attributional magnitude judgments were added to motivation to learn and knowledge. No direct effect was added from attributional magnitude to attitudes because mediation analyses indicated this effect was mediated by the learning process block. Figure 10 presents the modified model which also serves as a summary of the results for the analyses reported above.

The resulting model involves a net loss in 10 degrees of freedom as more parameters are being estimated rather than constrained to zero. The revised model is a poor fit of the data, $\chi^2(53, N=110) = 180.25$, $p < .00$, RMSEA = .15, AGFI = .67, NNFI = -.07. However, a chi-square difference test of these nested models suggests that the restrictions in the revised model provide a significant improvement in model fit, $\Delta\chi^2(10, N=110) = 53.59$, $p < .00$. None-the-less, neither of the models provides an adequate fit of the data. Further modifications to the model provide only small, incremental improvements in model fit. The high intercorrelation of many of the variables in the analysis create difficulty in achieving adequate model fit. Satisfactory fit was not obtained without abandoning theory and removing variables from the model. As a result, no additional models are presented.

DISCUSSION

The purpose of this research is to explore how different individuals react to and learn from difficult, early training experiences. Current research on errors in training focuses mainly on Error Management Training (EMT), which suggests a particular training strategy for incorporating errors in training. Current applications of EMT have proven useful, but they are difficult if not impossible to implement during the early stages of skill acquisition. Ordinarily, EMT suggests the addition of an entire training unit, provided sometime during the middle of a training sequence, that involves the active pursuit of errors.

While this area of research has successfully re-opened a long-standing debate in the learning literature, it has done so without providing theoretical grounding in the processes that follow the receipt of negative feedback. The goal of the current project is to explore the psychological and behavioral processes that result from error feedback. As EMT requires the addition of training units and is not easily applied to early stages of skill acquisition, training strategies that can be easily applied during the earliest stages of learning are still sorely lacking. Consequently, the process model was used to suggest two easily implemented training strategies. These strategies were evaluated for their usefulness in improving satisfaction and learning with error-filled early training experiences.

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The proposed process model suggests that two feedback perceptions are involved in learning from negative feedback – magnitude and diagnosticity. These perceptions are suggested as determinants of learning processes such as self-efficacy, motivation to learn, and attentional focus. Training strategies of mastery framing and sequencing were then suggested as practical means to affect these perceptions and ultimately lower the dissatisfaction and increase the learning that occurs from these training situations.

To accomplish these objectives, a realistic learning scenario was developed with a computer simulation task. Performance criteria were somewhat ambiguous, but the task was designed so that all mean performance scores were negative. Score feedback presented at the end of each three minutes trial was augmented with text stating the actual number of errors committed during the preceding scenario. No one achieved perfect performance, so trainees committed, and were accurately informed of, errors throughout the training. Despite the difficulty of the task, motivation to learn was relatively high and many trainees learned a great deal about the simulation. Thus, the experimental procedure provides a challenging training environment with a novel but engaging task. The discussion below first discusses the findings relevant to the theoretical model. Then, the evaluation of the training strategies is discussed. The section concludes with a discussion of study limitations and future directions for research.

Process Model. The results of this study suggest five specific limitations to the proposed theoretical model. First, the distinction between "motivational" and "information" process effects does not hold for this data. Results indicate that diagnosticity had only minor effects on trainee's attentional focus. Instead, diagnosticity influenced trainees' self-efficacy. This suggests that the notion of diagnosticity as the predominant influence of an "informational" learning track does not hold. Furthermore, the motivational variable of descriptive magnitude influenced attentional focus. A similar cross-over effect occurred for individual differences. Learning orientation was expected to influence magnitude and the motivational learning track only, yet it provided significant prediction of both attributional magnitude and diagnosticity. These results suggest that "motivational" and "informational" tracks are not distinguishable.

Second, the model suggests that feedback perceptions mediate the effects of individual differences on learning processes of self-efficacy, motivation to learn, and attentional focus. Further, the model suggests that these learning processes mediate the effects of feedback perceptions on learning outcomes. Results indicate direct influences of learning orientation on self-efficacy and motivation to learn, performance orientation on knowledge training outcomes, and attributional magnitude on knowledge training outcomes. Thus, the mediating effects posed in the model do not hold. The learning process is more complex and inter-related than the hypothesized model suggests.

Third, the original model suggests that self-efficacy and motivation to learn operate in a simple mediated relationship. To the contrary, results suggest that these variables are highly related, each occupying similar positions in a nomological network of the learning process. Both self-efficacy and motivation to learn are influenced by learning orientation, diagnosticity, and attributional magnitude perceptions. Both self-efficacy and motivation to learn influence attitudinal outcomes of training. And finally, neither self-efficacy nor motivation to learn have significant main effects on knowledge and skill outcomes.

None-the-less, there is evidence that these constructs differ. While self-efficacy was influenced by performance throughout training, motivation to learn was independent of performance throughout training. Self-efficacy changed over the course of training, but motivation to learn remained fairly constant, as suggested by the change analyses. Without additional data or future research, it is difficult to identify the true relationship between these constructs. In any case, it is clear that the hypothesized relationship is too simple to capture the complex inter-relationship between these constructs.

Fourth, the individual difference variable of negative affectivity did not influence magnitude perceptions. In fact, this trait had only one significant, unhypothesized effect. Contrary to expectations, trainees dispositions to experiencing negative affective states did not alter the process or the outcomes of this difficult training situation. The lack of this effect is puzzling, given the recent literature asserting the importance of affect for organizationally-relevant outcomes (e.g., George, 1992).

Fifth, the descriptive and attributional magnitude perceptions have different relationships than originally hypothesized. While most analyses indicate these constructs have similar effects, attributional magnitude exhibited a far greater influence on the learning process. For attentional focus, these two constructs even have opposing effects! Magnitude was expected to have negative influences on the learning process, but descriptive magnitude actually increases initial levels of on-task attention. Positive motivational effects were dismissed as a possibility early in this paper, as they were expected to be minimal during early stages of skill acquisition. Apparently this decision was inaccurate and should be revisited.

One perspective that may prove useful in understanding the opposing effects of descriptive and attributional magnitude is that of perceived feedback magnitude representing the internal assessment of goal--performance discrepancy. Research on goal setting suggests that trainees often hold internal standards or goals regarding desired performance levels (e.g., Locke & Latham, 1991). From this perspective, the larger the discrepancy between actual performance and standard, the greater the descriptive magnitude of negative feedback. This description of discrepancy suggests nothing about what the individual thinks caused the current gap between actual and desired performance level. The ascription of cause is assessed by attributional magnitude, which reflects whether individuals feel their goal--performance discrepancy is a result of something internal and stable. Those individuals who view large goal--performance discrepancies and see these discrepancies as caused by stable personal shortcomings should have lower self-efficacy and motivation for training than individuals who do not view the discrepancy this way. This explanation provides an accurate portrayal of the obtained results. The results for individual differences also support this perspective.

