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ABSTRACT

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By

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This paper is concerned with the definition and application of position, velocity, and acceleration performance information as feedback. Specifically, it examines individuals' affective, behavioral, and cognitive reactions to feedback frames over time and across two contrasting performance profiles. Repeated measures MANCOVA supported a performance profile x time interaction for state positive affect, task self-efficacy, satisfaction with performance, and goal commitment. Simple effects analyses indicated that participants' indicators of task motivation increased over time in the accelerating performance profile, but decreased over time in the decelerating performance profile. A three-way interaction between feedback frame, performance profile, and time was not supported as hypothesized.

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INTRODUCTION

In their review of the literature concerning the efficacy of feedback interventions, Kluger and DeNisi (1996) noted that organizational researchers have historically ignored the variable relationship between feedback and performance which, in turn, has contributed to the widely held assumption that providing feedback improves performance. This assumption prompted Pritchard, Jones, Roth, Stuebing, and Eckberg (1988) to proclaim, "The positive effect of feedback on performance has become one of the most accepted principles in psychology" (p. 338).

While other researchers have been more cautious in their statements regarding the efficacy of feedback (e.g., Balcazar, Hopkins & Suarez, 1985; Ilgen, Taylor & Fisher, 1979; Latham & Locke, 1991), Kluger and DeNisi (1996) identified Ammons' (1956) review as an often-cited source for the feedback assumption. After reviewing the research on feedback, Ammons had concluded that knowledge of performance positively affects both learning and motivation. However, Kluger and DeNisi claim that Ammons' conclusions are inappropriate considering their own review of his referenced studies revealed contradictory evidence, inaccurate operationalizations, and substandard methodologies. Indeed, their meta-analysis of feedback interventions found a sample-size weighted mean effect size of 0.41, which suggests a moderately positive effect of feedback on performance; however, they also noted that some 38% of the observed effects were negative. Ultimately, they concluded that much more needs to be learned about feedback, with a special emphasis on identifying the feedback property, task characteristic, contextual, and individual difference moderators of the feedback-performance relationship.

It is ironic that industrial and organizational psychologists do not know more about the effects of providing performance feedback given the prominent role it plays in theories and processes of performance appraisal, performance development, self-regulated learning, and skill-acquisition. One result of this situation is that, even though feedback can take many forms and be used for many purposes, there is no commonly-accepted typology of performance feedback. Some researchers have proposed differentiating among types of feedback according to its intended purpose or information content. For example, Kluger and DeNisi (1996) distinguish between providing knowledge of results (i.e., outcome or "what" information) and knowledge of performance (i.e., process or "how" information), Kozlowski et al. (2001) propose a feedback typology that distinguishes between the informational (i.e., descriptive) and interpretational (e.g., evaluative or attributional) properties of feedback, and Carver and Scheier's (1990; 1998) interpretation of Control Theory distinguishes between the use of position feedback (i.e., discrepancy with respect to goal) and velocity feedback (i.e., rate of change in discrepancy reduction with respect to goal). Without an organizing framework for the study of feedback, it is no wonder that some types of feedback are relatively unknown. For example, despite the introduction of velocity feedback by Carver and Scheier in 1990, only a handful of studies have been published that explore this concept and its related forms (i.e., position and acceleration feedback).

This paper is concerned with the definition and application of position, velocity, and acceleration performance information as feedback. Specifically, this study will examine individuals' affective, behavioral, and cognitive reactions to performance feedback presented in position-, velocity-, and acceleration-salient frames. By exploring the effects of these feedback frames on different performance profiles over time, I expect to find that some frames produce greater motivation gains than others in specific profiles and at specific time periods during skill acquisition. Before introducing my research hypotheses, I will first review the role of feedback in self-regulation theory; conceptually and operationally define position, velocity, and acceleration feedback frames; present two contrasting performance profiles (i.e., learning curves) that depict the process of self-regulated learning or skill acquisition over time, and describe several outcome variables that can be used to assess the effects of feedback in motivating performance.

LITERATURE REVIEW

The Role of Feedback in Theories of Self-Regulation

Feedback is a core component of many theories of self-regulation including Goal Setting Theory (Locke & Latham, 1990; Latham & Locke, 1991), Social Cognitive Theory (Bandura, 1986; 1991; Wood & Bandura, 1989), and Control Theory (Campion & Lord, 1982; Carver & Scheier, 1982; 1990; 1998; Lord & Hanges, 1987). In the following section, I will introduce each of these theories and discuss the role that feedback plays in their explanation of self-regulatory behavior.

Goal Setting Theory. With well over one-thousand goal-related studies in publication, Locke and Latham's (1990) Theory of Goal Setting has emerged as "the single most dominant theory in the field [of organizational behavior]" (Mitchell & Daniels, 2003, p. 231). At its core, the theory asserts that challenging, specific goals are a proximal regulator of human behavior because people have "things" that they want to achieve. Put simply, goal setting facilitates self-regulation because a goal specifies a standard, or defines an acceptable level of performance, for use in evaluating purposeful activities. In order to evaluate a performance relative to a standard, performance feedback must be available. When efforts produce outcomes and corresponding feedback that indicate a failure to meet the standard, then these efforts are evaluated negatively and prompt actions to improve subsequent performance. However, when efforts result in outcomes and associated feedback that reveals that the standard has been achieved or surpassed, then they are evaluated positively and can lead to a reduction in effort or the adoption of a new, higher standard.

The benefits of difficult and specific goals have been demonstrated across numerous studies employing different tasks, settings, subjects, countries, criteria, and time spans (see Latham and Locke, 1990, for a review), and is reflected in the results of several meta-analyses of the goal-performance relationship (e.g., Mento, Steel & Karren, 1987; Tubbs, 1986; Wright, 1990). However, this observed relationship is moderated by several individual and situational variables such as ability (Locke, 1982), task complexity (Wood, Mento & Locke, 1987), and the presence of feedback. Specifically, individuals must have adequate knowledge of results (i.e., feedback) if they are to evaluate their own progress toward their goals (Erez, 1977; Locke, Shaw, Saari & Latham, 1981). Bandura and Cervone (1983) found that feedback was an essential component of goal systems after observing significant increases in participants' performances on a strenuous physical task, but only when both goals and performance feedback were provided. Thus, feedback is not only necessary for self-regulation in Goal Setting Theory, it is also an important means for leveraging performance.

Social Cognitive Theory. Social Cognitive Theory provides a framework for understanding the interactions among human behavior, cognition, affect, and the environment in self-regulation. Like Goal Setting Theory, Social Cognitive Theory is capable of explaining the self-regulation of goal-directed behavior; however, it places greater emphasis on a person's cognitive and affective reactions to their performance and their environment (Kanfer, 1993).

According to Bandura (1986; 1991), three psychological "subfunctions" are employed for self-regulation: self-monitoring, self-evaluation, and self-reaction. Self-monitoring involves the observation of those behaviors, environmental conditions, and outcomes that are instrumental for goal attainment. These observations provide the information required to set achievable goals and evaluate goal progress. Self-evaluation entails making a judgment about goal progress. More precisely, it requires making a comparison between a current state (i.e., performance) and a desired state (i.e., goal). Finally, self-reaction refers to internal, affective responses to self-evaluation (i.e., satisfaction or dissatisfaction). When performance is substandard, self-reactions generate feelings of dissatisfaction. However, when performance meets or surpasses the standard, they generate feelings of satisfaction. In either case, the intensity of the self-reaction is commensurate with the magnitude of the discrepancy between the performance and the standard. Collectively, the self-monitoring, self-evaluation, and self-reaction subfunctions provide the mechanism for self-regulation. Wood and Bandura (1989) summarize this process best:

> People seek self-satisfactions from fulfilling valued goals, and they are motivated by discontent with substandard performances. Thus, discrepancies between behavior and personal standards generate self-reactive influences, which serve as motivators and guides for action designed to achieve desired results. (p. 366)

Thus, Social Cognitive Theory relies on feedback obtained during self-monitoring to evaluate performance during self-evaluation. Specifically, people self-monitor their performance and attend to environmental indicators of their performance during self-monitoring in order to generate performance feedback. This feedback is then used during self-evaluation to determine if performance is substandard, adequate, or more than adequate with respect to the goal. Therefore, like Goal Setting Theory, Social Cognitive

Theory requires feedback to evaluate goal progress and motivate subsequent goal-directed behaviors.

Control Theory. As with the preceding theories, Control Theory includes feedback in its explanation of self-regulation. However, Carver and Scheier's (1990; 1998) revised treatments of Control Theory distinguish among different types of feedback. Specifically, they discuss the role of position feedback, introduce the concept of velocity feedback, and allude to the possibility of acceleration feedback. As their theory is foundational to this study's discussion of feedback frames, I will review it in greater detail.

Many of the concepts found in Control Theory are drawn from Cybernetics, the science of feedback processes for the control and regulation of engineering systems (see Weiner, 1948). At the heart of both Cybernetics and Control Theory is the negative feedback loop, or discrepancy-reducing loop, the mechanism that affords system self-regulation in the pursuit of a desired outcome or state. In one of its earliest manifestations, Miller, Galanter, and Pribram (1960) referred to this loop as a Test-Operate-Test-Exit (TOTE) unit. This unit "tests" for discrepancies between the system's desired state and the environment's actual state, "operates" on the environment to reduce apparent discrepancies, "tests" again for discrepancies, and "exits" the loop when discrepancies are absent.

However, a more contemporary application of the discrepancy-reducing loop is presented in Carver and Scheier's (1982) initial explanation of Control Theory. Their theory is based on a negative feedback loop consisting of four system components: an input function, a reference value, a comparator, and an output function. The purpose of the input function, or sensor, is to obtain information from the environment and introduce it into the system. Put another way, the sensor "perceives" feedback from the external environment to aid in self-regulation. The reference value is an internally-derived standard by which the input function's feedback is to be judged. This reference standard is commonly referred to as a goal; an objective or state a self-regulating system is trying to achieve or maintain (Lord & Hanges, 1987). As its namesake implies, the comparator compares the sensed external information from the input function to the internal reference standard (i.e., goal) held by the system in order to determine if the values are discrepant. When a discrepancy exists, the output function, or effecter, initiates a response for the purposes of altering the environment. That is, an effecter "behaves" in a particular manner in order to generate feedback that is more consistent with the reference standard.

In subsequent work (i.e., Carver & Scheier, 1990; 1998), the authors expand and revise their theory to discuss the role of affect as a motivational influence in self-regulation. This is accomplished by proposing two nested negative feedback loops: an inner "action loop" and an outer "meta loop" (see Figure 1 in Appendix B). The action loop encompasses the discrepancy-reducing processes that take place in the negative feedback loop as described previously. In this inner loop, self-regulation consists of a monitoring function focused on the amount of discrepancy present. Thus, feedback in the action loop is positional. That is, position feedback is used in the action loop to determine the amount of discrepancy present at any given time. If discrepancies are present, the action loop triggers behaviors intended to reduce the likelihood of future discrepancies.

Although the outer meta loop is comprised of the same four components found in the inner action loop, the meta loop performs a "meta monitoring" function that is concerned with the rate of change in discrepancy reduction taking place in the action loop. Carver and Scheier (1990; 1998) refer to this type of feedback used in the meta loop as "velocity" because the rate of change in distance (i.e., the first derivative of distance) is called velocity in the physical sciences. So, while the action loop uses positional feedback to identify discrepancies between the current state and some desired state, the meta loop uses velocity feedback to determine if there is a discrepancy between the current rate of discrepancy reduction and some "acceptable rate of behavioral discrepancy reduction," (p. 122) which serves as the meta loop's reference value. Furthermore, the action and meta loops generate different outcomes in the event of a discrepancy. Whereas discrepancies in the action loop trigger discrepancy reducing behaviors, Carver and Scheier suggest that discrepancies in the meta loop generate affect.

Affect generated in the meta loop serves to motivate the intensity of discrepancy reducing behaviors (Carver & Scheier, 1990; 1998). Borrowing from Higgins' (1987) Self-Discrepancy Theory, Carver and Scheier classify affect as positive (i.e., elation or joy), neutral, or negative (i.e., depression). When the rate of discrepancy reduction in the meta loop is perceived to be consistent with the reference standard, affect is neutral and the intensity of discrepancy reducing behaviors is unchanged. However, when the rate of progress is slower than the standard, or when there is no progress whatsoever, affect is negative and in proportion to the size of the discrepancy. The experience of depression motivates the system to intensify its discrepancy reducing behaviors. By contrast, when the rate of progress is faster than the standard, affect is positive and proportional to the discrepancy. It is the experience of elation that motivates the system to scale back on excessive discrepancy reducing behaviors.

Carver and Scheier (1990; 1998) also note that people are able to sense acceleration, or changes in velocity (i.e., changes in the rate of change in discrepancy reduction), and assert that the presence of acceleration leads to changes in affect. Specifically, they propose that a sensed increase in velocity (i.e., positive acceleration) results in a change in affect that is manifested as a shift toward a more positive experience of elation. Conversely, a sensed decrease in velocity (i.e., negative acceleration or deceleration) results in a change in affect characterized by a shift toward a more negative experience of depression. While this explanation suggests the presence of an "uber-loop" that encapsulates both the meta and action loops to monitor acceleration feedback, Carver and Scheier do not specifically propose a third feedback control loop. Instead, they suggest that it is possible to sense a quality such as acceleration without a feedback loop.

Each of the theories discussed in this section provide an adequate explanation for self-regulatory behavior. Indeed, the three theories have much in common as each requires (1) a goal or standard that represents an objective or state that is desirable to individuals, (2) individuals engage in behaviors that are expected to achieve their goals, (3) feedback that indicates individuals' progress toward their goals, and (4) individuals evaluate their performance and take corrective action in the event of a discrepancy. However, Control Theory is particularly interesting because it proposes that position, velocity, and acceleration information are distinct forms of feedback that produce different behavioral or affective responses during self-regulation. In the following section, I will conceptually define position, velocity, and acceleration as they are presented in the physical sciences, review the limited number of studies that have applied these constructs in the social sciences, and discuss the appropriate translation of these constructs for self-regulatory research.

Feedback Frames: Position, Velocity & Acceleration Information

Carver and Scheier's (1990; 1998) conceptions of position, velocity, and acceleration feedback are derived from the same properties discussed in the physical sciences. Specifically, the Law of One-Dimensional Motion defines the position function of an object as $x(t) = 1/2at^2 + vt + c$, the velocity function as $v(t) = at + v$, and the acceleration function as $a(t) = a$ (where a is the object's acceleration, v is the object's velocity, and c is the object's position at time t). Using basic calculus, it can be shown that $v(t)$ is the first derivative of $x(t)$ and indicates the rate of change in position or the change in position over time. Furthermore, $a(t)$ is the first derivative of $v(t)$, the second derivative of $x(t)$, and indicates the rate of change in velocity over time (i.e., the rate of change in the rate of change in position over time). Graphically, position is often portrayed as a point on an axis at a given time, velocity is depicted as a slope indicating the rate of change in that position over time, and acceleration is illustrated by a curve revealing the rate of change in velocity over time, whereby any line (i.e., slope) drawn tangent to the curve is the velocity at that time.

Despite the popularity of Control Theory, the number of published studies examining velocity or acceleration feedback can be counted on just one hand. Working independently of Carver and Scheier (1990; 1998), Hsee and associates conducted a series of three studies exploring the relationship between outcomes, framed in terms of position, velocity, and acceleration, on individuals' levels of satisfaction. In the first study, Hsee and Abelson (1991) proposed that individuals not only derive satisfaction from the position of outcomes (e.g., a stock valued at $100), but also the velocity of outcomes (e.g., a stock rapidly appreciating from $50 to $100). To test their hypothesis, they presented individuals with pairs of hypothetical outcomes describing different positions and velocities and asked them to select the outcome that they found more satisfying. The data revealed that individuals preferred (1) a more positive outcome to a less positive outcome, (2) an outcome preceded by a rapid rise to the same outcome preceded by a slow rise, (3) an outcome preceded by a slow fall to the same outcome preceded by a fast fall, (4) an outcome preceded by a small but fast rise to the same outcome preceded by a large but slow rise, and (5) an outcome preceded by a large slow fall to the same outcome preceded by a small fast fall. This study established that outcome satisfaction is related to both the position and velocity of outcomes. Furthermore, it demonstrated that individuals do recognize and respond to velocity information in predictable ways. Specifically, more positive velocities are associated with greater satisfaction, while more negative velocities are associated with less satisfaction.

In a companion study, Hsee, Abelson and Salovey (1991) hypothesized that an individual's total satisfaction with an outcome was the sum of their position and velocity satisfactions. To test this hypothesis, they obtained baseline satisfaction ratings of two outcomes: a negative velocity resulting in a higher outcome position and a positive velocity culminating in a lower outcome position. The authors then asked participants to provide satisfaction ratings of additional outcome pairs in which either position or velocity information was made salient. They found that framing outcomes in position- and velocity-salient ways altered the relative contributions of position and velocity satisfaction, respectively, to the total amount of reported satisfaction for the outcomes. This study was significant as it demonstrated that the framing of outcomes in terms of position or velocity does affect individuals' decisions, a conclusion that is consistent with Kahneman and Tversky's (1979; 1984) research of the effect of positive or negative semantic frames on decision-making in situations involving risk.

In their final study of the outcome satisfaction relations, Hsee, Salovey and Abelson (1994) proposed that individuals derive satisfaction from the acceleration of outcomes as well as their position and velocity. After presenting pairs of outcome curves with common displacements and velocities but different accelerations, they found that participants were more satisfied with curves depicting more positive accelerations. However, they recognized that all positive acceleration curves used in the study also portrayed a positive tail-end velocity which constituted a potential confound in their study. To clarify their results, they conducted a second study in which they provided participants with outcome curves featuring varying displacements but identical velocities at the tail ends of their curves, and asked then to provide satisfaction ratings continuously as the curves were slowly drawn on a computer screen. The data revealed that participants' reported increasingly more positive satisfaction ratings when the tail ends of the acceleration curves grew more positive. Apparently, in addition to position and velocity information, the authors demonstrated that individuals are also responsive to acceleration information.