The effects for individual differences were more in line with the hypotheses. Learning and performance orientation were found to predict attributional judgments of feedback. Thus, individuals high in performance orientation reported higher attributional magnitude of negative feedback regardless of actual performance level. Attributional judgments were in turn related to lower task satisfaction and lower knowledge test scores. The direct effects of learning orientation included lower attributional magnitude judgments, higher self-efficacy, and higher motivation to learn. Through increases in self-efficacy and motivation to learn, learning orientation also indirectly improved task satisfaction. These results support ongoing research on goal orientation effects on training outcomes (e.g., Boyle & Klimoski, 1995; Ford et al., 1995; Kozlowski et al., 1995; 1996) and on the attributional influences of goal orientation (e.g., Dweck, 1986; 1989). Finally, cognitive ability was also discovered to be an important determinant of attributional magnitude and training outcomes. As a whole, then, individual differences were highly predictive of important learning processes as well as training outcomes.

Training Strategies. It is important to restate that the mastery goal did not elicit a mastery state orientation in trainees. Thus, it is difficult to interpret the obtained results as effects of mastery-framed training. The failure of this manipulation is discussed later, under study limitations, but the effects of the goal framing manipulation are interpreted cautiously below.

The supporting evidence for the goal framing strategy involves mastery framing lowering descriptive magnitude judgments. In other words, controlling for actual performance scores, individuals in this condition viewed their performance as more positive than trainees in the performance conditions. Results indicated that this effect decreased over time. That is, differences in magnitude judgments were found for the first and second block, but not for the third. This pattern suggests a diminishing effect for the manipulation.

It is likely that characteristics of the task and the training overwhelmed the manipulation to push all trainees toward a similar interpretation of the feedback they received. The form of the feedback (i.e., number of errors and score) and the nature of task (i.e., short performance episodes followed immediately by this feedback) both frame performance as a critical aspect of training success. Thus, trainees in mastery conditions may have received conflicting messages about the purpose and objectives of training. The effect for mastery training may have been stronger and may not have diminished if the feedback and structure the training were complementary to the training frame.

Complementary feedback would depict information regarding the practice and learning of critical skills, rather than the score that results from using these skills. The training structure could be modified so that trainees can focus on studying or practicing simultaneously rather than one or the other. While this solution creates potential confounds for exploration and amount of time spent in training, these factors can be controlled either by design or statistically.

The sequencing manipulation also has effects, including a trend for performance scores and the post-hoc finding that sequencing lowers descriptive magnitude judgments. The effect for performance was clear during the first two blocks; sequencing improves the basic skills of labeling and engaging. In the third block, performance suffered from attention to more complex aspects of the task. Sequenced trainees were so absorbed figuring out the prioritization component of the task that their basic task performance suffered. Beneficial effects for sequencing on prioritization likely did not occur because of the complexity and difficult of the prioritization action. Few individuals performed this action well, with cognitive ability serving as the best predictor of effective prioritization performance. If training time was extended and trainees had more time to practice the prioritization action, it likely that the sequencing condition would have performed better than the unsequenced trainees. This finding would suggest a return to the shape of the learning curves from blocks 1 and 2, and would result in greater benefits of sequencing for trainees.

An unexpected finding relating to the training strategies was that, counter to the model, descriptive magnitude of negative feedback was found to relate positively to self-report attentional focus. Thus, by lowering descriptive magnitude these training strategies indirectly inhibited at least one of the mechanisms they were designed to enhance. Meanwhile, training strategies had little influence on attributional magnitude judgments. This suggests that the current training strategies did little to change the interpretation of the negative feedback that was received. While mastery framing and sequencing did lessen the perception of magnitude, these manipulations were not able to stop individuals from attributing errors to internal, stable factors. Whether or not the manipulation improvements noted above would result in manipulations that can influence interpretations remains an interesting question, open for future investigation.

Limitations and Future Research Directions

The most clear limitation of the current study is the failure of the mastery framing to elicit a mastery state in trainees. This creates conceptual and empirical ambiguity in interpreting the effects of the goal manipulation. The performance strategy, which effectively raised performance state, is essentially compared to an unknown. A more powerful design would compare a performance condition directly to a "do your best" condition in which no framing was provided. This would create an interpretable comparison of the effects of performance framing. To create a comparison relevant to mastery framing, a more powerful framing manipulation must be employed.

A mastery framing condition that could be employed in future research would involve a short exercise which actively depicts the value of learning from negative feedback. A behavioral-modeling approach to teaching trainees how to deal with errors may both elicit mastery states and provide skills for dealing with errors. For example, trainees can be shown a video-tape of a successful person making a number of critical errors, but effectively dealing with these errors by stopping, thinking, and reviewing the error as a learning opportunity.

An alternative explanation for the failure of the mastery manipulation rests with the malleability of mastery states. Without modifying the task or the feedback, it may be difficult to focus attention away from performance. When specific feedback is presented regarding performance, it may be difficult for trainees to ignore the information contained therein. Further, focusing attention to performance may be an easy task because, if the information is readily available, it simply needs to be made salient. The truthfulness of this possibility should be investigated with future research.

Little research has been conducted on the distinction between goal orientation as a state and as a trait. In fact, research in this area often does not distinguish between the two, as noted by Kozlowski et al. (1995). The question of malleability or susceptibility to situational influence is one that should be addressed. This can be accomplished by varying the intensity of mastery-framing manipulations. In addition, changes in the form of feedback (e.g., Field, 1996) and characteristics of the task (e.g., Carroll & Carrithers, 1984) could be explored for their influence on goal orientation states. In conducting this research, it is clear that researchers must continue to measure both state (situational) and trait (dispositional) aspects of goal orientation. Without measuring both forms of goal orientation, the question of malleability cannot be addressed.

An additional limitation of this study is the artificial nature of the task and the utilization of college students as subjects. This is a common criticism of laboratory research, and one that has been addressed in great detail elsewhere (e.g., Locke, 1986). None-the-less, it is important to address this issue from the standpoint of the theory tested here. A blanket criticism of the current design is that trainees are less motivated to learn and perform than real world trainees, and, as a result, more likely to give up or withdrawal from training. The lack of real-world consequences for learning this task may have contributed to the empirical similarity between self-efficacy and motivation to learn. Conceptually these constructs are distinct, but they may be more closely tied in short, laboratory settings where motivation is tied to short term goal of protecting trainees' self-image. After all, why should a trainee exert effort learning an unimportant and difficult task? A major source of motivation in these situations may be the self-perception of efficacy, which lead trainees to protect this self-perception by working to maintain or improve performance. Future research is definitely needed to explore the relationship between self-efficacy and motivation to learn in a number of realistic settings.

Having recognized this criticism, there are two reasons why I believe this criticism is not entirely valid. First, trainees in this study were essentially compensated employees. As an experimenter I provided them with compensation in the form of experimental credit for trying to learn (or perform) the task. These were the experimental instructions. Further, there were potential rewards for good performance. This type of reward mirrors the benefits or bonuses that might be obtained in a real world work setting. Second, real world employees are not often in a "do or die" situation when it comes to training. Current methods of training evaluation rarely create situations where personal responsibility is demanded for transfer and maintenance of skills. Furthermore, only the "best-in-class" organizations actually track the utilization of learned skills back on the job (Olian, Durham, Kristof, Brown, & Pierce, 1995). Thus, while it is certainly possible to envision instances where real world training involve higher levels and greater persistence of motivation, those cases probably do not represent the majority of training situations.

The measurement approach employed in this study provides another limit to the generalizations that can be drawn. Many of the conclusions drawn from this study center around the influence of attributional magnitude of negative feedback. This is a new construct for which no other research has been conducted. Parallels were drawn to the self-evaluation that occurs as a result of goal--performance discrepancies. However, no direct measure of attributions or of self-set goals were collected. Furthermore, this construct collapses attribution and self-evaluation into one measure. Other studies in this area have directly assessed both self-set goals and attributions (e.g., Thomas & Mathieu, 1995).

Even with these differences in conceptualization and measurement, the current findings both agree with and extend the current literature in this area. Past findings have suggested that attributions can moderate the influence of a goal--performance discrepancy. The findings in this study regarding attributional magnitude suggest it is predicted by learning and performance orientation and it affects a number of important training processes and outcomes. These effects occur after controlling for actual performance. In many ways, this measurement approach may more accurately reflect the psychological process that occurs during performance episodes.

Other research in this area tests these effects using goal--performance difference scores. In addition to the statistical difficulties with difference scores, there are conceptual reasons to be concerned about the difference score value. Self-set goals are collected prior to performance and assumed to remain constant until feedback is received. Further, the weight of different self-set goals in determining self-evaluations are assumed to be the same. That is, everyone is assumed to be equally committed to and equally

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Even with these differences in conceptualization and measurement, the current findings both agree with and extend the current literature in this area. Past findings have suggested that attributions can moderate the influence of a goal--performance discrepancy. The findings in this study regarding attributional magnitude suggest it is predicted by learning and performance orientation and it affects a number of important training processes and outcomes. These effects occur after controlling for actual performance. In many ways, this measurement approach may more accurately reflect the psychological process that occurs during performance episodes.

Other research in this area tests these effects using goal--performance difference scores. In addition to the statistical difficulties with difference scores, there are conceptual reasons to be concerned about the difference score value. Self-set goals are collected prior to performance and assumed to remain constant until feedback is received. Further, the weight of different self-set goals in determining self-evaluations are assumed to be the same. That is, everyone is assumed to be equally committed to and equally value the goal. These assumptions have rarely, if ever, been tested. The current method circumvents these assumptions. If the intent of a goal--performance discrepancy is to assess the self-evaluation conducted after feedback is received, the current method of asking trainees about their feedback and performance seems the most parsimonious and direct. However, as noted before, because this method is new, research should be conducted to identify the relationship between perceived magnitude judgments and goal--performance discrepancies. Furthermore, the relationship between traditional attributional measures and the attributional measures employed in this study should be explored.

The individual difference and attributional magnitude results noted here have theoretical and practical implications for EMT and related error-based training. These results suggest that certain individuals are prone to react negatively to errors, and, as a result, may have their learning actually impaired by the addition of "error" training units. Training strategies may not be effective in eliminating the negative consequences of errors for individuals who have lower cognitive ability, lower learning orientation, and higher performance orientation. These "at-risk" individuals can be identified through relatively simple testing procedures, and training strategies specifically for these individuals should be developed and evaluated.

The particular strategies tested in this study were not strong enough to prevent the decline in motivation and learning that occurs these "at-risk" individuals. Martocchio (1994) has investigated additional training strategies that may be useful in lowering trainees' tendency to ascribe poor performance to ability. In his study, Martocchio suggested to trainees that everyone makes a great deal of mistakes and that these are a value the goal. These assumptions have rarely, if ever, been tested. The current method circumvents these assumptions. If the intent of a goal--performance discrepancy is to assess the self-evaluation conducted after feedback is received, the current method of asking trainees about their feedback and performance seems the most parsimonious and direct. However, as noted before, because this method is new, research should be conducted to identify the relationship between perceived magnitude judgments and goal--performance discrepancies. Furthermore, the relationship between traditional attributional measures and the attributional measures employed in this study should be explored.

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In conclusion, this study suggested a theoretical model of the process of learning from errors during early skill acquisition. A number of the paths suggested in the model were not supported and a number of unexpected paths were found to be significant. While future research is needed to validate these exploratory findings, it is clear from these findings that the learning process is not easily divisible into a motivational and informational track. Even so, the model is useful in identifying feedback perception and interpretation as a critical aspect of the learning process. Furthermore, individual differences of goal orientation and cognitive ability have both direct effects on training outcomes and indirect effects via these feedback perceptions. Thus, in considering early stages of complex skill acquisition, the present study suggests that certain individuals are more prone to reduce effort and withdraw. For these individuals, alternative methods of training may be necessary.

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APPENDICES

APPENDIX A

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Training Strategy Manipulations

Sequencing Manipulation

To help you meet the objectives you have been given, we have been investigating different ways to make RADAR-OP easier. Through a review of research, and some work done here, we have developed recommendations for how you should spend your time. Following our recommendations will help achieve your objectives faster and more easily.

Our suggestion is that you limit your attention to certain parts of the simulation for each block. Instead of working on all parts of the program, the best way to approach this task is to concentrate your efforts. So, before each block of trials we will give you a set of skills to focus on during that block. When you are practicing and studying RADAR-OP during that block, you should focus on the part of the task that we suggest.

For this first block, we suggest that you focus on [LABELING. Although there is more to the simulation than just this one skill, LABELING is integral to all subsequent skills and actions with the task. So, concentrate your efforts on LABELING]*. That means that you will have 3 trials in the coming block and on **ALL THREE** of these trials you should work on [LABELING]*. I will let you know when we recommend you shift your attention to other parts of the simulation.

Do you have any questions?

* For blocks 2 and 3 these sentences were replaced to focus trainee attention on engaging and prioritizing, respectively.

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Do you have any questions?

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Mastery Manipulation

Your purpose during this study is to learn and understand RADAR-OP. You will go through 3 blocks of trials to give you an opportunity to learn, practice, and explore the game. Pursuing knowledge about the game is the key to gaining skill with this simulation.

Learning RADAR-OP is not an easy task. We recognize that you have not played RADAR-OP before, that's why we are giving you a series of trials to play and explore. But, in order for you to truly understand RADAR-OP, you must work hard to learn its features. How you perform during any one trial is unimportant, what matters is how much you learn from each trial.

Everything you need to know to about this game was covered in the brief introductory training or is covered in the manual. . . the rest is up to you. How much you learn from each trial is completely under your control. RADAR-OP is challenging and complex. To truly understand how the game works, you must commit yourself to studying and exploring at all times.