Collectively, these studies by Hsee and colleagues demonstrate that people do respond differently to similar outcomes framed in ways that make different aspects of a given performance or outcome salient. However, in each case, the authors simply asked participants to rate their level of satisfaction with various hypothetical outcomes. Without the presence of a clear goal, it is difficult to explain the observed results in terms of Control Theory, as the comparator requires a reference value in order to evaluate feedback and identify a discrepancy. Consequently, it is neither clear what referent standard participants had in mind when making their satisfaction ratings of position-, velocity-, or acceleration-framed outcomes, nor how these different feedback frames might influence their reactions when immersed in a goal-directed environment or activity.

To date, Lawrence, Carver and Scheier (2002) have published the only study that incorporates velocity feedback and a behavioral goal in the discrepancy-reducing context of Control Theory. In an apparent test of Control Theory's meta-loop as an affect generator, the authors designed an ambiguous performance task that requested participants rely on their "social intuition" to identify which of 60 foreign words presented in 6 trials of 10 items were paired with their English translations. In fact, the foreign words were bogus and the task was sufficiently ambiguous that participants were forced to rely on the experimenter-provided feedback to determine how they were performing. The use of this type of task allowed the authors to plausibly manipulate performance feedback and subsequently assess participants' reactions to their feedback (i.e., participants' mood ratings obtained before trial 1 and after trial 6).

The participants' stated action-loop goal was to maximize the number of correct responses at the end of the trials and a guess rate of 50% was provided to serve as a meta-loop reference value. Because Lawrence et al. (2002) were not concerned with position feedback or action loop processes in this study, they only briefly discuss the role of participants' cumulative number of correct responses as an indication of action loop discrepancy reduction (i.e., position). Instead, they focused on the provision of velocity feedback, which they operationalized as the general slope of participants' performance over trials (i.e., the trend line fit to a plot of the number of correct items per trial).

The authors assigned participants to one of five velocity feedback conditions (see Figure 2). In the "high positive velocity" condition, participants were informed after each trial that they had correctly identified 9, 8, 8, 7, 6, and 5 items, respectively. The authors hypothesized that participants' reported moods would decrease (i.e., become more negative) from time 1 to time 2. In the "low positive velocity" condition, participants were informed after each trial that they had correctly identified 1, 2, 2, 3, 4, and 5 items, respectively, and the authors hypothesized that participants' reported moods would increase (i.e., become more positive) from time 1 to time 2. The middle three velocity conditions were described as medium-high, intermediate, and medium-low positive velocities; offered commensurate feedback; and were hypothesized to produce smaller or negligible mood changes in a pattern consistent with the more extreme conditions. Upon analyzing the data, Lawrence et al. (2002) found that participants receiving the increasingly more positive velocity feedback (i.e., those in the low positive velocity condition) reported more positive mood change, and those receiving the increasingly less positive velocity feedback (i.e., those in the high positive velocity condition) reported more negative mood change.

However, Lawrence et al.'s (2002) operationalization of velocity feedback is problematic. For example, the two upper trend lines portrayed in Figure 2 are clearly downward sloping (i.e., negative), yet are supposed to represent high and medium-high positive velocities, respectively. The authors assert that despite the decreasing performance across trials that contribute to these negative slopes, the two conditions actually exhibit positive velocities because participants are still approaching the action loop goal of maximizing the total number of correct responses. In short, they explain that all velocities in this study are positive, and negative velocities can only occur if participants were to "lose" points for incorrect items.

This confusing discrepancy can be avoided by defining velocity in a manner that is consistent with the construct as it is applied in the physical sciences. That is, velocity feedback should be operationally defined as a rate of change in position (i.e., discrepancy reduction) rather than a trend line or slope fit to participants' performance across trials. Thus, if a participant receives 90% of the items correct in trial 1, then their position is 9 with respect to their action loop goal of maximizing the total number of correct responses (i.e., a maximum value of 60), and their rate of change in discrepancy reduction (i.e., velocity) is positive 90%. Put simply, the percentage of items participants correctly identify in a trial is their velocity because it represents their current rate of discrepancy reduction (e.g., they are currently moving toward the goal value of 60 at a rate of 9 items per trial).

This error in operationalization appears to be the result of confusing velocity delivered as verbal feedback with velocity delivered as visual feedback. Recall that velocity is often verbally discussed as a rate, but visually portrayed as a slope. Lawrence et al. (2002) have focused on the representation of velocity as a slope and discuss it in terms of the "slopes of the success curves over trials" shown in Figure 2 (p. 793). The result of this inappropriate operationalization of velocity is a negative slope-positive velocity discrepancy. A more accurate and appropriate depiction of velocity is a slope indicating the rate of discrepancy reduction. For example, if the rate of discrepancy reduction is 90%, then a visual depiction of that rate would be a line with a slope of 9 (i.e., a line with a rise of 9 and a run of 1). In short, Figure 2 does not depict velocity feedback as a slope; it merely depicts a trend in the verbally-delivered velocity feedback plotted across trials. To plot each velocity feedback slope across trials would reveal a pattern resembling an acceleration curve.

This problem contributes to two errors in Lawrence et al.'s (2002) study. First, it led them to provide less than adequate velocity information to participants. Specifically, after each trial, they intended to provide velocity feedback to participants, yet actually reported the number of items each participant correctly identified. That is, they should have provided the rate of change in discrepancy reduction (i.e., percent of items correct as velocity-salient information), but instead provided the number of items correct (i.e., information that is more position- than velocity-salient). In this instance, there are only ten items per trial so the number of items correct is easily transformed into a velocity (e.g., 9 is 90%). However, we do not know if this information was transformed by participants or if it was interpreted as position or velocity (or even acceleration) information. This is not a trivial issue as Hsee et al. (1991) found that by framing outcomes in position-salient and velocity-salient ways, they could alter participants' levels of satisfaction with similar outcomes. Thus, the framing of outcomes can lead participants to respond to similar outcomes in different ways and researchers should take care to ensure that position feedback is position-salient and velocity feedback is velocity-salient.

The second error the velocity operationalization problem spawned concerns the source of the mood ratings provided by participants. Because Lawrence et al. (2002) improperly operationalized velocity as the "slopes" displayed in Figure 2, they were content to measure participants' mood at baseline and at the end of trial 6. However, the lack of clear velocity feedback (i.e., rate of discrepancy reduction) provided at the end of each trial leaves the object of participants' ratings in doubt. Did participants interpret their feedback (i.e., number of items correct) as position or velocity feedback? Also, is it possible that participants in the slowly declining and slowly rising performance conditions (i.e., the high positive velocity and low positive velocity conditions pictured at the top and bottom of Figure 2, respectively) derived some acceleration information from their feedback? If so, this could also explain why the former group reported more negative mood change and the latter group more positive mood change as such results are consistent with Hsee et al. (1994). In short, given their problems in operationalizing velocity, the immediate cause of Lawrence et al.'s observed results is not clear.

Perhaps the most recent study involving velocity feedback is an unpublished conference presentation by Johnson and Lord (2005) concerning the joint effects of performance goal discrepancies and progress rates on individuals' motivation. In their study, participants were asked to achieve an action loop performance goal and a meta loop progress rate goal while engaged in an ambiguous performance task that required them to learn artificial rules of grammar. The authors manipulated both the size of the participants' performance goal discrepancies (i.e., large or small) and their rates of progress (i.e., slow or fast) when providing position and velocity feedback after each trial. Motivational outcome variables including task satisfaction, task persistence, goal commitment and success expectancy were assessed at the conclusion of the trials. Analysis of the data revealed that both performance goal discrepancy (i.e., position feedback) and progress rate (i.e., velocity feedback) were related to participants' motivation. Specifically, small performance goal discrepancies predicted task satisfaction, success expectancy, and goal commitment, while faster progress rates predicted success expectancy. However, the most interesting finding of this study was a significant discrepancy x progress rate interaction for task satisfaction, success expectancy, and goal commitment, which suggests that experiencing faster progress rates may be capable of erasing the negative motivational effects of large performance goal discrepancies.

In summary, despite its introduction nearly 25 years ago, just five studies have explored the nature of velocity feedback, one study has addressed the use of acceleration feedback, and only two of the four studies have employed velocity feedback in a discrepancy-reducing context consistent with Control Theory. Consequently, not much is known about how position, velocity, and acceleration feedback are related and how they should be applied during goal-directed pursuits. One lesson to be learned from Lawrence et al. (2002) is that position, velocity, and acceleration feedback should be defined in a manner that is consistent with the use of these properties in the physical sciences. By doing so, we are able to maintain the conceptual relationships between the constructs and the utility of the metaphor. Given the importance of properly defining and implementing each feedback frame, I will now provide conceptual and operational definitions and present examples of verbal and graphical feedback for each frame as they might be applied in a study using an ambiguous performance task paradigm as found in Lawrence et al. (2002) and Johnson and Lord (2005).

Position feedback. In the action loop, position feedback is conceptually defined as feedback that describes the current level of performance as referenced to the desired level of performance. Therefore, an appropriate operational definition of position feedback for an ambiguous task would be the cumulative number of correct responses. Thus, at the conclusion of each trial, verbal position feedback should emphasize only the current level of performance using position-salient information. For example, if the stated action loop goal is to maximize the total number of responses, then appropriate position feedback for a participant who correctly responds to 9 items after the first trial is, "thus far, you have correctly responded to a total of 9 items." When multiple trials are used, then the cumulative number of correct responses should be provided at the end of each trial to indicate the current level of performance relative to the desired standard. Similarly, the visual representation of position feedback should only emphasize position-salient information (i.e., the current level of performance relative to the desired level of performance). Figure 3 provides an example of position feedback for a participant correctly responding to 9 items in their first trial. Note that the use of a "thermometer" or "tape" display draws attention to the position of the current level of performance (i.e., 9 correct responses thus far) relative to the desired level of performance (i.e., 100 correct responses) as displayed on the y-axis.

Velocity feedback. Velocity feedback is conceptually defined as the rate of change in discrepancy reduction between the current level of performance and the desired level of performance. As previously discussed, velocity feedback should be operationally defined as the percentage of items correct per trial in the context of an ambiguous performance task. Therefore, verbal velocity feedback should emphasize velocity-salient rate information (e.g., "You correctly responded to 90% of the items in this trial"). Similarly, visual velocity feedback should remove any references to position and provide current rate information in the form of a slope. As shown in Figure 4, this depiction of velocity feedback draws attention to the slope of the line, while downplaying positional information. Specifically, the x-axis is used to emphasize the velocity-salient rate of 90% rather than the position-salient cumulative score of 9 and the higher possible scores emphasized in the positional graphic shown in Figure 3.

Acceleration feedback. Acceleration feedback is conceptually defined as the rate of change in velocity (i.e., the rate of change in the rate of change in discrepancy reduction) and operationally defined as the change in current velocity relative to past velocity. Thus, verbal acceleration feedback should emphasize changes in velocity (e.g., "You correctly responded to 80% of the items in this trial; this is 10% less than in the last trial"). Visually, acceleration feedback should be represented as a curve in order to emphasize changes in velocity over time. Figure 5 shows a decelerating performance curve; note that drawing a series of tangent lines (i.e., slopes) at various points on the curve will reveal that velocity is decreasing over time. Depictions of pure acceleration feedback should minimize velocity- and position-salient information by smoothing curves (as opposed to presenting a series of connected velocity slopes) and removing positional references on the x-axis, respectively. The use of axes with indeterminate bounds assists in de-emphasizing position information.

Thus, position, velocity, and acceleration feedback, properly framed, can communicate unique aspects of performance information to learners and trainees. But what is the practical utility of such frames? The position x velocity feedback interaction reported by Johnson and Lord (2005) provides some indication of their potential uses. As previously mentioned, the authors found that the relationship between participants' reports of motivational outcomes (i.e., task satisfaction, success expectancy, and goal commitment) and performance-goal discrepancy (small or large as described by position feedback) depended on progress rate (slow or fast as described by velocity feedback). Specifically, when progress rate was fast, the relationship between performance-goal discrepancy and motivational outcomes was negligible. However, when progress rate was slow, the relationship was moderately positive. This suggests that the potentially demotivating effects of large performance-goal discrepancies may be offset by the presence of fast discrepancy-reducing progress rates. In the following section, I will demonstrate how this finding can be used to benefit individuals during learning or training.

Learning or Skill Acquisition Performance Profiles Over Time

"Practice makes perfect" is a maxim that refers to the nearly universal observation that individuals' task performance, as measured by speed or accuracy, tends to improve with practice over time (Newell & Rosenbloom, 1981). More specifically, the benefits of practice demonstrate a nonlinear relationship with performance, such that performance improvement is rapid during early stages of task learning, but diminishes over time as individuals become more skilled. This pattern has been found for such a wide variety of perceptual-motor and cognitive skill tasks (see Newell & Rosenbloom, 1981 for a review), that contemporary researchers describe it as "ubiquitous" and refer to it as the Power Law of Practice, Power Law of Learning, or more simply, the "learning curve" (e.g., Anderson, 1982; Logan, 1988; 1992; Ritter & Schooler, 2001; VanLehm, 1996).

Scholars have proposed a number of mechanisms to explain the observed relationship between learning and performance, including Anderson's (1982) composition and strengthening of knowledge, Crossman's (1959) identification of ideal task methods, Logan's (1988) memory retrieval speeds, MacKay's (1982) strength of network connections, and Newell and Rosenbloom's (1981) chunking of stimulus patterns. Despite their differences in proposed mechanisms, all theories agree that the learning curve is a negatively accelerating (i.e., decelerating) curve characterized by an initial period of rapid performance gains that diminish over time.

Figure 6 presents a prototypical learning curve that is arbitrarily bisected into early and late performance periods. Although acceleration is negative (i.e., decelerating) across the two periods, position and velocity are different in early and late periods. Specifically, in the early period, position is low relative to the standard (e.g., the upper limit value on the x-axis) indicating a large discrepancy between current performance and the goal, and velocity is positive and steep indicating a rapid rate of discrepancy reduction. However, in the late period, current position is high and close to the standard indicating a small discrepancy, and velocity remains positive, but shallow, indicating a slow rate of discrepancy reduction. The difference between early and late period performance suggests the potential for different feedback frames to be used to maintain learner motivation during different periods of the learning curve by emphasizing different characteristics of the same performance.

For example, consider a newly-hired Transportation and Safety Administration Airport Screening Technician undergoing training to recognize 100 types of forbidden items via x-ray during a 10 week course. There are many ways for the trainer to provide weekly feedback to the technician, including position-salient (i.e., number of items recognized) or velocity-salient (i.e., rate of item recognition) performance feedback. As item recognition is a learning task, we would expect the technician's learning performance to follow the Power Law of Learning; that is, we would expect rapid recognition performance improvements during the early weeks of training as the easy items are learned, but diminishing gains over time, and near stagnation during the final weeks of training as the technician struggles to recognize the more obscure or difficult items. During the opening weeks of training, which type of feedback is likely to be more motivating to the technician: "You have learned to recognize 10 items" (i.e., position feedback) or "You are learning to recognize items at a rate of 10 per week" (i.e., velocity feedback)? In the final weeks of training, which type of feedback would be most motivating: "You have learned to recognize 98 items" (i.e., position feedback) or "You are learning to recognize items at a rate of 1 per week" (i.e., velocity feedback)? In short, not only might individuals respond differently to feedback framed in different ways, but their response might also vary with time and their location on the learning curve (e.g., early or late). Thus, learner motivation might benefit from performance feedback that is framed in one way during one segment of a learning curve, and some other way during another segment. I will now explore this potential by describing several measures of motivation to be assessed in this study before introducing my research hypotheses.

Motivational Indicators

With the exception of Johnson and Lord (2005), past research on velocity and acceleration feedback has only measured participants' outcome satisfaction and mood states. Yet, indicators of task motivation can be classified as affective (e.g., mood, emotion), behavioral (e.g., effort, persistence), or cognitive (e.g., self-efficacy, self-evaluation). This study uses state affect, task effort, task self-efficacy, goal commitment, and self-satisfaction with performance to examine participants' motivational responses to various types of feedback. A broad range of dependent variables was selected in order to enhance the study of feedback frames by incorporating motivational measures that are commonly used in research on self-regulation. While the typical self-regulation study fails to differentiate between types of feedback, the combination of feedback frames and multiple reaction measures in this study provides a unique opportunity to examine how they interact.

State affect. Despite a long history of neglect, the study of affect in the workplace has experienced a renaissance in recent decades (Brief & Weiss, 2002). Since the 1980s, a substantial and growing body of cross-cultural literature suggests that affective structure is most appropriately defined by two dominant, independent dimensions of positive and negative affect (Burke, Brief, George, Roberson & Webster, 1989; Diener, Larson, Levine & Emmons, 1985; George, 1996; George & Brief, 1996; Meyer & Shack, 1989; Russell, 1980; 1983; Watson, Clark & Tellegen, 1988; Watson & Tellegen, 1985; Zevon & Tellegen 1982). Individuals experiencing a positive affective state may feel alert, excited, determined, strong, and active, while those experiencing a negative state affect may feel anxiety, hostility, fear, shame, or guilt (George & Brief, 1996; Watson et al., 1988).