As I demonstrated earlier, RADAR-OP keeps a tab on how you are progressing. After each trial, RADAR-OP will give you information about the correctness of each of your actions. You can use this feedback to help you learn about the game. The feedback is presented in terms of different aspects or facets of the simulation, its up to you to USE that feedback to learn as much as you can. It's not the number of actions or errors that you make that's important, its how you use that information as feedback to improve your understanding of the task.

So, remember, your objective in this study is LEARN AS MUCH AS YOU CAN ABOUT RADAR-OP! How you perform on any one trial is unimportant... it's what you LEARN that matters!

Do you have any questions?

Performance Manipulation

Your purpose during this study is to perform at you maximum on RADAR-OP. You will go through 3 blocks of trials to give you an opportunity to maximize your performance. Your level of performance, as measured by the overall score, is critical to demonstrating your skill at this game.

Performing extremely well on this task is difficult. We recognize that you have not played RADAR-OP before, that's why we are giving a series of trials to get high scores on the game. In order for you to be one of the best RADAR-OP players, you have to get high scores by committing many LABEL and ENGAGE actions and very few errors.

Everything you need to know to perform your maximum on this game was covered in the brief introductory training or is covered in the manual. RADAR-OP is challenging and complex. To truly perform at the highest level of play, you must commit yourself to striving for maximum performance at all times.

As I demonstrated earlier, RADAR-OP keeps a running count of your performance. The overall score shows how well you have maximized the number of LABEL and ENGAGE actions and minimized the number of errors. The best performers commit many LABEL and ENGAGE actions and few errors.

So, remember, your objective in this study is PERFORM AT YOUR MAXIMUM DURING ALL RADAR-OP TRIALS!

Do you have any questions?

APPENDIX B

APPENDIX B

Training Outcome Questionnaire

Outcome Measures

Please use the following scale to respond to the following statements. There are no right or wrong answers here, please just answer honestly.

```
Strongly                                      Strongly
Disagree  Disagree   Neutral   Agree          Agree
 <-|-------------|-----------|-----------|-------------|->
  (1)           (2)         (3)         (4)           (5)
```

83. I was generally satisfied while performing this task. [TSAT1]
84. The simulation was boring to me. [TSAT2-R]
85. I didn't like performing the simulation. [TSAT3-R]
86. I am glad that I participated in this experiment. [TSAT4]
87. I often thought about quitting this task. [WTHD1]
88. If I hear about other projects like this, I would be interested in participating. [WTHD2-R]
89. If I knew in advance what this project would entail, I would not have chosen to participate.[WTHD3]
90. I would recommend this project to my friends. [WHTD4-R]
91. I think my friends would be interested in applying for this project. [WTHD5-R]
92. I became frustrated with my ability to improve my performance. [NEGTHT1]
93. I thought about how poorly I was doing. [NEGTHT2]
94. I was very dissatisfied with my performance on this task. [NEGTHT3]
95. I got mad at myself during the task. [NEGTHT4]

96. Would you be willing to participate in another session for follow-up purposes? [WTHD6]
    1 - Yes, I'd like to participate in this experiment again whether or not I receive credit or money for participating.
    2 - Yes, I'd like to participate in this experiment again for credit or money.
    3 - Maybe I'll participate again. I'll leave my telephone number and you can contact me for a later appointment.
    4 - Probably not. If you get in contact with me, I probably will say no.
    5 - No. I'm definitely not willing to participate again.

Outcome Measures, cont. -- Task Knowledge Test

This is a knowledge test about RADAR-OP. For each question there is one answer which is the best answer, try to get as many of these questions right as possible. Awards for knowledge will be distributed based on the number of these items you get correct.

97. Altitude of 2506 NM suggests the contact is likely which of the following: [KN1]
    a. Civilian
    b. Military
    c. Air
    d. Surface
    e. Peaceful
98. Maneuvering Pattern of Code_Foxtrot indicates which of the following: [KN2]
    a. Civilian
    b. Military
    c. Air
    d. Surface
    e. Unable to decide, need more information
99. Before a contact can be labeled, you have to do the following: [KN3]
    a. Identify it as peaceful or hostile
    b. Hook it using the mouse
    c. Warn the contact that it is being labeled
    d. Turn the manual to page 8
    e. Clear the contact from the screen
100. Communication Time of 12 Seconds indicates the contact is: [KN4]
    a. Civilian
    b. Military
    c. Air
    d. Surface
    e. Unable to decide, need more information
101. Altitude of 2 NM means the contact is definitely: [KN5]
    a. Civilian
    b. Military
    c. Air
    d. Surface
    e. Unable to decide, need more information
102. If a contact has Altitude 0 NM, Maneuvering_Pattern Code_Delta, and Speed 495 NM/HR, which of the following is appropriate: [KN6]
    a. Check another cue value before labeling
    b. Label the contact as Surface and Military
    c. Label the contact as Surface and Civilian
    d. Engage the contact with an "attack"
    e. Check to see whether the contact is peaceful

103. A contact with Altitude of 0 NM, Maneuvering Pattern of Code_Delta, Speed of 410 NM/HR, Response Given, and Communication Time of 42 Seconds should be labeled: [KN7]
   a. Air_Military
   b. Surface_Military
   c. Air_Civilian
   d. Surface_Civilian
   e. Unable to decide, need more information

104. Before a contact can be Engaged, which of the following MUST be completed? [KN8]
   a. Turn the manual to page 10
   b. Make sure no other contacts have the same communication time
   c. Identify how fast the contact is going
   d. Figure whether the Manuevering_Pattern is negative
   e. Label the contact as Air/Surface and Civilian/Military

For the next three questions, please pick the letter that represents the correct engage decision to pick for the described contact:

105. Contact with Threat_Level of 3 and Response Given: [KN9]
   a. Clear
   b. Monitor
   c. Warn
   d. Attack
   e. Unable to decide, need more information

106. Contact that is Air and Military with a Threat_Level of 3, No Response, current Range of 52 NM, Speed of 27 NM/HR, and Missile Lock Clean: [KN10]
   a. Clear
   b. Monitor
   c. Warn
   d. Attack
   e. Unable to decide, need more information

107. Contact with Threat_Level of 1 and Response Given, Missile is Locked_On, but Speed is only 3 NM/HR: [KN11]
   a. Clear
   b. Monitor
   c. Warn
   d. Attack
   e. Unable to decide, need more information

108. Given the following situation, what is the appropriate action? A contact has been labeled Air and Military and Threat Level of 3. You should: [KN12]
   a. Engage the contact with an "attack"
   b. Go back and label the contact as surface and military
   c. Engage the contact with a "warning"
   d. Check more cue values before engaging
   e. Engage the contact with an "attack"

109. In terms of the ENGAGE decision, what does a Clean Missile_Lock tell you? [KN13]
    a. The contact must be Cleared
    b. The contact should not be Attacked
    c. The contact is not dangerous to your station
    d. You need more information
    e. Response for that contact will likely be Given
110. Where are the two defensive perimeters? [KN14]
    a. 12 and 20 NM
    b. 12 and 256 NM
    c. 10 and 256 NM
    d. 10 and 512 NM
    e. 256 and 512 NM
111. At least once or twice during each scenario, you should: [KN15]
    a. Use the zoom function
    b. Write down a note about program functioning
    c. Relabel a contact
    d. Find the contact with the highest threat level and engage it
    e. Engage the contact moving the slowest
112. What is a "marker" contact? [KN16]
    a. A contact that indicates the highest possible speed for vessels
    b. A contact whose location is useful for identifying invisible boundaries
    c. The contact that appears closest to the center of the screen
    d. The contact that must be engaged first or points will be lost
    e. The contact that is most likely to penetrate a defensive perimeter
113. Five contacts appear at Bearing 45 Degrees. Which of the following is the one contact that has the greatest possibility of intruding (crossing) a defensive perimeter? [KN17]
    a. Speed 80 NM/HR, Course 90 Degrees
    b. Speed 80 NM/HR, Course 210 Degrees
    c. Speed 120 NM/HR, Course 212 Degrees
    d. Speed 120 NM/HR, Course 52 Degrees
    e. Speed 30 NM/HR, Course 90 Degrees

For the next four questions, read the scenario and choose the correct action.

114. Two contacts appear outside the outer defensive perimeter. Contact #1 is an Air_Military with Speed of 27 NM, Threat Level of 3, and a Course value that is directing it toward your station. There is No Response and Missile Lock is Locked_On. Before engaging this contact, which of the following is most appropriate? [KN18]
    a. Check another cue value before engaging
    b. Check the Speed and Course on contact #2, the other contact
    c. Engage contact #1 as quickly as possible
    d. Zoom out to ensure no other contacts are outside this perimeter
    e. Zoom in to ensure no contacts are inside this perimeter

115. Three contacts appear just outside the inner defensive perimeter, all around Bearing 0 degrees (or 12 o'clock). Two of the contacts are Surface_Civilian with Speed of 68 NM, Threat Levels of 1, Clean Missile_Lock, and Response Given. The other contact is a Surface_Military with Speed of 10 NM/HR, Threat Level of 3, No Response, and its Missile Lock is On. All contacts have Course of 169 degrees. Which of the following is the most appropriate action? [KN19]
   a. Engage one of the two Surface_Civilian contacts
   b. Engage the Surface_Military contact
   c. Zoom out to check out the outer defensive perimeter
   d. Zoom in to verify that no other contact has penetrated the inner perimeter
   e. Wait and see which direction these contacts move

116. Three contacts appear outside the outer defensive perimeter. Two of them are Air_Military with speed of 45 NM, threat levels 3, no response, and Missile_Lock On. The other is an Air_Civilian with Speed of 300 NM, Threat Level of 1, Response Given, and Clean Missile_Lock. All of the contacts have Course headings that will take them toward your station. Which of the following is best action to take next? [KN20]
   a. Engage the Air_Civilian contact
   b. Engage the Air_Military contacts
   c. Engage the contact farthest from the defensive perimeter
   d. Engage the contacts that are closest together
   e. Collect more information before Engaging any contact

117. Contact #1 appears at Bearing 270 Degrees and has a Course of 93 Degrees, Speed of 90 NM, and Range of 257 NM. There are two other contacts (#2 and #3) right next to this contact, on either side. Both contact #2 and #3 have Course of 180 Degrees and Speed of 200 NM. That is all the information you have collected thus far. Which of the following would be the best step to take next in order to avoid a penalty intrusion? [KN21]
   a. Check the Range on the two contacts on either side of Contact #1
   b. Immediately get information to Engage one of the flanking contacts (#2 or #3)
   c. Immediately get information to Label one of the two flanking contacts (#2 or #3)
   d. Immediately get information to Engage Contact #1
   e. Immediately get information to Label Contact #1

THANK YOU!

APPENDIX C

APPENDIX C

Feedback and Mediating Constructs Questionnaire

Experimental Questions -- BLOCK 1

Please respond to the following statements about how you think and feel right now. Use the scale below and fill in the appropriate numbers on the scantron sheet.

```
Strongly                                        Strongly
 Disagree   Disagree   Neutral   Agree           Agree
  <-|--------------|------------|------------|--------------|->
   (1)          (2)          (3)          (4)          (5)
```

44. I plan on learning something. [MST1]
45. I wonder who will see my results. [PRF1]
46. I hope I don't make any mistakes. [PRF2]
47. I'd like to get a chance to discuss or investigate my mistakes. [MST2]
48. I wonder how my scores will compare with others. [PRF3]
49. I hope this isn't something I already know. [MST3]
50. I'm eager to get started trying to figure this out. [MST4]
51. I want to look competent. [PRF4]
52. I want to do better than others. [PRF5]
53. Its okay if I make mistakes as long as I learn something. [MST5]

These next questions ask you to describe your training experience and your thoughts about it thus far. Use the same scale above to rate these statements.

54. The experimenter told me to focus my attention on certain aspects of the task first, before moving on to others. [SEQ1]
55. I plan to focus my attention on different parts of the experiment, depending on the instructions provided by the experimenter. [SEQ2]

STOP!

Put your pencils down and turn your attention back to the computer screen.

Experimental Questions -- BLOCK 1, cont.

Please respond to the following statements based on your most recent exposure to RADAROP and the feedback that you were provided about your performance. Use the following scale to answer these questions:

```
 Strongly                                     Strongly
 Disagree   Disagree   Neutral   Agree         Agree
 <-|-----------|----------|----------|-----------|->
  (1)         (2)        (3)        (4)         (5)
```

Regarding all of the feedback you received for that last trial:

56. The feedback I received from RADAROP indicated that I performed poorly.
57. Based on those feedback numbers, I did not do well on that last trial.
58. The feedback tells me whether I'm meeting my objectives.
59. The feedback is useful for determining my progress.
60. I am obviously really bad at this game.
61. Based on that feedback, I will never be very good at this task.
62. With the feedback I have useful information about how I am doing.
63. The feedback will help me improve next time.
64. The feedback I got provides some clues about what I should do next.
65. When I reviewed the feedback, it seemed that I did well.
66. The score and error count are NO help in determining my progress.
67. My score and the number of errors I made indicate that I did not perform well.
68. With that score and error count, I don't see how I'll ever do well on RADAR-OP.
69. Its clear from the feedback that I don't have what it takes to be good at RADAR-OP.
70. With this feedback, I have a better idea what to do for the coming study and practice sessions.
71. Even with this feedback, I'm not sure what to do next in order to get better.

Please turn to the next page and continue...

Experimental Questions -- BLOCK 1, cont.

Please respond to the following statements based on your most recent exposure to RADAROP and the feedback that you were provided about your performance. Use the following scale to answer these questions:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

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Please turn to the next page and continue...