There are some scholars who treat affect as information. For example, Frijda (1988) suggests that affective experiences "signal states of the world that have to be responded to, or that no longer need response and action" (p. 354) and Schwarz (1990) views feelings as information capable of motivating individuals to attend to particular environmental stimuli. Consistent with Social Cognitive Theory and Control Theory, workers who obtain performance information from their environments are likely to react affectively to this information and self-regulate accordingly. Specifically, George and Brief (1996) suggest that affect can increase or decrease workplace motivation and, subsequently, job performance. Recent related research is beginning to provide supporting evidence as Côtè (1999) reported pleasant state affect was associated with better performance and unpleasant affect was associated with worse performance, among samples of students, salespersons, and professional athletes. In general, feedback that is interpreted favorably should generate positive affect while unfavorable feedback should generate negative affect.

Task self-efficacy. Wood and Bandura (1989) define self-efficacy as "beliefs in one's capabilities to mobilize the motivation, cognitive resources, and courses of action necessary to meet given situational demands" (p. 408). Such beliefs influence all aspects of the self-regulatory process (Bandura, 1986; 1991). For example, compared to individuals with low self-efficacy, those with high self-efficacy tend to set more challenging goals (Bandura & Cervone, 1986; Locke, Frederick, Lee & Bobko, 1984;

Locke & Latham, 1990; Wood & Bandura, 1989), exert greater effort and persevere in the face of obstacles (Bandura & Cervone, 1983; 1986), and spend less time dwelling on their deficiencies (Ozer & Bandura, 1989). Furthermore, there is substantial evidence of a link between self-efficacy and performance; Stajkovic and Luthans (1998) found a weighted average correlation of .38 between self-efficacy and job performance, leading them to conclude that self-efficacy may be a more useful predictor of performance than many personality measures.

According to Wood and Bandura (1989), self-efficacy can be strengthened over time by providing successful practice experiences and realistic encouragement, both of which are generally accompanied by performance feedback. Empirically, the provision of positive feedback has been shown to be an optimal way to increase self-efficacy (Karl, O'Leary-Kelley & Martocchio, 1993; Martocchio & Webster, 1992). Thus, feedback that is evaluated favorably should increase task self-efficacy, while unfavorable feedback should decrease task self-efficacy.

Task effort and self-satisfaction with task performance. Bandura's (1986; 1991) Social Cognitive Theory proposes that motivation results from anticipated self-satisfaction with future performance (or, alternately, self-dissatisfaction with past performance). When a self-monitoring function provides performance feedback, the self-evaluation function determines the magnitude of a perceived discrepancy between the current and desired state, and the self-reaction function generates feelings of satisfaction or dissatisfaction as appropriate. In short, the desire to feel self-satisfaction with performance provides the incentive to mobilize greater effort. Thus, favorable feedback should bolster ratings of self-satisfaction and increase task efforts, while unfavorable feedback should have the opposite effect.

Goal commitment. Goal commitment has been defined as the determination to try for a goal (Locke et al., 1981) and it implies a persistence of effort over time and an unwillingness to lower or abandon that goal (Campion & Lord, 1982). As with the preceding measures, feedback that is interpreted favorably should make the goal appear more achievable, enhance learner persistence of effort, and build commitment to that goal. When feedback is viewed unfavorably, goal commitment is at risk as effort is withdrawn. These responses are anticipated in the following research hypotheses.

Research Hypotheses

One way to examine the motivational effects of different forms of feedback on the preceding motivational indicators is to explore the interactions between feedback frame, learning curves (or performance profiles), and time. I have already presented the three feedback frames (i.e., position, velocity, and acceleration feedback), discussed the role of time (i.e., early and late), and introduced the learning curve (i.e., a decelerating performance profile). Before I proceed, I will introduce a second performance profile that stands in contrast to the first.

As previously mentioned, the learning curve has been described as "ubiquitous" due to its applicability to a wide variety of tasks (Newell & Rosenbloom, 1981). However, the ubiquity of the decelerating learning curve may simply reflect the kinds of tasks studied by its proponents. For example, many of the simple tasks cited by Newell and Rosenbloom (e.g., rolling cigars, reading inverted text, choice reaction tasks) afford rapid, initial performance gains because performers can begin work immediately, acquire task knowledge and skill, and realize these gains. Yet more complex tasks may require some degree of preparation or investment of effort before any significant performance gains can be made. For example, in a code breaking task, the code breaker is unlikely to produce useful text until the code has been cracked. Similarly, if the task is to prevent a nuclear reactor meltdown, then the reactor core temperature may not be significantly reduced until systems are statused, the problem is diagnosed, and appropriate action is taken. In short, more complex tasks may require initial amounts of trial and error, fact-finding, or knowledge integration before any significant progress can be made. Such tasks might be characterized by an accelerating learning curve defined by an initial period of slow performance gains that grow over time (see Figure 7). Like the decelerating curve, an accelerating curve exhibits large positional discrepancies in its early period but small discrepancies in its later period. However, the two curves are different when velocity is considered. Specifically, an accelerating curve possesses higher velocities in its early period and lower velocities in its later period; this pattern is in opposition to that of a decelerating curve.

In sum, individuals following the decelerating performance profile shown in Figure 6 will achieve rapid performance gains in the early period, but greatly diminished returns in the late period. In contrast, those following the positively accelerating performance profile shown in Figure 7 will experience tepid initial performance gains in the early period followed by rapid performance gains in the late period. For the purposes of this study, combining the two contrasting learning performance profiles (i.e., decelerating and accelerating), several time periods (i.e., baseline, early, and late), and three feedback frames (i.e., position, velocity, and acceleration) provides an opportunity to explore how different feedback frames describing the same level of performance might differentially benefit learner motivation during different stages of a learning task.

Performance profile x time interaction. There is reason to believe that performance profile will interact with time for motivational outcomes such as state affect, task self-efficacy, self-satisfaction with task performance, goal commitment, and task effort. Hsee and Abelson (1991) found that people were more satisfied with a high positive velocity outcome as compared to a low positive velocity outcome with the same displacement, and more satisfied with a low negative velocity outcome as compared to a high negative velocity outcome with the same displacement. Despite their problematic operationalization of velocity, participants in Lawrence et al.'s (2002) study reported more positive moods after experiencing more positive velocities. Finally, Johnson and Lord (2005) found progress rate was positively related to task satisfaction and expectations for success. These results suggest that velocity feedback may drive this interaction as high positive velocities are present in the early period of the decelerating performance profile and late period of accelerating performance profile condition.

Although there is no direct empirical evidence that acceleration feedback will help velocity drive this interaction, Hsee et al.'s (1994) study of participants' satisfaction with accelerations curves with different displacements and velocities does provide some support. Specifically, Hsee et al. found that participants' ongoing reports of satisfaction grew more positive when participants perceived a sudden increase in a constant velocity (i.e., acceleration). In this study, participants in the decelerating performance profile condition will experience a diminishing rate of performance gains; therefore, their pattern of motivation scores should decrease over time. In contrast, participants in the accelerating performance condition will experience an increasing rate of gains and should report greater motivation over time.

In sum, regardless of the feedback frame provided, I hypothesize a performance profile x time (P x T) interaction such that participants in the decelerating performance profile condition will report increasingly less positive (and more negative) affect, task effort, task self-efficacy, satisfaction with performance, and goal commitment over time as compared to their counterparts in the accelerating performance profile condition. Conversely, participants in the accelerating performance profile condition will report or demonstrate increasingly greater motivation over time relative to those in the decelerating performance profile condition (see Figure 8).

Feedback frame x performance profile x time interaction. An understanding of the different feedback frames and their referents suggests the potential for a three-way interaction between feedback frame, performance profile, and time. In Control Theory, the referent for position feedback in the action loop is the goal, and the referent for velocity feedback in the meta-loop is some "acceptable rate" of discrepancy reduction (Carver & Scheier, 1988, p. 122). It is interesting to note that the source of an action loop goal is often easily identified (i.e., self-set, dictated by the task, or supervisor-directed), but the origin of the meta-loop referent is not. While Carver and Scheier do not speculate as to the source of the acceptable rate, it is likely determined by the individual based on their expectation of the rate of discrepancy reduction resulting from an initial performance or their observations or knowledge of others' performances and associated rates of discrepancy reduction. To complicate matters, as performance improves, both the individual's actual rate of discrepancy reduction (i.e., their velocity) as well as their acceptable rate of discrepancy reduction (i.e., the meta-loop standard) may change. Even less is known about the referent for acceleration feedback, as Carver and Scheier (1998) only briefly mention the role of acceleration as the source for changes or shifts in the intensity of experienced affect. While they do not discuss acceleration as a source of feedback monitored in a third "uber-loop" encompassing the action and meta-loops, presumably, individuals respond to discrepancies between the sensed rate of change in velocity and some acceptable rate of change in velocity in order to manifest their changes in affect. In short, the nature and origin of the referent for acceleration feedback is likely to be at least as ambiguous as the referent for velocity feedback, and is probably determined by the individual due to the complexity of the concept.

Given what we know about feedback frames and their referents, when learners respond to position feedback, their motivation results from the discrepancy between their current and desired positions (Carver & Scheier, 1998). In the early period of learning, an individual's position is more likely to be greatly discrepant relative to the goal, while in the late period, the learner's position is likely to be less discrepant. Consequently, learners receiving position feedback will likely view it less favorably and report less positive affect (and more negative affect), exert less task effort, report less task self-efficacy, satisfaction with performance, and goal commitment in the earlier portions of their performance profiles as compared to their later portions (Hsee & Abelson, 1991; Johnson & Lord, 2005). This result should be observed whether the learner's performance is consistent with an accelerating performance profile or a decelerating performance profile, as the position discrepancies will always be larger early on as compared to later (see Figure 9a).

However, this pattern of results is not expected to be the case when the learner receives either velocity or acceleration feedback. As previously mentioned, learning is rapid in the early period of the decelerating performance profile but greatly diminished in the late period. Thus, a learner performing in a manner consistent with a decelerating performance profile will receive high positive velocity feedback and more "peaked" acceleration feedback signaling changes in high velocities. As a result, during the early portions of a decelerating performance profile, the learner is less likely to encounter large discrepancies with respect to their acceptable rates of velocity and acceleration, and therefore more likely to view this feedback favorably and report more positive affect (and less negative affect), exert more task effort, report more task self-efficacy, more satisfaction with performance, and more goal commitment (Hsee et al., 1994; Johnson & Lord, 2005; Lawrence et al., 2002; see Figure 9b and 9c). However, over time, this pattern of reactions will reverse. As the learner approaches the latter portion of the profile, velocity is low positive and the acceleration curve is flatter. These conditions are more likely to generate large discrepancies between current and acceptable rates of velocity and acceleration. As learners view this feedback unfavorably, they are expected to report less positive affect (and more negative affect), exert less effort, report less self-efficacy, satisfaction, and commitment (Hsee et al., 1994; Johnson & Lord, 2005; Lawrence et al., 2002).

By comparison, velocity and acceleration feedback are expected to produce opposing motivational effects in the contrasting accelerating performance profile condition. During the early portion of the profile, learners will receive low positive velocity feedback or flatter acceleration feedback that is more likely to create large discrepancies. When viewed unfavorably, learners will respond with reports of less positive affect (and more negative affect), task self-efficacy, satisfaction with task performance, and goal commitment while also demonstrating less task effort (Hsee et al., 1994; Johnson & Lord, 2005; Lawrence et al., 2002). As they transition into the latter portion of the profile, velocity and acceleration feedback will be high positive and more peaked, respectively. Thus feedback-referent discrepancies are likely to be lower, learners will evaluate their feedback more favorably, and they will report more positive affect (and less negative affect), more satisfaction, more self-efficacy, more goal commitment, and demonstrate more effort. In short, I hypothesize a feedback frame x performance profile x time interaction such that the use of position performance feedback deviates from the pattern of results found when using velocity or acceleration feedback.

METHOD

Design

This study employs a 3 x 2 x 2 fully-crossed repeated measures research design featuring (1) a between-subjects feedback frame factor with three levels (i.e., position, velocity, and acceleration), (2) a between-subjects performance profile factor with two levels (i.e., decelerating and accelerating), and (3) a within-subjects time factor with three levels (i.e., baseline, early, and late). In addition, several individual difference covariates (i.e., cognitive ability and trait anxiety) were included in the analyses.

Sample

Prior to data collection, a power analysis performed in accordance with the procedures described by Murphy and Myors (2003) suggested a sample size of 180 (i.e., 30 per cell) would provide at least 80% power to detect a small effect size (d = .20). The initial sample consisted of 185 undergraduate psychology students from a large Midwestern university who were recruited to participate in the experiment in exchange for course credit. Two participants were subsequently removed for failing to complete the study; a third was removed because she communicated via American Sign Language and could not distinguish between similar words in the anxiety and affect scales. Thus, the final sample consists of 182 participants with a mean age of 22. It is predominately female (71%) but tests of participants' scores revealed no systematic, significant differences due to sex. Caucasians comprise 59% of the sample, followed by African Americans (23%), and Asian Americans (8%).

Procedure

Preparations. At the beginning of the study, participants were asked to provide informed consent for their participation (see Appendix C) and to permit experimenter access to their undergraduate admissions' standardized test scores (i.e., SAT, ACT) via the university admissions' office (see Appendix D). The test scores would serve as proxy measures of cognitive ability.

Task. The task employed in this study was the Social Intuition Task (SIT) designed by Lawrence et al. (2002) and used in their initial study of velocity feedback in a goal-directed, behavioral context. The SIT allows experimenters to plausibly manipulate participants' task performance in order to assess performer's reactions to their own performance feedback. Put simply, the task requires that participants determine if a foreign word has the same meaning as an adjacent English word. In fact, the foreign words are bogus and the participants' resulting performance is indeterminate. A similar performance task, the Implicit Grammar Task (IGT; Knowlton & Squire, 1996), has been employed by others in related research (e.g., Johnson & Lord, 2005). The fundamental requirement of both the SIT and the IGT is that the task stimulus be sufficiently ambiguous as to require that participants attend to the experimenter-provided feedback in order to determine how they are performing.

Task stimulus. Task stimulus materials consisted of 12 tests composed of 10 foreign-English word pair items for a total of 120 items. All 60 of the foreign-English word pairs used by Lawrence et al. (2002) were incorporated into the 12 tests. The remaining 60 foreign-English word pairs were derived from the Thai language. Specifically, 60 common Thai words were converted to bogus foreign words by first spelling them phonetically, then transposing their syllables. The original and newly-created word pairs were then evenly distributed in an alternating fashion across each of the 12 tests (see Appendix E).

Background. Participants were told that the purpose of the study is to learn how people extract meaning from foreign words. To lend credibility to the study and the task, participants were provided the following background information:

> "Recent work on social perception has discovered that people are sensitive to a far broader range of nonverbal and paraverbal cues than had previously been believed. Similarly, it is now thought that the evolution of languages was far less random than was once believed, and that words in most languages actually have subtle connections to the semantic qualities that the words were intended to communicate. Though the connections are subtle, people often pick them up, even when they don't know the language they are hearing or seeing. This process appears to happen largely outside of consciousness, and people usually cannot identify very clearly when it is happening" (C. S. Carver, personal communication, March 3, 2005).

Participants then completed a brief questionnaire packet requesting both useful demographic information (i.e., sex, race, age, language ability or exposure, word game experience), cover items that are seemingly related to one's social intuition (e.g., number of siblings, social interaction patterns), and the individual difference covariates (see Appendix F).

Instructions, familiarization trial, and baseline data. Before the first trial, participants were read the instructions accompanying each test and they completed a 10-

item familiarization trial (see Appendix G). The purpose of the familiarization trial was threefold. First, it verified that participants understood the trial's instructions and how to respond to items; any ambiguity was clarified by the experimenter. Second, it made salient the action loop goal of maximizing the number of correct responses (out of a possible 120 items) across all trials, and provided an acceptable rate of discrepancy reduction for the meta loop (i.e., 50% to reflect the probability of "guessing" on the items). Finally, it provided the basis for participants to complete baseline assessments of state positive and negative affect, task self-efficacy, self-satisfaction with task performance, goal commitment, and task effort (see discussion of measures below).

Experimental trials. At the start of each trial, participants were asked to review the directions, complete each of the items on the test, and return it to the experimenter for scoring. The experimenter then made a show of "scoring" the trials, generated performance feedback that contained the manipulation, and provided the individualized feedback to participants. After reviewing their feedback, participants began their next trial.

The feedback manipulation materials consist of both textual and graphical task performance feedback (see Appendix H). Participants randomly assigned to the position feedback frame condition received verbal position-salient feedback (e.g., "Thus far, you have correctly responded to 9 items") and a thermometer chart depicting this information. Those assigned to the velocity condition received velocity-salient feedback (e.g., "You have correctly responded to 90% of the items in this trial") and a slope chart representing this information. Finally, participants in the acceleration condition received acceleration-salient feedback (e.g., "You have correctly responded to 80% of the items in this trial;

this is 10% less than the previous trial") and a curve that was consistent with this information.

Participants randomly assigned to the accelerating performance profile condition received position, velocity, or acceleration feedback indicating a gradual improvement in goal progress (i.e., maximizing correct responses) over successive trials. Specifically, participants receiving position feedback observed that the "mercury" in their thermometer position charts rose from 1 to 17 during their first six trials and from 17 to 60 during their last six trials. Those participants receiving velocity feedback observed that the slope of the rate of discrepancy-reduction line in their velocity charts ascended from 10 to 50 in the first six trials and from 50 to 90 in the last six trials. For those participants receiving acceleration feedback, their position and velocity movements created a corresponding curve in their acceleration charts that exhibited a slowly increasing slope in the first six trials and a rapidly increasing slope in the last six trials.

In contrast, participants randomly assigned to the decelerating performance profile condition received feedback suggesting a gradual slowing of goal progress over successive trials. Participants receiving position feedback observed their mercury rise from 9 to 43 during their first six trials and from 43 to 60 during their last six trials. For velocity feedback, the depicted slopes grew shallow as they descended from 90 to 50 in the first six trials and from 50 to 10 in the last six trials. Similarly, the acceleration curves provided to participants reflected a rapidly decreasing slope in the first six trials and a slowly decreasing slope in the last six trials. For the baseline trials in both performance profiles, participants were provided with feedback identical to the feedback they would receive at the end of their first trial. This was expected to satisfy the objectives of the baseline trial without biasing participants' reactions.