Experimental Questions -- BLOCK 1, cont.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

Regarding the feedback on Labeling:

72. The labeling feedback helped me decide what I will focus on in the coming trials.
73. I could tell how well I labeled contacts from the feedback I got at the end of this trial.
74. I can use the labeling feedback to help me label better next time.
75. The label feedback provides valuable information on how well I labeled.

Regarding the feedback on Engaging

76. I could tell how well I engaged contacts from the feedback I got.
77. The feedback I got about engaging is useful for showing me what to do next.
78. The engage feedback clearly indicates how well I engaged.
79. I have an idea for what to focus on in order to improve my engaging for next time.

Regarding the feedback on Prioritizing

80. The feedback helped tell me how well I prioritized contacts.
81. With this feedback, I know what to do regarding prioritizing to over the next few trials.
82. I know how I did prioritizing from that feedback.
83. I can use the prioritization feedback to prioritize better next time.

STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 1, cont.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

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STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 1, cont.

Use this scale to indicate what you were thinking about ***while studying the manual.***

```
Never      Seldom     Occasionally   Frequently   Constantly
<-|----------------|----------------|----------------|----------------|->
 (1)          (2)          (3)          (4)          (5)
```

84. I daydreamed while I studied.
85. I concentrated on the material.
86. I lost interest in learning the material for short periods of time.
87. I thought about other things that I have to do today.
88. I let my mind wander while I was studying the manual.
89. I looked for information to help improve (i.e., lower) my error counts.

```
Strongly                                     Strongly
 Disagree   Disagree   Neutral   Agree      Agree
 <-|--------------|------------|------------|--------------|->
   (1)          (2)         (3)         (4)          (5)
```

90. I can meet the challenges of my role in this simulation.
91. I can learn how to handle my role successfully.
92. I do NOT want to learn any more about RADAR-OP.
93. I want to perform well on RADAR-OP.
94. I am willing to commit extra time to this study in order to learn more about RADAROP.
95. I am confident in my understanding of how information cues are related to the decisions I have to make.
96. I am willing to commit extra time in order to improve my RADAR-OP score.
97. I am confident that I can grasp the rules of RADAR-OP as long as I have time to study.
98. I am certain that I can manage the requirements of my position for this task.
99. I don't care if I ever get high scores on this game.
100. I believe I can acquire the skills needed in this game.
101. I am certain that I am capable of learning how to do well on RADAR-OP.
102. I believe I will fare well in this task if the workload is increased.
103. I don't care if I learn another thing about this game.
104. I believe that learning this simulation is something I can handle.
105. I am motivated to learn the RADAR-OP game.
106. I want to get high RADAR-OP scores.
107. I want to learn as much as I can from the manual and game.
108. I am certain I can cope with task components competing for my time.
109. I am motivated to perform well on this game.

STOP -- Put your pencils down and take a quick break.

Experimental Questions -- BLOCK 1, cont.

Use this scale to indicate what you were thinking about ***while studying the manual.***

Never	Seldom	Occasionally	Frequently	Constantly
(1)	(2)	(3)	(4)	(5)

84. I daydreamed while I studied.
85. I concentrated on the material.
86. I lost interest in learning the material for short periods of time.
87. I thought about other things that I have to do today.
88. I let my mind wander while I was studying the manual.
89. I looked for information to help improve (i.e., lower) my error counts.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

90. I can meet the challenges of my role in this simulation.
91. I can learn how to handle my role successfully.
92. I do NOT want to learn any more about RADAR-OP.
93. I want to perform well on RADAR-OP.
94. I am willing to commit extra time to this study in order to learn more about RADAROP.
95. I am confident in my understanding of how information cues are related to the decisions I have to make.
96. I am willing to commit extra time in order to improve my RADAR-OP score.
97. I am confident that I can grasp the rules of RADAR-OP as long as I have time to study.
98. I am certain that I can manage the requirements of my position for this task.
99. I don't care if I ever get high scores on this game.
100. I believe I can acquire the skills needed in this game.
101. I am certain that I am capable of learning how to do well on RADAR-OP.
102. I believe I will fare well in this task if the workload is increased.
103. I don't care if I learn another thing about this game.
104. I believe that learning this simulation is something I can handle.
105. I am motivated to learn the RADAR-OP game.
106. I want to get high RADAR-OP scores.
107. I want to learn as much as I can from the manual and game.
108. I am certain I can cope with task components competing for my time.
109. I am motivated to perform well on this game.

STOP -- Put your pencils down and take a quick break.

<u>Experimental Questions -- BLOCK 2</u>

Please respond to the following statements based on your most recent exposure to RADAROP and the feedback that you were provided about your performance. Use the following scale to answer these questions:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

<-|--------------|------------|------------|--------------|->

Regarding all of the feedback you received for that last trial:

1. The feedback I received from RADAROP indicated that I performed poorly.
2. Based on those feedback numbers, I did not do well on that last trial.
3. The feedback tells me whether I'm meeting my objectives.
4. The feedback is useful for determining my progress.
5. I am obviously really bad at this game.
6. Based on that feedback, I will <u>never</u> be very good at this task.
7. With the feedback I have useful information about how I am doing.
8. The feedback will help me improve next time.
9. The feedback I got provides some clues about what I should do next.
10. When I reviewed the feedback, it seemed that I did well.
11. The score and error count are NO help in determining my progress.
12. My score and the number of errors I made indicate that I did not perform well.
13. With that score and error count, I don't see how I'll <u>ever</u> do well on RADAR-OP.
14. Its clear from the feedback that I don't have what it takes to be good at RADAR-OP.
15. With this feedback, I have a better idea what to do for the coming study and practice sessions.
16. Even with this feedback, I'm not sure what to do next in order to get better.

Please turn to the next page and continue...

Experimental Questions -- BLOCK 2

Please respond to the following statements based on your most recent exposure to RADAROP and the feedback that you were provided about your performance. Use the following scale to answer these questions:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

Regarding all of the feedback you received for that last trial:

1. The feedback I received from RADAROP indicated that I performed poorly.
2. Based on those feedback numbers, I did not do well on that last trial.
3. The feedback tells me whether I'm meeting my objectives.
4. The feedback is useful for determining my progress.
5. I am obviously really bad at this game.
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7. With the feedback I have useful information about how I am doing.
8. The feedback will help me improve next time.
9. The feedback I got provides some clues about what I should do next.
10. When I reviewed the feedback, it seemed that I did well.
11. The score and error count are NO help in determining my progress.
12. My score and the number of errors I made indicate that I did not perform well.
13. With that score and error count, I don't see how I'll ever do well on RADAR-OP.
14. Its clear from the feedback that I don't have what it takes to be good at RADAR-OP.
15. With this feedback, I have a better idea what to do for the coming study and practice sessions.
16. Even with this feedback, I'm not sure what to do next in order to get better.

Please turn to the next page and continue...

Experimental Questions -- BLOCK 2, cont.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

Regarding the feedback on Labeling:

17. The labeling feedback helped me decide what I will focus on in the coming trials.
18. I could tell how well I labeled contacts from the feedback I got at the end of this trial.
19. I can use the labeling feedback to help me label better next time.
20. The label feedback provides valuable information on how well I labeled.

Regarding the feedback on Engaging

21. I could tell how well I engaged contacts from the feedback I got.
22. The feedback I got about engaging is useful for showing me what to do next.
23. The engage feedback clearly indicates how well I engaged.
24. I have an idea for what to focus on in order to improve my engaging for next time.

Regarding the feedback on Prioritizing

25. The feedback helped tell me how well I prioritized contacts.
26. With this feedback, I know what to do regarding prioritizing to over the next few trials.
27. I know how I did prioritizing from that feedback.
28. I can use the prioritization feedback to prioritize better next time.

STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 2, cont.

```
Strongly                                      Strongly
 Disagree   Disagree   Neutral   Agree     Agree
 <-|--------------|------------|------------|--------------|->
  (1)           (2)         (3)        (4)           (5)
```

Regarding the feedback on Labeling:

17. The labeling feedback helped me decide what I will focus on in the coming trials.
18. I could tell how well I labeled contacts from the feedback I got at the end of this trial.
19. I can use the labeling feedback to help me label better next time.
20. The label feedback provides valuable information on how well I labeled.

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21. I could tell how well I engaged contacts from the feedback I got.
22. The feedback I got about engaging is useful for showing me what to do next.
23. The engage feedback clearly indicates how well I engaged.
24. I have an idea for what to focus on in order to improve my engaging for next time.

Regarding the feedback on Prioritizing

25. The feedback helped tell me how well I prioritized contacts.
26. With this feedback, I know what to do regarding prioritizing to over the next few trials.
27. I know how I did prioritizing from that feedback.
28. I can use the prioritization feedback to prioritize better next time.

STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 2, cont.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

<-|--------------|------------|------------|--------------|->

Regarding the feedback on Labeling:

17. The labeling feedback helped me decide what I will focus on in the coming trials.
18. I could tell how well I labeled contacts from the feedback I got at the end of this trial.
19. I can use the labeling feedback to help me label better next time.
20. The label feedback provides valuable information on how well I labeled.

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21. I could tell how well I engaged contacts from the feedback I got.
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24. I have an idea for what to focus on in order to improve my engaging for next time.

Regarding the feedback on Prioritizing

25. The feedback helped tell me how well I prioritized contacts.
26. With this feedback, I know what to do regarding prioritizing to over the next few trials.
27. I know how I did prioritizing from that feedback.
28. I can use the prioritization feedback to prioritize better next time.

STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 3

Please respond to the following statements based on your most recent exposure to RADAROP and the feedback that you were provided about your performance. Use the following scale to answer these questions:

```
Strongly                                      Strongly
Disagree   Disagree   Neutral   Agree          Agree
<-|-------------|------------|------------|-------------|->
 (1)          (2)         (3)         (4)          (5)
```

Regarding all of the feedback you received for that last trial:

29. The feedback I received from RADAROP indicated that I performed poorly.
30. Based on those feedback numbers, I did not do well on that last trial.
31. The feedback tells me whether I'm meeting my objectives.
32. The feedback is useful for determining my progress.
33. I am obviously really bad at this game.
34. Based on that feedback, I will never be very good at this task.
35. With the feedback I have useful information about how I am doing.
36. The feedback will help me improve next time.
37. The feedback I got provides some clues about what I should do next.
38. When I reviewed the feedback, it seemed that I did well.
39. The score and error count are NO help in determining my progress.
40. My score and the number of errors I made indicate that I did not perform well.
41. With that score and error count, I don't see how I'll ever do well on RADAR-OP.
42. Its clear from the feedback that I don't have what it takes to be good at RADAR-OP.
43. With this feedback, I have a better idea what to do for the coming study and practice sessions.
44. Even with this feedback, I'm not sure what to do next in order to get better.

Please turn to the next page and continue...

Experimental Questions -- BLOCK 3, cont.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

<-|--------------|------------|------------|--------------|->

Regarding the feedback on Labeling:

45. The labeling feedback helped me decide what I will focus on in the coming trials.
46. I could tell how well I labeled contacts from the feedback I got at the end of this trial.
47. I can use the labeling feedback to help me label better next time.
48. The label feedback provides valuable information on how well I labeled.

Regarding the feedback on Engaging

49. I could tell how well I engaged contacts from the feedback I got.
50. The feedback I got about engaging is useful for showing me what to do next.
51. The engage feedback clearly indicates how well I engaged.
52. I have an idea for what to focus on in order to improve my engaging for next time.

Regarding the feedback on Prioritizing

53. The feedback helped tell me how well I prioritized contacts.
54. With this feedback, I know what to do regarding prioritizing to over the next few trials.
55. I know how I did prioritizing from that feedback.
56. I can use the prioritization feedback to prioritize better next time.

STOP!

Put your pencils down and return to RADAROP.

Experimental Questions -- BLOCK 3, cont.

Use this scale to indicate what you were thinking ***while studying the manual.***

Never Seldom Occasionally Frequently Constantly
<-|----------------|----------------|----------------|----------------|->
(1) (2) (3) (4) (5)

57. I daydreamed while I studied.
58. I concentrated on the material.
59. I lost interest in learning the material for short periods of time.
60. I thought about other things that I have to do today.
61. I let my mind wander while I was studying the manual.
62. I looked for information to help improve (i.e., lower) my error counts.

Strongly Disagree Disagree Neutral Agree Strongly Agree
<-|--------------|------------|------------|--------------|->
(1) (2) (3) (4) (5)

63. I can meet the challenges of my role in this simulation.
64. I can learn how to handle my role successfully.
65. I do NOT want to learn any more about RADAR-OP.
66. I want to perform well on RADAR-OP.
67. I am willing to commit extra time to this study in order to learn more about RADAROP.
68. I am confident in my understanding of how information cues are related to the decisions I have to make.
69. I am willing to commit extra time in order to improve my RADAR-OP score.
70. I am confident that I can grasp the rules of RADAR-OP as long as I have time to study.
71. I am certain that I can manage the requirements of my position for this task.
72. I don't care if I ever get high scores on this game.
73. I believe I can acquire the skills needed in this game.
74. I am certain that I am capable of learning how to do well on RADAR-OP.
75. I believe I will fare well in this task if the workload is increased.
76. I don't care if I learn another thing about this game.
77. I believe that learning this simulation is something I can handle.
78. I am motivated to learn the RADAR-OP game.
79. I want to get high RADAR-OP scores.
80. I want to learn as much as I can from the manual and game.
81. I am certain I can cope with task components competing for my time.
82. I am motivated to perform well on this game.

STOP -- Put your pencils down and take a quick break.

APPENDIX D

APPENDIX D

Individual Differences Questionnaire

Radar Operator Experiment (RADAR-OP) Questionnaire

INSTRUCTIONS

Please DO NOT write on this survey. Answer all questions on the scantron sheets provided. Please write in and bubble the corresponding numbers for your Personal Identification Number (PID). If you are willing to provide your name so we can contact you about possible rewards and/or future studies, go ahead and write in your LAST NAME and FIRST INITIAL (you do not have to bubble in those letters). Either way all your responses today are confidential.