Although participants received feedback after every trial, their reactions to feedback were assessed on three occasions during the experiment to create the three-level time factor (i.e., baseline, early, and late). Thus, while time is inherent in the trials of the social intuition task, participants provided their retrospective reactions to three "blocks" of manipulated trial feedback. State affect, task self-efficacy, self-satisfaction with task performance, goal commitment, and task effort were measured after the familiarization trial (i.e., time 1), trial 6 (i.e., time 2) and again after trial 12 (i.e., time 3). To prevent a maximum performance effort in the later trials, participants were not informed that trial 12 was to be their last trial until after they had completed their time 3 assessments. The experimenter then debriefed participants (see Appendix I).

Measures

Cognitive ability. Participants were asked to self-report their undergraduate admissions' test scores (i.e., ACT or SAT scores) as a proxy measure of cognitive ability. If access was granted by the participant, then missing, illegible, or out of range scores were requested from the university's admissions' office. Scores were standardized for later use as a covariate in the analysis (see Table 1 in Appendix A for means, standard deviations, zero-order correlations, and reliabilites of the individual difference covariates and reaction measures).

Trait anxiety. The trait anxiety covariate was assessed using 20-items from Spielberger's (1983) State-Trait Anxiety Instrument (STAI; $\alpha = .93$). As a trait measure, participants were instructed to describe how they generally feel (i.e., trait), rather than how they feel right now (i.e., state). Participants used a 5-point Likert scale (1 = *very slightly or not at all* to 5 = *extremely*) to respond to items such as "I feel pleasant" and "I am worried."

State affect. State affect was measured using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), a 20-item assessment of the positive and negative affect dimensions. In short, the positive affect subscale captures the extent to which a respondent feels enthusiastic and alert (i.e., high positive affect) or upset and lethargic (i.e., low positive affect), while the negative affect subscale reflects the presence (i.e., high negative affect) or absence (i.e., low negative affect) of aversive mood states such as anger, guilt, fear, or anxiety. As a measure of state affect, participants were asked to indicate the extent to which they felt at the present moment, for example, "enthusiastic" or "upset," using a 5-point Likert scale (1 = *very slightly* to 5 = *extremely*).

Subsequent analysis of the negative affect subscale revealed a skewed and substantially kurtotic distribution that proved resistant to attempts at normalization via transformation. Participants across all conditions overwhelmingly reported the lack of an aversive mood state such as anger, fear, anxiety, or guilt. Applying increasingly severe transformations (i.e., square root, logarithmic, inverse) as outlined in Tabachnick and Fidell (2001) failed to produce a normal distribution. Therefore, the negative affect measure was dropped and only the positive affect subscale was retained for analysis. This scale demonstrated acceptable internal consistency across each combination of performance profile, feedback frame, and time (i.e., $\alpha = .88\text{-}.96$).

Task self-efficacy. Task self-efficacy was assessed by creating a composite of participants' ratings of task self-efficacy magnitude and strength for various levels of task performance as described in Lee and Bobko (1994). Participants were asked to report the degree of confidence (i.e., percent confidence) they have in their ability to achieve specific levels of task performance (e.g., correctly respond to 50% of the SIT items). The performance levels ranged from 10% through 100% and include every possible score (i.e., 20%, 30%, 40%, etc.). Composite task self-efficacy scores were calculated by summing their non-zero confidence ratings.

Self-satisfaction with performance. Participants' satisfaction with their task performance was measured using a 4-item scale created by Toney and Kozlowski (1999). Using a 5-item Likert scale (1 = *strongly disagree* to 5 = *strongly agree*), participants responded to items such as "I am happy with my performance at this point." This scale demonstrated adequate reliability across cells (i.e., .89-.98).

Goal commitment. The goal commitment measure was adapted from Hollenbeck, Williams and Klein (1989). Participants responded to this 5-item measure consisting of items such as "Quite frankly, I don't care if I achieve this goal or not" using a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). Scale alphas across cells ranged from .70 to .91.

Task effort. Effort, as a proxy measure of task motivation, was assessed via an optional word game. Participants were told that such games can stimulate the language centers of the brain and that this priming could improve their performance on future trials. In practice, participants were provided with a word (e.g., backpacker) and asked to use the letters found in the given word to create as many new words as possible in 2 minutes time (e.g., acre, back, creak). The number of words recorded served as an objective measure of participants' task motivation. A "new task effort" measure was also administered to participants at the end of the study to provide an indication of their motivation to "apply their social intuition" to a new verbal task that was unrelated to the recently completed trials. This word game involved a 4 x 4 matrix of letters that participants could use to form words by combining adjacent letters. Once again, the number of words produced served as a measure of participants' new task motivation.

RESULTS

Table 1 displays the means, standard deviations, zero-order correlations, and reliabilities of the individual difference covariates and the reaction measures. Note that cognitive ability was relatively unrelated to the reaction measures except for the new task effort measure given at time 3. This was unexpected as it was intended to explain some of the variance in all of the task effort measures. The other covariate, trait anxiety, was significantly correlated with positive affect as anticipated but also goal commitment. Tables 2a through 2c provide means and standard deviations for the five motivational reaction measures over time by performance profile and feedback frame.

Manipulation Check

At the conclusion of the study, participants were asked to rate the degree to which they agreed with four statements such as "My performance on the task seemed to get better over time" and "I seemed to do better earlier as compared to more recently" using a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). Independent samples t-tests provided evidence that the feedback manipulation was perceived by participants as intended. Specifically, participants assigned to the decelerating performance profile condition reported significantly greater agreement with statements describing a worsening of performance over time as compared to their counterparts assigned to the accelerating performance profile condition ($t(173) = 30.92$, $p < .001$). Conversely, those assigned to the accelerating performance profile condition reported significantly greater agreement with statements describing an improvement in performance relative to those participants assigned to the decelerating performance profile condition ($t(178) = -30.42$, $p < .001$).

Interaction Hypotheses

The presence of the two hypothesized interactions were analyzed simultaneously using repeated measures multivariate analysis of covariance (MANCOVA) with time as the within-subjects factor; feedback frame and performance profile as between-subjects factors; state positive affect, task effort, task self-efficacy, task self-satisfaction with performance, and goal commitment as the motivational reaction measures of interest; and trait anxiety as a covariate. To conserve degrees of freedom, cognitive ability was not used as a covariate in the overall analyses due to its low and non-significant correlations with each of the reaction measures (see Table 1).

The analytic strategy for testing both hypotheses involved three steps, with each successive step contingent upon a significant finding in the preceding step: (1) test for significant multivariate within-subjects interactions, (2) identify the reaction measure or measures contributing to the interaction via univariate tests, and (3) conduct post hoc comparisons and prepare mean plots to verify that the pattern of mean differences are consistent with the interactional hypotheses.

Performance profile x time interaction. To review, the first hypothesized interaction is a two-way interaction between performance profile and time (P x T) such that participants in the decelerating performance profile condition will report or demonstrate less motivation over time while those in the accelerating performance profile condition will report or demonstrate more motivation over time (review Figure 8).

The multivariate test provided support for the hypothesized two-way interaction (F(10, 644) = 63.75, p < .001; see Table 3). Univariate tests summarized in Table 4 revealed a significant P x T interaction for participants' self-reports of positive affect ($F(2, 326) = 55.09$, $p < .001$), self-efficacy ($F(2, 326) = 175.86$, $p < .001$), satisfaction with performance ($F(2, 326) = 287.66$, $p < .001$), and goal commitment ($F(2, 326) = 27.70$, $p < .001$), but not participants' demonstrated task effort (F(2, 326) = 1.18, *n.s.*).

To identify the nature of these interactions, a series of univariate ANOVAs were performed for each of the reaction measures identified. The first four analyses included those participants assigned to the decelerating performance profile condition and grouped the motivational scores by time. Each omnibus analysis (see Table 5) indicated at least one significant mean difference over time was present for positive affect (F(2, 269) = 11.18, $p < .001$), self-efficacy (F(2, 267) = 18.51, $p < .001$), satisfaction with performance (F(2, 268) = 92.59, $p < .001$), and goal commitment (F(2, 267) = 12.23, $p < .001$). Four additional ANOVAs were then performed for participants assigned to the accelerating performance profile condition. The omnibus analyses revealed that at least one significant mean difference was present for self-efficacy (F(2, 267) = 43.43, $p < .001$) and satisfaction with performance (F(2, 270) = 116.68, $p < .001$). Additionally, the analysis for positive affect proved to be marginally significant (F(2, 269) = 2.60, $p = .08$).

Mean plots (see Figures 10a through 10d) revealed that the pattern of participants' motivational scores for the decelerating performance profile decreased from time 1 to time 2 as well as from time 2 to time 3. Post hoc multiple comparisons revealed significant differences between the time 1 and time 2 means for positive affect, satisfaction with performance, and goal commitment, and between time 2 and time 3 for affect, self-efficacy, satisfaction, and commitment. In contrast, a review of the pattern of means for participants assigned to the accelerating performance profile condition revealed that, with one exception, participants' motivational scores increased from time 1 to time 2 as well as from time 2 to time 3. Multiple comparisons identified significant mean differences for self-efficacy and satisfaction with performance both from time 1 to time 2 and time 2 to time 3.

In sum, participants assigned to both performance profiles responded to the range of feedback frames as expected. Those in the decelerating performance profile reported significantly more positive affect, self-efficacy, satisfaction with performance, and goal commitment over time, while those receiving feedback consistent with an accelerating performance profile generally reported less positive motivation over time, especially self-efficacy and satisfaction. Taken as a whole, these results provide substantial support for the hypothesized P x T interaction.

Feedback frame x performance profile x time interaction. The second hypothesized interaction is a three-way between feedback frame, performance profile, and time (F x P x T) such that the pattern of results seen in the P x T interaction would not hold for participants receiving position feedback (review Figures 9a through 9c). Specifically, participants were expected to report or demonstrate more motivation over time, regardless of performance profile condition, because position discrepancies are always greatest at the beginning of a curve, but smaller towards the ends. Thus, motivation should increase over time as position discrepancies decrease even at two differing rates as represented in the two performance profiles.

As shown in Table 3, the multivariate analysis provided support for the presence of the three-way interaction ($F(20, 1069) = 1.64, p < .05$). However, the univariate tests displayed in Table 4 revealed a significant F x P x T interaction for participants' reports of self-efficacy only ($F(4, 326) = 6.16, p < .001$). Once again, a series of ANOVAs were performed for participants assigned to each feedback frame and performance profile combination with self-efficacy scores as the dependent variable. A review of Table 6 indicates the presence of at least one significant mean difference in self-efficacy scores across time periods for each of feedback frame by performance profile combinations except one. Specifically, significant differences in self-efficacy scores were identified for position feedback provided in the accelerating profile condition ($F(2, 86) = 6.08, p < .01$), velocity feedback provided in both the accelerating and decelerating profile conditions ($F(2, 89) = 21.29$ and $19.59, p < .001$, respectively), and acceleration feedback provided in both the accelerating and decelerating profile conditions ($F(2, 86) = 25.77$ and $3.63, p < .001$ and $p < .05$, respectively). The test for a significant mean difference for position feedback provided in the decelerating performance profile condition received only marginal support ($F(2, 86) = 2.88, p = .06$).

To determine if these mean differences were in the expected directions, the self-efficacy means were plotted and subjected to post hoc comparisons. As displayed in Figures 11b and 11c, the pattern of means for participants receiving velocity and acceleration feedback is largely consistent with the results of the P x T interaction; they depict increasing scores over time in the accelerating profile and decreasing scores over time in the decelerating profile. However, the pattern for participants receiving position feedback was not as predicted. Rather than showing increasing scores over time for both the accelerating and decelerating profiles, the position feedback plot (Figure 11a) reveals a pattern of means that is similar to, but less robust than, that found in the velocity and acceleration plots. Apparently, participants in the decelerating performance condition reported significantly less task efficacy at time 3 relative to time 2, rather than significantly more. Therefore, despite the presence of a significant interaction, the F x P x T interaction was not supported as hypothesized.

Additional Analyses

As previously mentioned, participants were offered the opportunity to "apply their social intuition" by engaging in an optional word game at the end of the study but prior to debriefing. Unlike the three preceding word games, this was not a "word generation" task but a "word find" task (see Appendix J). The purpose of the task was to provide an index of participants' motivation to use their "newly-developed" social intuition now that the trials were completed. In turn, this permitted a test of the effects of performance profile and feedback frame on a measure of participant motivation (i.e., the new task effort score) that was psychologically removed from the trials. These effects were tested using an ANOVA with performance profile and feedback frame as factors, new task effort scores as the dependent variable, and cognitive ability as a covariate. Unfortunately, neither feedback frame, performance profile, nor their interaction had a significant effect on participants' new task effort scores.

This study was never intended to compare the feedback frames for the purposes of identifying the single "best" type of feedback. In fact, it is unlikely that any one feedback frame would be optimal under all conditions. However, this data set does permit a purely exploratory examination of which feedback frames produced the highest motivation scores for participants assigned to each of the performance profiles. To examine these effects, a series of ANOVAs were conducted for the reaction measures with feedback frame as the grouping variable (see Table 7). In the decelerating performance condition, participants who received position feedback reported significantly higher positive affect and goal commitment than did their counterparts who received either velocity or acceleration feedback. By contrast, participants in the accelerating profile who received either velocity or acceleration feedback reported higher task self-efficacy and goal commitment scores than those who received position feedback. Furthermore, those who received acceleration feedback reported greater positive affect and satisfaction with performance scores than those who received position feedback. Apparently, participants experiencing declining performance reported greater motivation when they received position feedback, while those enjoying improving performance reported greater motivation when they received acceleration or velocity (i.e., non-position) feedback. While these results are far from definitive in identifying an optimal feedback frame, they do raise some interesting ideas for future research which will be discussed in greater detail in the following section.

DISCUSSION

The purpose of this study was to (1) conceptually and operationally define position, velocity, and acceleration feedback for use as performance information during learning or skill acquisition, and (2) examine individuals' affective, behavioral, and cognitive reactions to performance feedback presented in position-, velocity-, and acceleration-salient frames in a goal-directed, self-regulatory context. The initial proponents of velocity and acceleration information as feedback had been inconsistent in their definitions and applications of these frames, leaving some doubt as to the distinction between them as well as their demonstrated effects on individuals' performance. This study sought to remove these doubts by drawing from the original metaphor from the physical sciences (i.e., the laws of motion) to explicitly define each feedback frame and draw attention to their characteristic components for improved application. These clarified frames could then be studied to examine their effects on individuals' motivation as they pursue a task goal.

The first hypothesis, a P x T interaction, proposed that, regardless of feedback frame, participants assigned to a decelerating performance profile condition would report or demonstrate less motivation over time, while those assigned to an accelerating performance profile condition would report or demonstrate greater motivation over time. This interaction was supported for four of the five motivational measures used in the study: state positive affect, task self-efficacy, self-satisfaction with task performance, and goal commitment.

Simple effects analyses for positive affect revealed that participants in the decelerating performance profile reported significantly less positive affect at time 2 relative to time 1, and at time 3 relative to time 2. Apparently, receiving position, velocity, or acceleration information that described a worsening of performance served to reduce their enthusiasm while inspiring lethargy. Although participants in the accelerating performance profile reported more positive affect at time 2 relative to time 1, as well as at time 3 relative to time 2, the mean differences were not significant. Still, this trend is consistent with Lawrence et al. (2002) who reported that their participants expressed more positive moods after experiencing more positive velocities, even if their velocity manipulation did have acceleration components. The lack of significant mean differences in the accelerating performance profile may be due to the choice of task, which was both ambiguous and repetitive. Specifically, the task may have engendered little enthusiasm among participants as evidenced by a lack of skew in the positive affect measure indicating neither enthusiasm nor lethargy, as well as the severe skew in the defunct negative affect measure which indicates the near absence of anxiety or guilt.

Post hoc analyses of the self-efficacy measure also revealed that participants in the decelerating performance profile reported less task efficacy at time 2 relative to time 1, and significantly less efficacy at time 3 relative to time 2. The lack of a significant mean difference in the early period may reflect participants' skepticism of the highly favorable feedback in the first few trials. Specifically, participants in the decelerating performance profile condition received a 90% on a test of "foreign" words after both the familiarization trial and trial 1. Given the ambiguity of the task, some may have rejected the high scores as an indication of their actual level of social intuition, and reported less task efficacy in response. This view is supported by experimenter observations which noted some disbelief among participants when they received their feedback. On the other hand, participants assigned to the accelerating performance profile reported significantly more task efficacy at time 2 relative to time 1, and at time 3 relative to time 2. This result is consistent with the theory and literature that concludes self-efficacy is strengthened by positive performance feedback (Martocchio & Webster, 1992; Wood & Bandura, 1999). The presence of a significant mean difference in the early period of this condition may reflect the fact that participants were more likely to believe their initial poor performance (i.e., they received a 10% on the familiarization trial and trial 1) as the experimenter observed that some participants responded to their feedback with self-deprecating humor or comments that they had "expected" to do that poorly.

Planned comparisons of participants' self-satisfaction with performance scores indicated that participants in the decelerating performance profile reported significantly less satisfaction at time 2 relative to time 1, and significantly less satisfaction at time 3 relative to time 2. Conversely, those in the accelerating profile reported significantly more satisfaction at time 2 relative to time 1 as well as at time 3 relative to time 2. These results are consistent with Hsee and Abelson (1991) and Hsee et al. (1994) who concluded that people were more satisfied with more positive velocity outcomes and more positive accelerations, respectively, as well as with Johnson and Lord (2005) who found that participants' velocities were positively related to their reports of task satisfaction.