Answer the following questions by filling in the bubble for the number that represents your response. There are no right or wrong answers, I just want to know a little about you. When you reach the end of page that says "STOP -- Please wait for further instructions," put your pencil down and stop answering the questions.

Read the INSTRUCTIONS and the SCALE on each page carefully.

Demographics

1. What is your sex? [sex]
   (1) Male (2) Female

2. What is your age? [age]
   (1) less than 18 yrs (2) 18-19 yrs (3) 20-21 yrs (4) 22-23 yrs (5) greater than 23 yrs

3. What is your overall grade point average? [gpa]
   (1) 0 to .9 (2) 1.0 to 1.9 (3) 2.0 to 2.9 (4) 3.0 to 3.9 (5) $\geq$ 4.0

4. Have you ever played TAG (The Tactical Action Game) or TAS (The Tactical Action Simulation) before ? [evertag]
   (1) Yes (2) No (3) Uncertain

5. Are you left or right handed? [hand]
   (1) Left (2) Right

6. Do you play with video/computer games? [playvid]
(1) Never (2) Rarely (3) Sometimes (4) Frequently (5) Always

7. How often do you work with a "mouse" on computers? [mouse]
(1) Never (2) Rarely (3) Sometimes (4) Frequently (5) Always

Individual Differences

This set of questions asks you to describe what you think about each of the following statements. Please use the scale shown below to make your ratings.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

<---|------------|------------|------------|------------|--->

8. I do my best when I'm working on a fairly difficult task. [L1]
9. I like to be fairly confident that I can successfully perform a task before I attempt it. [P1]
10. When I have difficulty solving a problem, I enjoy trying different approaches to see which one will work. [L2]
11. I try hard to improve on my past performance. [L3]
12. The things I enjoy the most are the things I do the best. [P2]
13. The opportunity to do challenging work is important to me. [L4]
14. I feel smart when I do something without making any mistakes. [P3]
15. I prefer to do things that I can do well rather than things that I do poorly. [P4]
16. The opportunity to extend the range of my abilities is important to me. [L5]
17. The opportunity to learn new things is important to me. [L6]
18. I feel smart when I can do something better than most other people. [P5]
19. The opinions others have about how well I can do certain things are important to me. [P6]
20. I prefer to work on tasks that force me to learn new things. [L7]
21. I am happiest at work when I perform tasks on which I know that I won't make errors. [P7]
22. I like to work on tasks that I have done well on in the past. [P8]
23. When I fail to complete a difficult task, I plan to try harder next time I work on it. [L8]

Individual Differences, cont.

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to the word. ***Indicate to what extent you generally feel this way, that is, how you feel on the average.*** Use the following scale to record your answer.

very slightly or not at all	a little	moderately	quite a bit	extremely
(1)	(2)	(3)	(4)	(5)

<----|---------------|---------------|-------------|---------------|---->

24. Distressed [NA1]
25. Upset [NA2]
26. Enthusiastic [PA1]
27. Interested [PA2]
28. Hostile [NA3]
29. Determined [PA3]
30. Irritable [NA4]
31. Scared [NA5]
32. Afraid [NA6]
33. Excited [PA4]
34. Inspired [PA5]
35. Alert [PA6]
36. Ashamed [NA7]
37. Active [PA7]
38. Guilty [NA8]
39. Nervous [NA9]
40. Strong [PA8]
41. Proud [PA9]
42. Attentive [PA10]
43. Jittery [NA10]

STOP!

Put your pencils down and wait for further instructions.

APPENDIX E

APPENDIX E

Hypotheses, Analyses, and Summary of Results

#	Variables in Analysis	Technique(s)	Expected Direction of Results	Support
1	IV: Mastery Focus (MF: 0,1) DV: Mag. Neg. Fdbck (MNF)	RM-ANOVA	Lower MNF means in mastery (MF) conditions	Marginal
2a	IV: Sequencing (SQ: 0,1) DV: Diagnosticity of Fdbck (DF)	RM-ANOVA	Higher DF means in sequenced (SQ) conditions	No
2b	Diagnosticity of Feedback (DF)	RM-ANOVA	DF increases over time	Marginal
2c	Diagnosticity of Feedback (DF)	Paired Sample T-Test	Higher DF for sequenced variable at the time it is sequenced, compared to other DNF values that have yet to be sequenced within subject	Yes
2d	IV: Sequencing (SQ: 0,1) DV: Diagnosticity Feedback (DF)	Independent Sample T-Test	Higher DF for sequenced variable at time in the sequenced condition compared to unsequenced subjects	Partial
3a	IVS: Sequencing (SQ: 0,1) Mastery Focus (MF: 0,1) Seq. x Mastery (SQ*MF) DV: Mag. Neg. Fdbck (MNF)	RM-ANOVA	Higher MNF mean in performance+unsequenced (SQ*MF) cell, other cells equivalent	No
3b	IVS: Sequencing (SQ: 0,1) Mastery Focus (MF: 0,1) Seq. x Mastery (SQ*MF) DV: Diagnosticity Feedback (DF)	RM-ANOVA	Lower DNF mean in performance+unsequenced cell (SQ*MF), other cells equivalent	No
4a	IV: Cognitive Ability (COG) DV: Diagnosticity Feedback (DF)	Regression	Positive correlation/beta-weight between COG and DF	No
4b	IV: Cognitive Ability (COG) DVS: Know/Skill Outcomes	Regression	Positive correlation/beta-weight between COG and KO, SO	Yes
4c	IV: Negative Affectivity (NEG) DV: Mag. Neg. Fdbck (MNF)	Regression	Positive correlation/beta-weight between NEG and DNF	No
4d	IV: Trait Goal Orientation (TGO) DV: Mag. Neg. Fdbck (MNF)	Regression	Negative correlation/beta-weight between TGO and MNF	Partial
5	IV: Diagnosticity Feedback (DF) DV: Attentional Focus (ATF)	Regression	Positive correlation/beta-weight between DF and ATF	No
6	IV: Magnitude Neg. Fdbck (MNF) DV: Self-Efficacy (SEF)	Regression	Negative correlation/beta-weight between MNF and SEF	Yes
7	IV: Self-Efficacy (SEF) DV: Motivation to Learn (MOT)	Regression	Positive correlation/beta-weight between SEF and MOT	Not Tested
8a	IVS: Motivation to Learn (MOT) Attentional Focus (ATF) DVS: Knowledge Outcomes (KO) Skill Outcomes (SO)	Hierarchical Regressions (each DV tested separately)	Positive beta-weight on the MOT*ATF interaction term predicting KO and SO	No
8b	IV: Motivation to Learn (MOT) DV: Affective Outcomes (AO)	Regression	Positive correlation/beta-weight between MTL and ALO	Yes

LIST OF REFERENCES

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