Finally, the results of the post hoc analyses of the goal commitment measure were similar to that of the positive affect measure. Commitment in the decelerating performance profile decreased significantly from time 2 relative to time 1 and from time 3 relative to time 2. However, in the accelerating profile, there were no significant mean differences as scores remaining relatively unchanged over time. Once again, the nature of the task may help to explain the observed results as an uninspiring task may not generate increases in goal commitment, but may be more susceptible to decreases in commitment in the face of unfavorable feedback.

It is interesting to note that the observed P x T interaction did not hold for the task effort measure. It is possible that the word game did not measure participants' task motivation, but instead reflected a desire to do "something" as a diversion from the study. Recall that the word game was an optional activity. However, those who chose not to participate in the game were instructed to sit quietly for the duration of the game. In practice, few could stand to do nothing for two minutes. Perhaps the effort measure did not measure task motivation, but the motivation to escape the task regardless of condition or time.

Overall, the results of the P x T interaction analysis suggests that the set of position, velocity, and acceleration feedback frames, as conceptually and operationally defined in this paper, operate in a predictable manner consistent with theory and past research. Not only did the observed results for the range of motivational measures support past research which applied more ambiguous conceptions of velocity and acceleration, but the use of contrasting performance profiles provided additional evidence that the feedback frames affected participants' motivation whether their task performance was improving or worsening.

The hypothesized F x P x T interaction proposed that the observed P x T interaction pattern would hold for the velocity and acceleration feedback frames, but not the position frame. Specifically, an understanding of the referents for each frame suggests that, for position feedback, discrepancies will always be greater in the early period of either performance profile while, for velocity or acceleration feedback, they can be either more or less in the early period of an accelerating or decelerating performance profile, respectively. Despite the presence of a significant three-way interaction for task efficacy, the simple effects analysis did not support this pattern of results. Apparently, participants responded to position feedback in much the same way they responded to velocity and acceleration feedback. Specifically, participants in the accelerating profile reported increasing task self-efficacy over time while those in the decelerating profile reported decreasing efficacy over time.

Carver and Scheier (1990; 1998) proposed that, in the action loop, position feedback is compared to the referent standard to determine if a discrepancy is present, and the system takes actions to reduce sensed discrepancies. Why, then, did participants receiving position feedback not sense and respond appropriately to greater positional discrepancies early in both performance profile conditions as shown in Figure 9a? It is possible that they did not interpret position feedback in an action loop consistent with Control Theory. Despite attempts to provide only position-salient information in the position feedback condition, participants may have converted their position feedback into a more popular or useful "percent correct" score (i.e., velocity feedback). For example, during data collection, at least eight participants were observed recording their position feedback scores on their desktops or study packets. They used this record to subtract their preceding position from their current position to determine the number of items they answered correctly in the last trial. Since each trial consisted of 10 items, this number could then be multiplied by 10 to obtain the percentage of items they responded to correctly (i.e., the operational equivalent of velocity feedback). In the meta loop, velocity feedback is compared to some "acceptable rate" of discrepancy reduction, and the system produces affect in response to sensed rate discrepancies (Carver & Scheier, 1990; 1998). Therefore, if participants routinely used simple math to convert their position feedback into velocity feedback, then the observed results are not unexpected. That is, the observed pattern of efficacy means for position feedback is consistent with that of participants responding to velocity feedback (see Figure 9b).

Implications

Despite the complex distinctions between the position, velocity, and acceleration feedback frames, participants were able to comprehend their respective feedback frames and respond appropriately in a goal-directed, self-regulatory context. When they received feedback intended to be favorable, they responded with increased motivation; when they received feedback intended to be judged unfavorably, they reported or demonstrated decreased motivation. Furthermore, their responses were generally congruent with their location, with respect to time, within their assigned performance profiles. That is, motivation improved with favorable feedback in the early portion of a decelerating profile as well as in the late portion of an accelerating profile. Taken as a whole, this suggests that the proposed conceptualizations and operationalizations of the three feedback frames are acceptable. Not only are they consistent with the results of earlier research on satisfaction with outcomes, but they also support the results of the two studies of velocity feedback as applied in a goal-directed context. Therefore, researchers who wish to study self-regulated learning or feedback frames can use the guidance offered here to formulate and deliver their feedback.

Practitioners may be wondering which type of feedback to use for different tasks. This study found that while each frame was interpretable by participants, it was clear that some participants would have preferred to receive their feedback in one frame rather than another. Specifically, several participants assigned to the position feedback condition went to great lengths to track their position feedback for conversion into velocity feedback. This observation suggests that, given the task, some participants found velocity feedback to be easier to understand or more useful for self-regulation. While this study necessitated the application of each feedback frame, practitioners should consider the nature of the task or goal when selecting the type of feedback to provide. For example, if an individual's goal is phrased in terms of achieving a numerical standard (e.g., learn 25 ways to signal a rescue plane), then position feedback may be easier to use for self-regulation. If the task does not suggest a feedback frame, perhaps individuals can be given the option of receiving their feedback framed in terms of position, velocity, or acceleration. For maximum flexibility, the optimal solution may be to provide multiple frames as a means of communicating all aspects of an individual's goal progress.

Limitations & Future Research

This study employed the Social Intuition Task developed by Lawrence et al., (2002) for use in studying velocity feedback in a goal-directed context. Like Knowlton and Squire's (1996) Implicit Grammar Task, the SIT is designed to be ambiguous so that participants will accept and respond to the manipulated feedback provided to them by the experimenter. However, it is important to recognize that participants are neither performing nor learning in this experiment, even if they truly believe they are improving their social intuition. Therefore, we cannot be certain that individuals engaged in a real world task involving desirable goals and actual performance would respond to these feedback frames in the same way. Unfortunately, the limitations of the ambiguous task paradigm must be accepted if we are to study participants' reactions to the two contrasting performance profiles. Future research should study feedback frames in the context of a realistic task involving actual performance and desirable goals. It is likely that the thrill of actually acquiring greater knowledge or skill would produce a greater motivational response than that observed in an ambiguous task in which participants were merely told that their performance was improving. Conversely, the real world experience of slowing knowledge or skill acquisition would likely produce a greater demotivating response as compared to that observed in this study.

The new task motivation measure also proved to be a limitation of the study as it may have been a measure of cognitive ability rather than task effort or motivation. The task effort word game measures were selected because they represented behaviorally-based, objective measures of task motivation. In retrospect, it would not have been difficult to add a subjective assessment of task effort. Future studies using the ambiguous task paradigm should continue to incorporate a broad range of affective, behavioral, and cognitive reaction measures, including a self-report measure of task effort and motivational states (e.g., state goal orientation; Elliot & Church, 1997; VandeWalle, Cron & Slocum, 1999).

Another limitation of this study concerns the operationalization of the feedback frames. Past research did not carefully review the laws of motion metaphor before defining and applying position, velocity, and acceleration feedback. As a result, it was possible to make the mistake of, for example, providing velocity feedback with position or acceleration components. This study represents an attempt to use the metaphor to provide guidelines for applying the feedback frames as independently as possible, for the sake of exploring their unique effects on task motivation. However, this proved to be easier said than done. Conceptually, position, velocity, and acceleration are related; any physics text provides a series of equations that reveal how any one can be derived from any of the others. In retrospect, this study's attempt to provide "pure" position, velocity, and acceleration feedback to participants was not fully successful. Specifically, the acceleration feedback contained velocity-salient information. While the feedback curves removed positional references from their axes, the accompanying verbiage referred to a velocity-salient current score (e.g., 10% in Figure 5) even as it emphasized an acceleration-salient increase in performance (e.g., 10% more than last trial). This may explain why the results of analyses involving velocity and acceleration looked similar. Future research on feedback frames should pursue both an isolation and an integration track. The purpose of the isolation track is to confirm the results of this study using pure position, velocity, and acceleration feedback. As a start, this can be done by removing the velocity-salient information from the acceleration feedback and by using a prime number of items in a trial to make it more difficult for participants to convert position to velocity information. The integration track addresses the idea that it may not be possible or even advisable to completely separate position-, velocity-, and acceleration-salient information. In practice, velocity and acceleration information are often provided concurrently (e.g., the position and rate of movement of a car's speedometer needle) and participants have demonstrated a willingness to go to great lengths to calculate velocity from position information. Such research might determine that particular combinations of feedback frames (i.e., position with velocity or velocity with acceleration) are more effective than any one frame.

One question that this study was not intended to address is: which feedback frame works best? The additional analyses introduced in the results section seem to indicate that individuals may realize greater motivation gains if they receive velocity or acceleration feedback when their performance follows an accelerating performance profile. This may be due to the fact that both frames provide rate or trend information that may lead individuals to believe that their rosy performance is destined to continue. However, when individuals' performance follows a decelerating profile, unfavorable rates and trends suggest that performance will only get worse. Perhaps individuals are less likely to see this future when position feedback is supplied. In any case, these speculations raise a number of empirical questions that can be investigated in a controlled setting.

Conclusions

In the 15 years since Carver and Scheier (1990) first introduced the concept of velocity feedback, little progress has been made in the attempt to understand its relationship to position and acceleration feedback, or how it functions in the self-regulatory cycles associated with learning and skill-acquisition. However, the tide is turning. Within the last three years, Lawrence et al. (2002) published the first study of velo

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velocity feedback in a self-regulatory context and Johnson and Lord (2005) studied the joint effects of position and velocity feedback on individuals performing an ambiguous task. This study has contributed to this ongoing effort to understand feedback frames by refining the conceptual and operational definitions of position, velocity, and acceleration feedback and examining individuals' application of this feedback in the context of their referents and Control Theory. While the hypothesized F x P x T interaction was not supported, the proposed feedback frames are instructive to those who wish to continue this research as students and trainees stand to benefit from their application once researchers identify how and when they operate effectively.

APPENDICES

APPENDIX A

Tables

Table 1. Means, standard deviations, zero-order correlations, and reliabilities of the individual difference and reaction measures.

Measures	*M*	*SD*	1	2	3	4	5
1. Standardized Cognitive Ability	0.00	1.00	--				
2. Trait Anxiety	43.41	13.25	.02	(.93)			
3. State Positive Affect (Time 1)	27.10	8.84	-.08	-.33**	(.92)		
4. State Positive Affect (Time 2)	27.04	9.11	-.09	-.29**	.80**	(.92)	
5. State Positive Affect (Time 3)	25.68	10.74	-.11	-.28**	.61**	.87**	(.95)
6. Task Effort (Time 1)	11.86	4.83	.14	-.09	.10	.14	.16*
7. Task Effort (Time 2)	11.68	4.34	.12	-.02	.05	.13	.13
8. Task Effort (Time 3)	12.28	4.66	.10	.02	-.05	.05	.05
9. Task Self-Efficacy (Time 1)	469.64	238.07	-.06	-.09	.23**	.09	-.06
10. Task Self-Efficacy (Time 2)	510.13	209.13	-.08	-.02	.18*	.09	.05
11. Task Self-Efficacy (Time 3)	523.52	236.84	.01	-.13	.10	.27**	.38**
12. Performance Satisfaction (Time 1)	12.13	6.15	.02	-.16*	.27**	-.00	-.21**
13. Performance Satisfaction (Time 2)	12.87	4.04	-.02	-.12	.05	.19*	.21**
14. Performance Satisfaction (Time 3)	12.46	5.25	-.01	-.06	-.09	.18*	.38**
15. Goal Commitment (Time 1)	17.82	3.83	-.03	-.24**	.33**	.29**	.27**
16. Goal Commitment (Time 2)	17.19	4.07	-.04	-.26**	.32**	.41**	.42**
17. Goal Commitment (Time 3)	16.60	4.68	-.10	-.23**	.20**	.41**	.54**
18. New Task Effort	9.66	4.52	.27**	.00	.03	.06	.13

Note: Reliabilities on the diagonal. *$p < .05$; **$p < .01$

Table 1 (cont'd).

Measures	6	7	8	9	10	11	12
1. Standardized Cognitive Ability							
2. Trait Anxiety							
3. State Positive Affect (Time 1)							
4. State Positive Affect (Time 2)							
5. State Positive Affect (Time 3)							
6. Task Effort (Time 1)	--						
7. Task Effort (Time 2)	.63**	--					
8. Task Effort (Time 3)	.56**	.58**	--				
9. Task Self-Efficacy (Time 1)	.01	.00	.02	--			
10. Task Self-Efficacy (Time 2)	.01	.03	.03	.79*	--		
11. Task Self-Efficacy (Time 3)	.16*	.11	.10	.18*	.44**	--	
12. Performance Satisfaction (Time 1)	-.16*	-.10	-.14	.52**	.34**	-.27**	(.98)
13. Performance Satisfaction (Time 2)	.08	.05	.05	-.14	.07	.28**	-.02
14. Performance Satisfaction (Time 3)	.14	.10	.07	-.42**	-.19*	.46**	-.52**
15. Goal Commitment (Time 1)	-.04	-.02	-.08	.15*	.17*	.13	.15*
16. Goal Commitment (Time 2)	-.02	-.01	-.08	.08	.14	.25**	.06
17. Goal Commitment (Time 3)	.01	-.00	-.02	-.05	.08	.36**	-.15*
18. New Task Effort	.38**	.37**	.36**	-.05	.03	.12	-.06

Note: Reliabilities on the diagonal. * $p < .05$; ** $p < .01$

Table 1 (cont'd).

Measures	13	14	15	16	17	18
1. Standardized Cognitive Ability						
2. Trait Anxiety						
3. State Positive Affect (Time 1)						
4. State Positive Affect (Time 2)						
5. State Positive Affect (Time 3)						
6. Task Effort (Time 1)						
7. Task Effort (Time 2)						
8. Task Effort (Time 3)						
9. Task Self-Efficacy (Time 1)						
10. Task Self-Efficacy (Time 2)						
11. Task Self-Efficacy (Time 3)						
12. Performance Satisfaction (Time 1)						
13. Performance Satisfaction (Time 2)	(.94)					
14. Performance Satisfaction (Time 3)	.61**	(.98)				
15. Goal Commitment (Time 1)	-.08	-.05	(.80)			
16. Goal Commitment (Time 2)	.07	.15*	.76**	(.82)		
17. Goal Commitment (Time 3)	.13	.33**	.61**	.75**	(.86)	
18. New Task Effort	.18**	.17**	-.05	.03	.03	--

Note: Reliabilities on the diagonal. * $p < .05$; ** $p < .01$

Table 2a. Descriptive statistics for reaction measures by time and performance profile for participants receiving position feedback.

Position Feedback

	Time 1		Time 2		Time 3		Marginal Means	
Reaction Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Decelerating Performance Profile				
Positive Affect	30.44	8.10	30.11	8.52	25.48	10.34	28.21	9.13
Task Effort	9.56	5.38	10.70	4.76	10.96	5.75	10.45	5.23
Task Self-Efficacy	592.22	237.36	564.33	210.37	466.81	182.86	550.24	216.12
Satisfaction	17.07	4.15	12.56	4.11	8.59	3.83	12.72	5.12
Goal Commitment	19.56	3.72	18.15	4.08	16.70	5.21	17.90	4.50
				Accelerating Performance Profile				
Positive Affect	24.61	8.73	26.82	8.35	26.11	10.51	25.17	9.24
Task Effort	13.79	3.63	13.57	3.26	14.75	4.45	13.69	3.98
Task Self-Efficacy	319.54	185.93	339.36	187.15	475.61	198.22	378.78	195.80
Satisfaction	7.25	4.35	12.82	4.04	14.29	3.40	11.30	4.97
Goal Commitment	17.25	4.49	16.50	4.66	16.46	4.32	16.83	4.33

Table 2b. Descriptive statistics for reaction measures by time and performance profile for participants receiving velocity feedback.

Velocity Feedback

	Time 1		Time 2		Time 3		Marginal Means	
Reaction Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Decelerating Performance Profile				
Positive Affect	28.97	7.85	24.63	7.02	21.23	6.87	24.82	7.77
Task Effort	10.97	5.15	11.47	4.24	11.60	5.29	11.39	4.80
Task Self-Efficacy	621.83	172.72	630.77	166.13	400.83	153.13	551.17	192.80
Satisfaction	17.23	3.00	11.40	2.77	8.00	3.30	12.00	4.94
Goal Commitment	17.80	3.09	16.73	3.46	14.50	3.24	16.30	3.47
				Accelerating Performance Profile				
Positive Affect	25.79	8.57	28.68	9.94	30.57	11.84	27.48	10.47
Task Effort	11.68	4.13	11.50	3.99	12.39	3.98	11.94	4.00
Task Self-Efficacy	310.96	169.47	438.50	157.75	683.14	264.58	468.32	246.20
Satisfaction	7.86	4.33	13.61	4.39	16.57	3.13	12.43	5.22
Goal Commitment	17.61	4.72	18.18	4.91	18.96	5.01	18.20	4.78

Table 2c. Descriptive statistics for reaction measures by time and performance profile for participants receiving acceleration feedback.

	Acceleration Feedback							
	Time 1		Time 2		Time 3		Marginal Means	
Reaction Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	Decelerating Performance Profile							
Positive Affect	26.93	9.87	24.10	9.66	21.31	9.66	23.82	9.86
Task Effort	11.62	4.81	10.76	5.12	11.59	4.14	11.40	4.62
Task Self-Efficacy	577.10	240.19	568.38	236.33	431.93	257.32	528.60	251.32
Satisfaction	16.76	4.19	12.34	4.60	10.14	4.92	13.00	5.34
Goal Commitment	16.97	3.62	15.90	3.80	14.90	4.68	15.86	4.06
	Accelerating Performance Profile							
Positive Affect	27.89	9.32	31.04	8.92	32.14	11.28	30.18	9.67
Task Effort	13.29	4.69	11.61	4.08	12.54	3.73	12.78	4.34
Task Self-Efficacy	385.75	194.13	492.71	167.01	703.04	180.74	528.45	222.60
Satisfaction	7.50	3.66	15.21	3.59	17.89	3.00	13.48	5.57
Goal Commitment	17.79	2.71	18.07	3.21	19.04	3.96	18.14	3.61

Table 3. Results of the repeated measures multivariate analysis of covariance.

Between Subjects	*df*	*F*	η^2	*p*
Intercept	5, 159	196.23***	.86	.000
Performance Profile (P)	5, 159	6.12***	.16	.000
Feedback Frame (F)	5, 318	1.13*	.34	.034
P x F	10, 318	1.98	.06	.059
Trait Anxiety (A)	5, 159	5.85	.16	.155
Within Subjects				
Time (T)	10, 644	1.54	.02	.120
T x P	10, 644	63.75***	.50	.000
T x F	20, 1069	1.74*	.03	.023
T x A	10, 644	1.40	.02	.191
T x P x F	20, 1069	1.64*	.03	.032

Note: F-test of Wilks' Lambda; * $p < .05$; *** $p < .001$

Table 4. Results of the repeated measures univariate analyses of covariance.

	Positive Affect			Task Effort			Task Self-Efficacy		
Between Subjects	*df*	*F*	η^2	*df*	*F*	η^2	*df*	*F*	η^2
Intercept	1	273.18***	.63	1	156.39***	.49	1	134.96***	.45
Performance Profile (P)	1	4.20*	.03	1	9.40**	.05	1	8.00**	.47
Feedback Frame (F)	2	0.06	.00	2	0.35	.00	2	2.18	.03
P x F	2	3.17*	.04	2	2.93	.04	2	2.75	.03
Trait Anxiety (A)	1	19.65***	.11	1	1.01	.01	1	1.41	.01
Error	163	(198.92)		163	(43.62)		163	(93330.26)	
Within Subjects									
Time (T)	2	0.07	.00	2	0.96	.01	2	4.50*	.03
T x P	2	55.09***	.25	2	1.18	.01	2	175.86***	.52
T x F	4	1.11	.01	4	1.47	.02	4	2.04	.02
T x A	2	0.62	.00	2	1.38	.01	2	2.79	.02
T x P x F	4	1.92	.02	4	0.20	.00	4	6.16***	.07
Error	326	(17.93)		326	(8.89)		326	(13419.32)	

Note: Mean squared error in parentheses. * $p < .05$; $p < .01$ **; *** $p < .001$

Table 4 (cont'd).

Between Subjects	Satisfaction with Performance *df*	*F*	η^2	Goal Commitment *df*	*F*	η^2
Intercept	1	378.20***	.70	1	458.14***	.74
Performance Profile (P)	1	0.02	.00	1	3.78	.23
Feedback Frame (F)	2	2.42	.03	2	0.32	.00
P x F	2	1.20	.01	2	3.09*	.04
Trait Anxiety (A)	1	6.39**	.04	1	14.10***	.08
Error	163	(22.51)		163	(38.613)	
Within Subjects						
Time (T)	2	0.30	.00	2	0.87	.01
T x P	2	287.66***	.64	2	27.70***	.15
T x F	4	3.00*	.04	4	1.86	.02
T x A	2	0.62	.00	2	0.48	.00
T x P x F	4	0.82	.01	4	1.32	.02
Error	326	(10.76)		326	(4.40)	

Note: Mean squared error in parentheses. * $p < .05$; $p < .01$ **; *** $p < .001$

Table 5. Results of the simple effects univariate analyses for the performance profile x time interaction.

Dependent Variable	*df*	*F*	η^2
	Decelerating Performance Profile		
State Positive Affect	2, 269	11.18***	.08
Task Self-Efficacy	2, 267	18.51***	.12
Satisfaction with Performance	2, 268	92.59***	.41
Goal Commitment	2, 267	12.23***	.08
	Accelerating Performance Profile		
State Positive Affect	2, 269	2.60†	.02
Task Self-Efficacy	2, 267	43.43***	.25
Satisfaction with Performance	2, 270	116.68***	.46
Goal Commitment	2, 269	0.190	.00

*** $p < .001$; † $p < .10$

Table 6. Results of the feedback frame x performance profile x time interaction's simple effects univariate analyses for the task self-efficacy measure.

Performance Profile	*df*	*F*	η^2
		Position Feedback	
Accelerating	2, 86	6.08^{**}	.12
Decelerating	2, 86	$2.88^{\dagger}$	.06
		Velocity Feedback	
Accelerating	2, 89	21.29^{***}	.32
Decelerating	2, 89	19.59^{***}	.31
		Acceleration Feedback	
Accelerating	2, 86	25.77^{***}	.38
Decelerating	2, 86	3.63^{*}	.08

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{\dagger}p < .10$

Table 7. Feedback frames that produced significantly higher motivational scores by performance profile.

Performance Profile	Positive Affect	Reaction Measure Task Self-Efficacy	Satisfaction with Performance	Goal Commitment
Decelerating	P > (V and A)	--	--	P > (V and A)
Acceleration	(V and A) > P	A > P	A > P	(V and A) > P

P = position feedback; V = velocity feedback; A = acceleration feedback

APPENDIX B

Figures

Figure 1. A nominal meta loop with an embedded action loop.

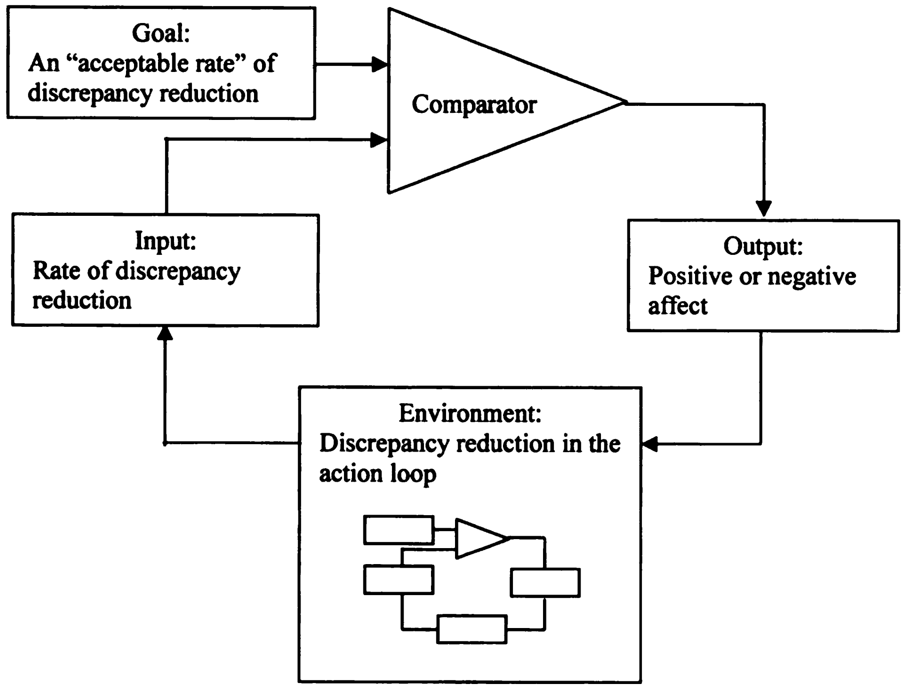
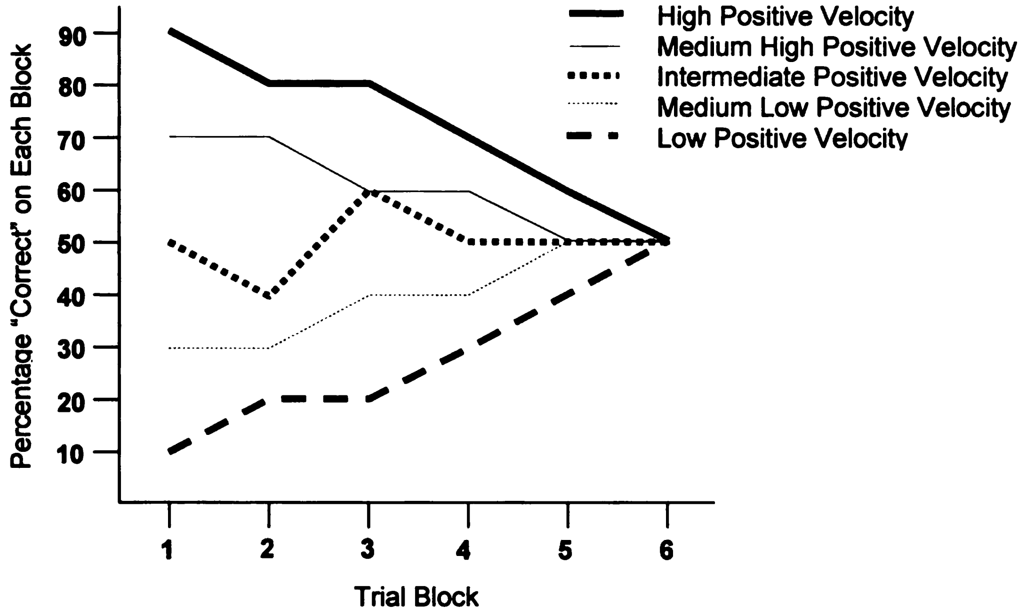


Figure 2. Lawrence et al.'s (2002) velocity feedback conditions.



Adapted from "Velocity toward goal attainment in immediate experience as a determinant of affect," by J. W. Lawrence, C. S. Carver, and M. F. Scheier, 2002, *Journal of Applied Social Psychology, 32*, p. 794.

Figure 3. An example of position-salient feedback.

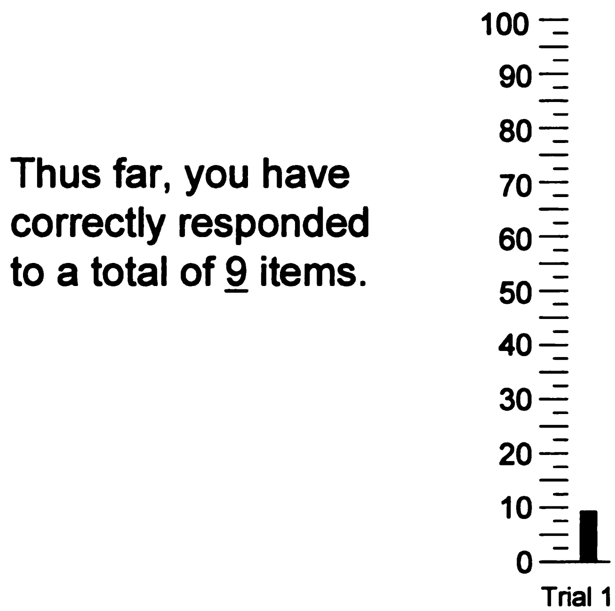


Figure 4. An example of velocity-salient feedback.

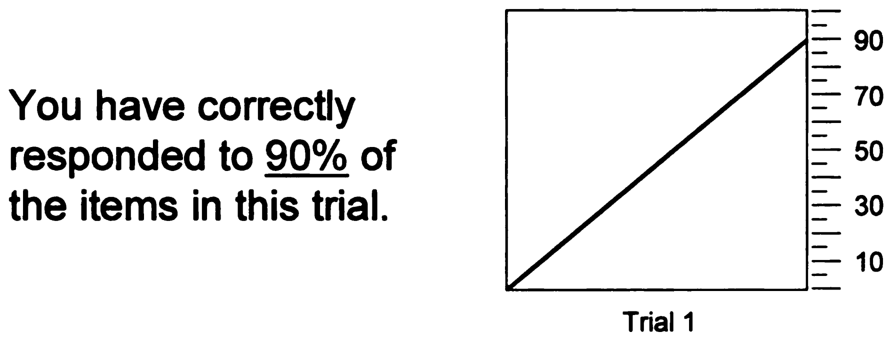


Figure 5. An example of acceleration-salient feedback.

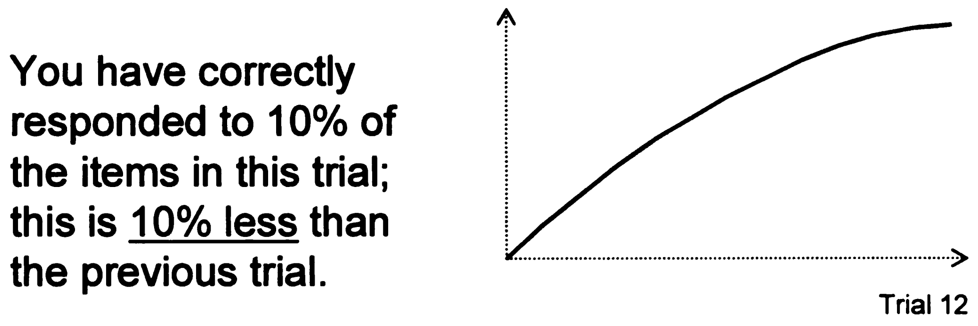


Figure 6. A decelerating learning curve characterized by rapid early performance gains that slowly diminish over time.

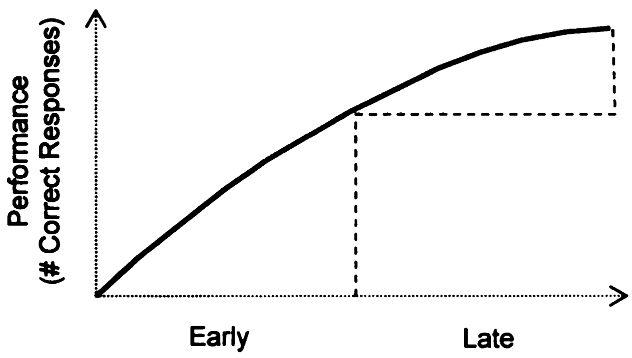


Figure 7. An accelerating learning curve characterized by slow early performance gains that rapidly increase over time.

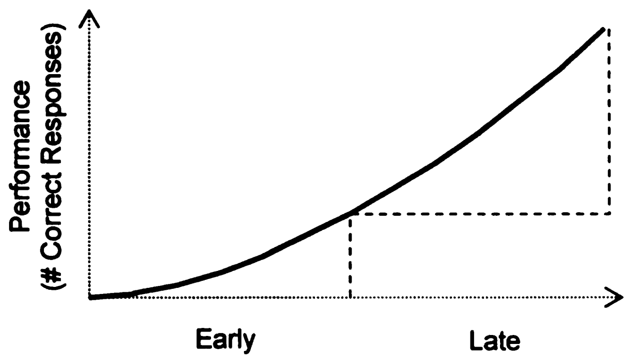


Figure 8. Hypothesized performance profile x time interaction.

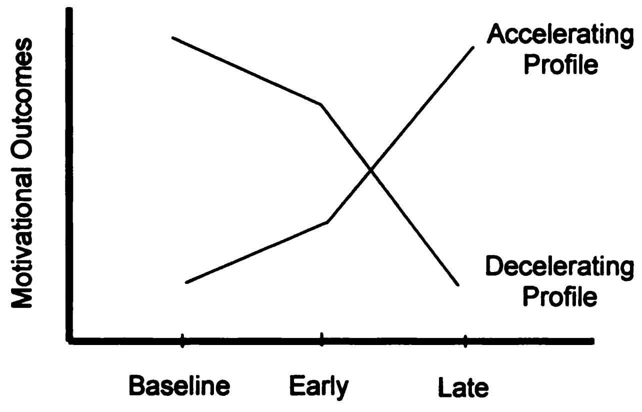


Figure 9a. Hypothesized feedback frame x performance profile x time interaction for position feedback.

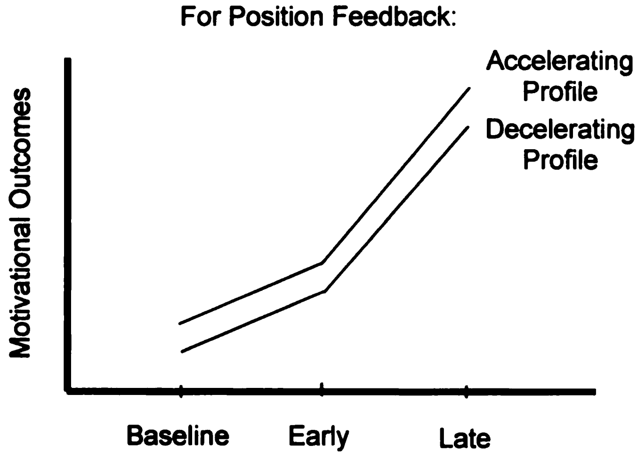


Figure 9b. Hypothesized feedback frame x performance profile x time interaction for velocity feedback.

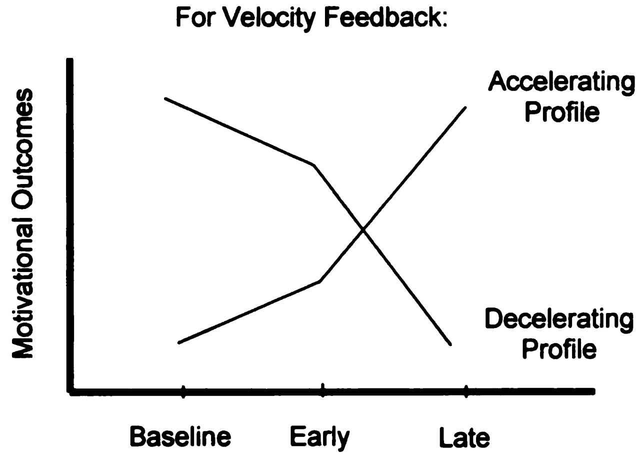


Figure 9c. Hypothesized feedback frame x performance profile x time interaction for acceleration feedback.

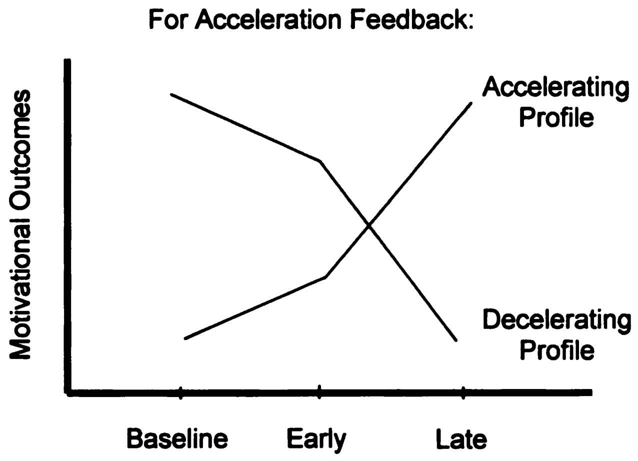
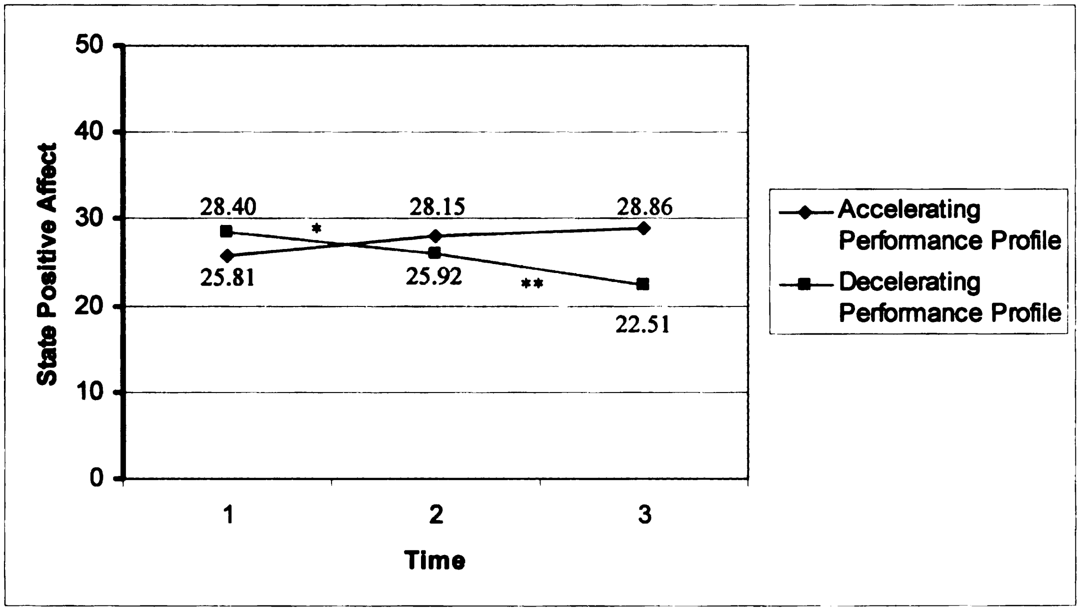
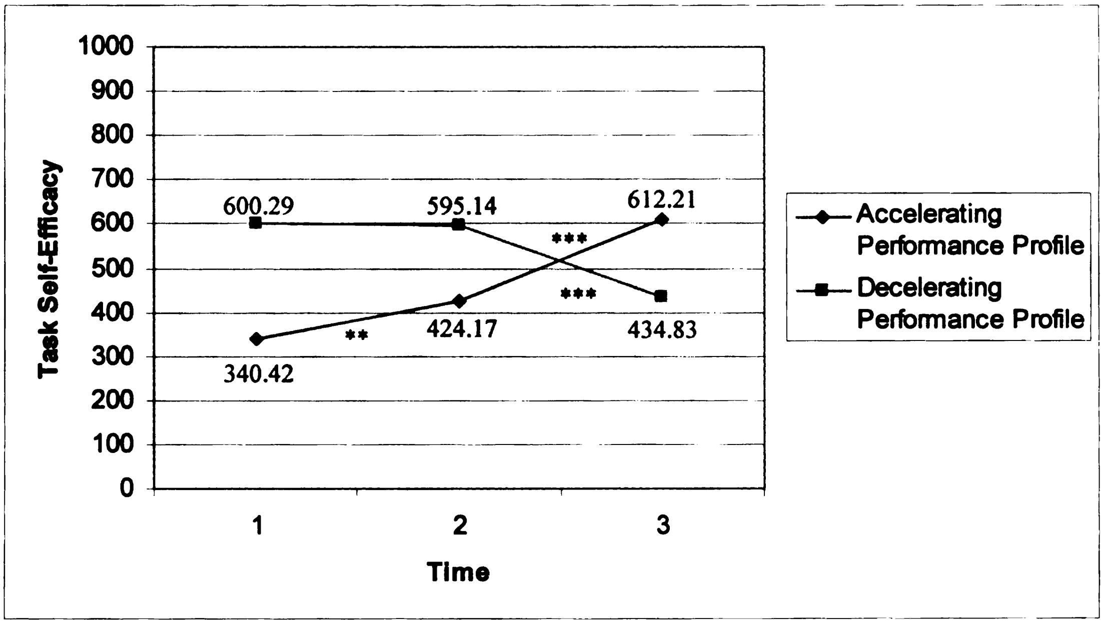


Figure 10a. Performance profile x time interaction for state positive affect.



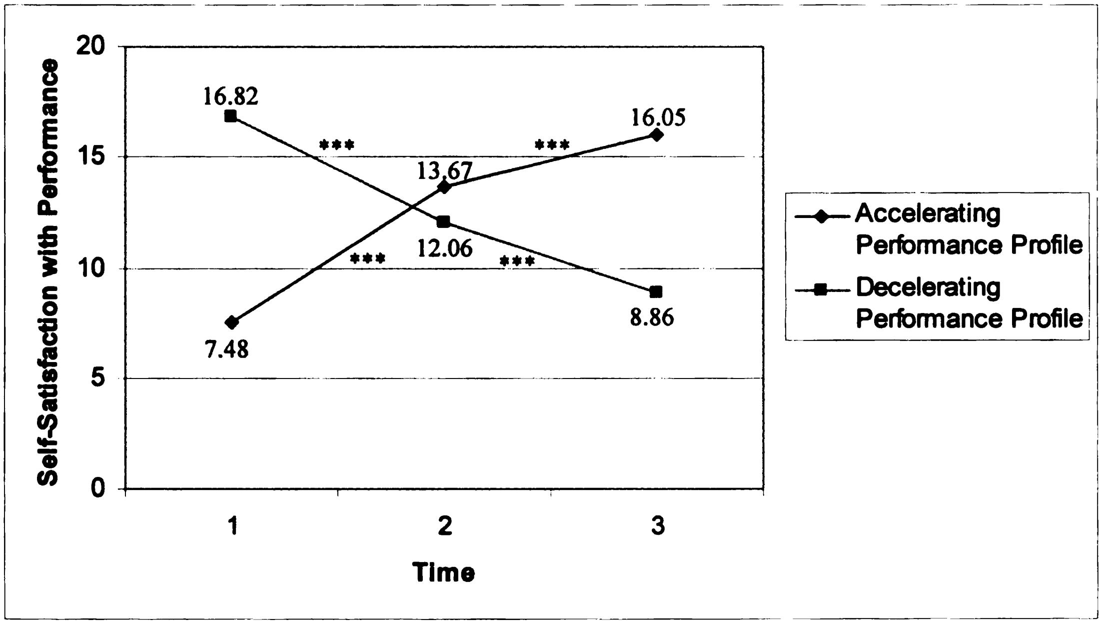
$^{*}p < .05$; $^{**}p < .01$

Figure 10b. Performance profile x time interaction for task self-efficacy.



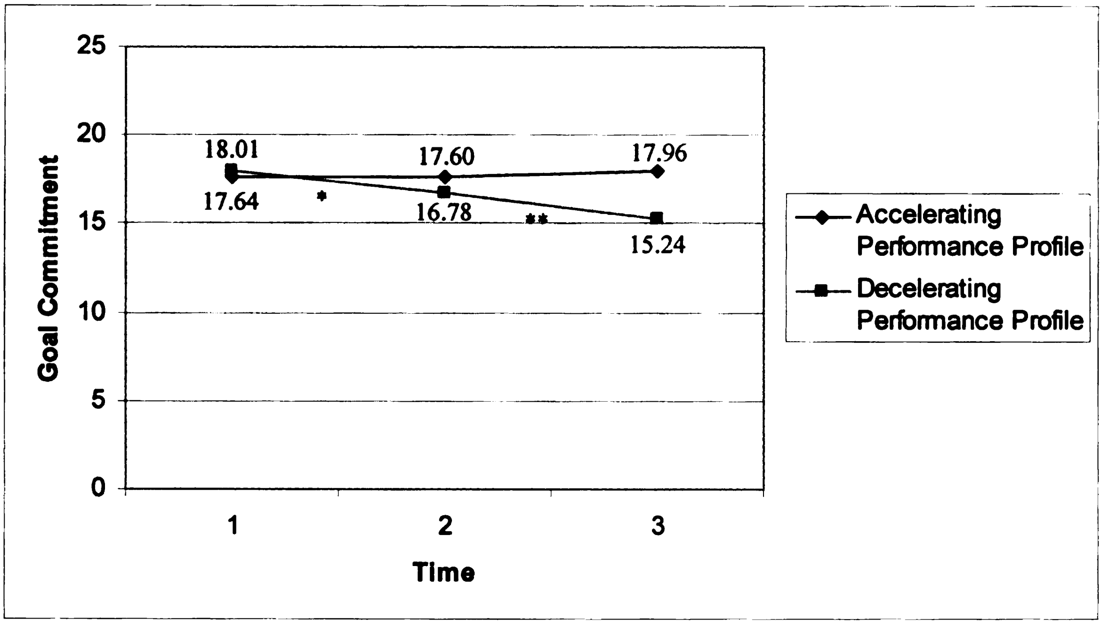
$^{**}p < .01$; $^{***}p < .001$

Figure 10c. Performance profile x time interaction for self-satisfaction with performance.



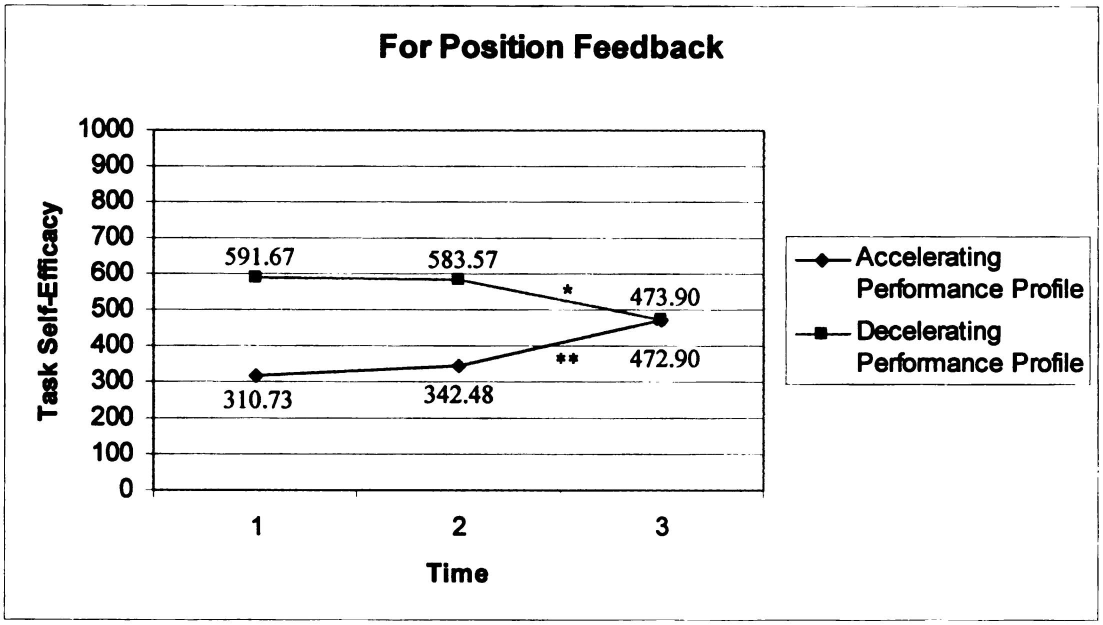
$^{***}p < .001$

Figure 10d. Performance profile x time interaction for goal commitment.



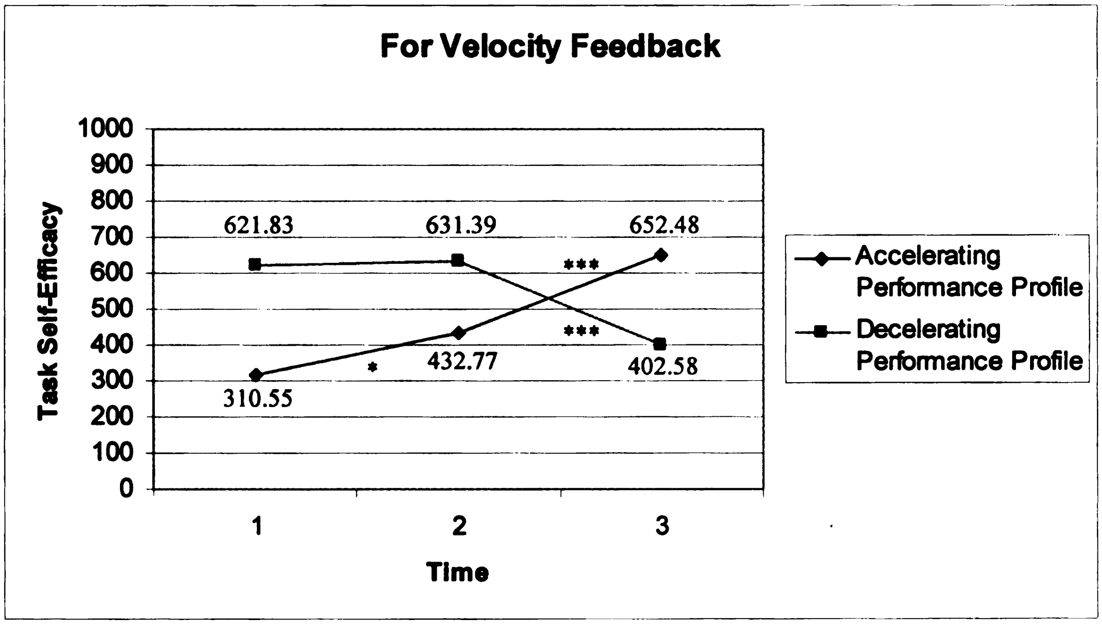
*$p < .05$; **$p < .01$

Figure 11a. Feedback frame x performance profile x time interaction for task-self efficacy with position feedback.



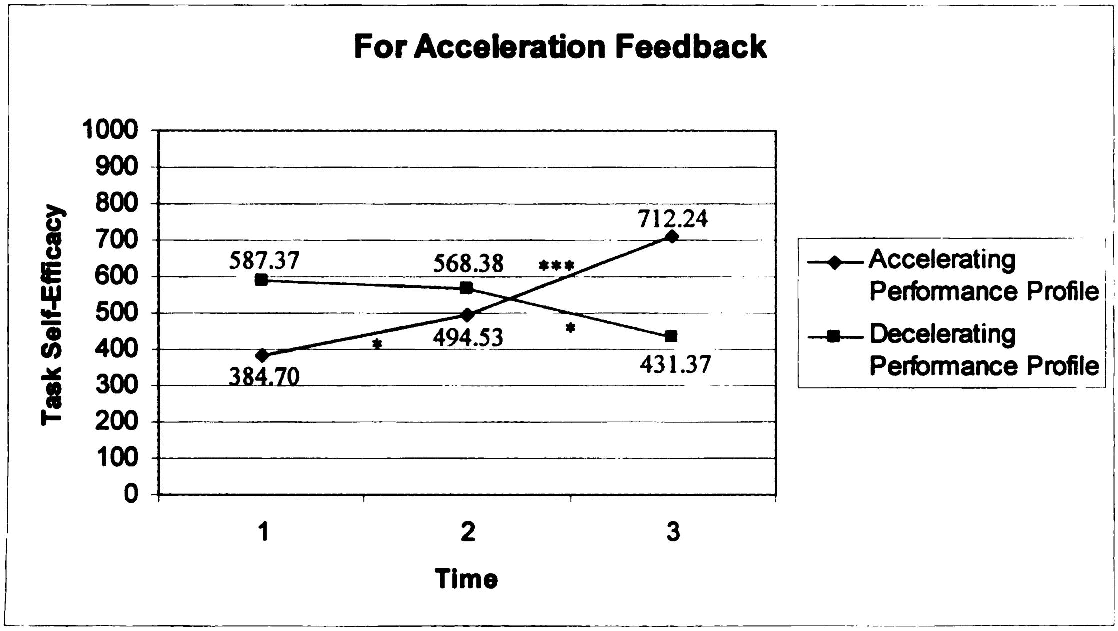
$^{*}p < .05$; $^{**}p < .01$

Figure 11b. Feedback frame x performance profile x time interaction for task-self efficacy with velocity feedback.



$^{*}p < .05$; $^{***}p < .001$

Figure 11c. Feedback frame x performance profile x time interaction for task-self efficacy with acceleration feedback.



$^{*}p < .05$; $^{***}p < .001$

APPENDIX C

Informed Consent Form

INFORMED CONSENT FORM
for the Social Intuition Study

Overview. This study examines how people use their "social intuition" to determine the meaning of unfamiliar words. Should you choose to participate in this study, you will be asked to provide some information about yourself, including demographic information (e.g., age, gender, race), personal preferences (e.g., hobbies, social interaction), and your SAT or ACT test scores as a measure of cognitive ability. Next, you will be asked to review several lists of foreign words to decide what they mean. Your responses will then be used to determine how people's unique characteristics affect the use of their social intuition.

In order to verify forgotten or illegible SAT or ACT test scores, we will request your authorization to release your test scores via the MSU Admissions Office. You can still participate in this study even if you choose not to grant this authorization. Please read and initial **one** of the following statements to indicate your desired level of participation in this study:

_______ I would like to participate in this study **and I am also willing** to authorize release of my
Initials SAT/ACT test scores via the MSU Admissions Office using the attached form.

OR

_______ I would like to participate in this study **but I am NOT willing** to authorize release of my
Initials SAT/ACT test scores via the MSU Admissions Office.

Time & Compensation. This study will take approximately one hour of your time to complete. In exchange for your participation, you will receive one hour of research study extra credit.

Risks. There are no foreseeable risks or discomforts associated with your participation in this study.

Confidentiality. Your privacy will be protected to the maximum extent allowable by law. The responses you provide during this study will be held in strict confidence by the investigator. You will not be identifiable in any report of this study's results. When available, you may request a copy of this study's results.

Participation. Your participation in this study is completely voluntary. Without penalty, you may refuse to participate in all or part of this study and may refuse to answer some or all questions.

Contact Information. If you have any questions about this study, please contact the investigator, Dan Watola, at 340C Psychology Building, East Lansing, MI 48824, (517) 432-7752, watolada@msu.edu; or the Department of Psychology Chair, Dr. Neal Schmitt, at (517) 355-8305, schmitt@msu.edu. If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact—anonymously, if you wish—Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) at (517) 355-2180, ucrihs@msu.edu, 202 Olds Hall, East Lansing, MI 48824.

Your signature below indicates your voluntary agreement to participate in this study. A copy of this for will be provided to you upon your request.

_________________________ __________
Participant's Signature Date

____
Participant's Printed Name

APPENDIX D

Authorization to Release Test Scores Form

Authorization to Release ACT and/or SAT Scores

As part of the "Social Intuition" research project conducted by the MSU Department of Psychology, I authorize the MSU Office of Admissions to release my ACT and/or SAT scores to Dr. Steve Kozlowski. As soon as my test scores are linked to the other information I am providing as a participant in this study, any information identifying me personally will be permanently removed from the data file. Furthermore, this information will not be released to any other research teams or individuals and the results of this study will only report average test scores that do not permit personal identification.

______________________________ ____________

Signed Date

______________________________ ____________

Printed Name PID

APPENDIX E

Social Intuition Task Trials 1-12

TRIAL 1

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Akce	Rain	YES	NO
2.	Neetdu	Internet	YES	NO
3.	Senaz	Future	YES	NO
4.	Doob	Point	YES	NO
5.	Fefe	Tree	YES	NO
6.	Tackrote	Taxi	YES	NO
7.	Osha	Enemy	YES	NO
8.	Wylow	Wine	YES	NO
9.	Pahu	Food	YES	NO
10.	Bortki	Keyboard	YES	NO

TRIAL 2

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Rajas	Harmful	YES	NO
2.	Tanakan	Bank	YES	NO
3.	Dhakk	Cart	YES	NO
4.	Cownack	Journalist	YES	NO
5.	Chudoba	Round	YES	NO
6.	Seefanya	Toothpaste	YES	NO
7.	Takur	Help	YES	NO
8.	Balasin	Painting	YES	NO
9.	Naha	Dwelling	YES	NO
10.	Pawnzee	Bridge	YES	NO

TRIAL 3

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Mbiomha	Lucky	YES	NO
2.	Pimcroy	Printer	YES	NO
3.	Murda	Sit	YES	NO
4.	Maijot	Letter	YES	NO
5.	Rokna	Title	YES	NO
6.	Gileena	Clock	YES	NO
7.	Pastha	Fork	YES	NO
8.	Amsue	Toilet	YES	NO
9.	Kattora	Forgive	YES	NO
10.	Mook	Nose	YES	NO

TRIAL 4

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Ehu	Obedient	YES	NO
2.	Bet	Ball	YES	NO
3.	Taa	Beach	YES	NO
4.	Taykah	Fighting	YES	NO
5.	Chunga	Ice	YES	NO
6.	Pakroam	Campsite	YES	NO
7.	Ghalana	Dog	YES	NO
8.	Dygra	Rabbit	YES	NO
9.	Madgura	Year	YES	NO
10.	Angdi	Bed	YES	NO

TRIAL 5

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Kachna	Rotten	YES	NO
2.	Sowluke	Daughter	YES	NO
3.	Starat	Open	YES	NO
4.	Hommootsa	Library	YES	NO
5.	Sunut	Hero	YES	NO
6.	Fanmore	Dentist	YES	NO
7.	Eroste	Barrel	YES	NO
8.	Weepandee	Compact Disk	YES	NO
9.	Oihu	Crumb	YES	NO
10.	Ahoo	Head	YES	NO

TRIAL 6

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Pupupu	Affection	YES	NO
2.	Dreedon	Music	YES	NO
3.	Itibari	Growth	YES	NO
4.	Pate	Fan	YES	NO
5.	Peleka	Calf	YES	NO
6.	Binang	Airplane	YES	NO
7.	Rozsah	Water	YES	NO
8.	Homepa	Blanket	YES	NO
9.	Zidor	Tomato	YES	NO
10.	Roakbe	Jungle	YES	NO

TRIAL 7

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Umatu	Job	YES	NO
2.	Na	Chest	YES	NO
3.	Chitr	East	YES	NO
4.	Sapra	Phone	YES	NO
5.	Latta	Shadow	YES	NO
6.	Chideck	Boy	YES	NO
7.	Plavec	Under	YES	NO
8.	Bowgre	Suitcase	YES	NO
9.	Andi	Sweet	YES	NO
10.	Morsaydu	Motorcycle	YES	NO

TRIAL 8

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Dohain	Chair	YES	NO
2.	Nitten	Tennis	YES	NO
3.	Haka	Dusk	YES	NO
4.	Teetan	Week	YES	NO
5.	Shauri	Kick	YES	NO
6.	Ahgot	Air Conditioning	YES	NO
7.	Gharsa	Pray	YES	NO
8.	Roketah	Infant	YES	NO
9.	Chinitti	Hard	YES	NO
10.	Satonsue	Zoo	YES	NO

TRIAL 9

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Lagwa	Memory	YES	NO
2.	Grigone	Scissors	YES	NO
3.	Safha	Car	YES	NO
4.	Dib	Father	YES	NO
5.	Caj	Over	YES	NO
6.	Cowahoo	Knee	YES	NO
7.	Rak	Get	YES	NO
8.	Firote	Train	YES	NO
9.	Jaunze	Finish	YES	NO
10.	Egow	Couch	YES	NO

TRIAL 10

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Pitzu	Improve	YES	NO
2.	Natubla	Tuna Fish	YES	NO
3.	Makua	Direct	YES	NO
4.	Neesawbry	Mail	YES	NO
5.	Kamba	Land	YES	NO
6.	Yatun	Sick	YES	NO
7.	Donest	Report	YES	NO
8.	Dumgra	Button	YES	NO
9.	Hertu	Art	YES	NO
10.	Tayuwit	Radio	YES	NO

TRIAL 11

<u>Directions:</u> Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". <u>Your goal is to maximize the number of correct responses across all trials.</u> When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Mutlag	Insult	YES	NO
2.	Binamsee	Airport	YES	NO
3.	Ganda	Even	YES	NO
4.	Atku	Bottle	YES	NO
5.	Balwa	Change	YES	NO
6.	Diwon	Eyeglasses	YES	NO
7.	Rahm	Fire	YES	NO
8.	Royah	Boat	YES	NO
9.	Elizkoi	Bird	YES	NO
10.	Rayto	Television	YES	NO

TRIAL 12

Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Kalati	Education	YES	NO
2.	Dugree	Bone	YES	NO
3.	Ranta	Human	YES	NO
4.	Toptra	Sun	YES	NO
5.	Ribost	King	YES	NO
6.	Atroodam	Police	YES	NO
7.	Pesha	Amount	YES	NO
8.	Labinsin	Artist	YES	NO
9.	Khet	Conflict	YES	NO
10.	Andoo	Month	YES	NO

APPENDIX F

Demographic and Individual Difference Measures

Demographic Information

1. What is your sex?
2. What is your race?
3. What is your age?
4. If you took the SAT, write down your total score (math + verbal) in the space below.
5. If you took the ACT, write down your total score in the space below.
6. How many brothers and sisters do you have?
7. Approximately how many people do you have a conversation with in an average day?
8. Do you often play word games (e.g., crossword puzzles, word finds, word of the day)?
9. Other than English, how many languages do you speak fluently?

Individual Differences

Trait Anxiety

1. I feel calm.
2. I feel secure.
3. I am tense.
4. I am regretful.
5. I feel at ease.
6. I feel upset.
7. I am presently worrying over possible misfortunes.
8. I feel rested.
9. I feel anxious.
10. I feel comfortable.
11. I feel self-confident.
12. I feel nervous.
13. I am jittery.
14. I feel "high strung."
15. I am relaxed.
16. I feel content.
17. I am worried.
18. I feel overexcited and rattled.
19. I feel joyful.
20. I feel pleasant.

APPENDIX G

Familiarization Trial

FAMILIARIZATION TRIAL

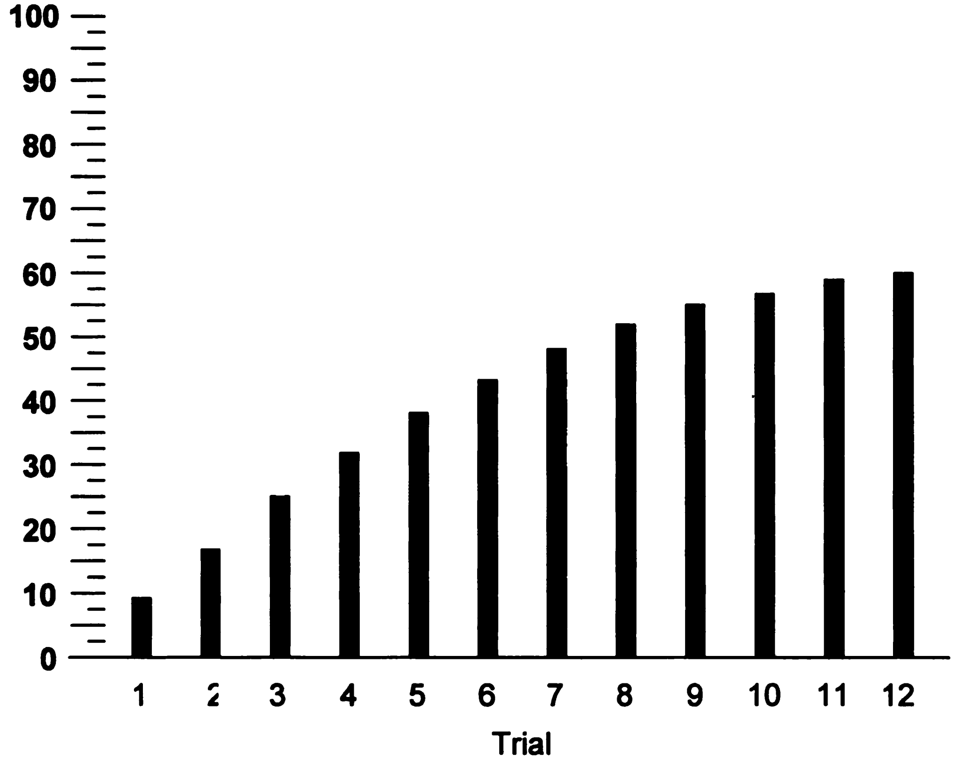
Directions: Read the foreign word and decide if it expresses the same meaning as the adjacent English word. If you decide the two words have similar meanings, circle "YES". If you decide their meanings are not similar, circle "NO". Your goal is to maximize the number of correct responses across all trials. When you are finished with this trial, return this page to your folder and wait for further instructions.

	FOREIGN WORD	ENGLISH WORD	RESPONSE	
1.	Palola	Degree	YES	NO
2.	Sendotu	Peace	YES	NO
3.	Kana	New	YES	NO
4.	Adelu	Last	YES	NO
5.	Pundra	Faster	YES	NO
6.	Luberri	Cut	YES	NO
7.	Ko	Spirit	YES	NO
8.	Mbogo	Red	YES	NO
9.	Phirkta	Work	YES	NO
10.	Larazi	Leap	YES	NO

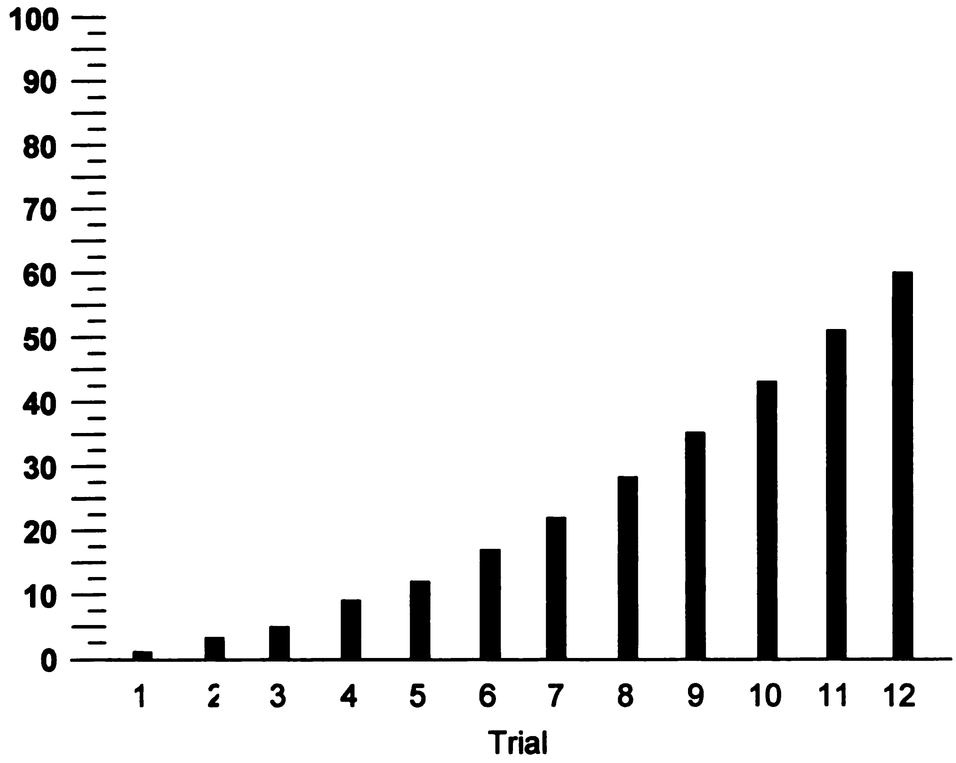
APPENDIX H

Feedback Manipulation

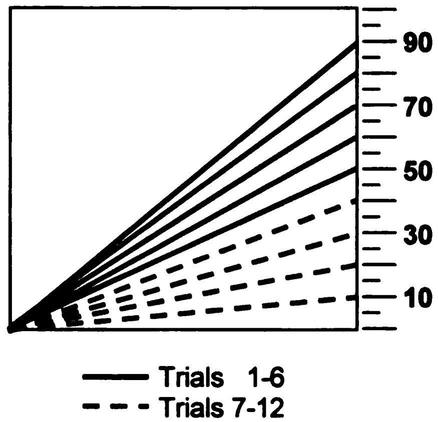
Decelerating Performance Profile with Position Feedback



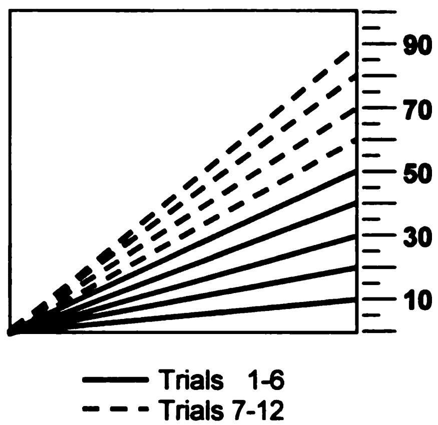
Decelerating Performance Profile with Position Feedback



Decelerating Performance Profile with Velocity Feedback

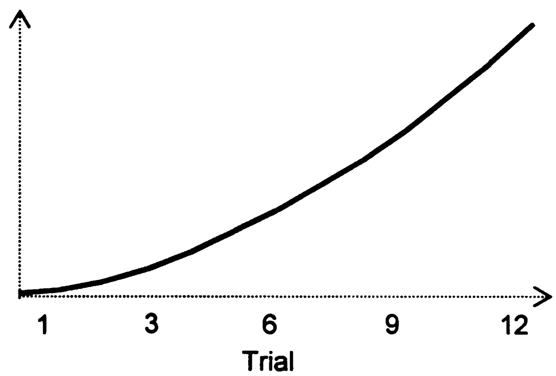


Accelerating Performance Profile with Velocity Feedback



Decelerating Performance Profile with Acceleration Feedback

Accelerating Performance Profile with Acceleration Feedback



APPENDIX I

Debriefing Form

THANK YOU for participating in this study!

Although the stated purpose of this study is to examine social intuition, the actual purpose is to examine your reactions to the type of feedback provided to you throughout the study. Current research suggests that people may respond more or less favorably to feedback based upon when it is provided, the way in which it is provided, and their unique individual differences. Therefore, in addition to your reactions, we will also examine your demographic information and personal preferences to understand how they may have affected your reactions to the feedback you had received. Ultimately, the results of this study could be used to determine how to provide the right feedback at the right time to enhance the motivation and performance of students or trainees. The social intuition "cover story" was used to ensure that your knowledge of the actual purpose of this study would not affect your reactions to the feedback. Therefore, it is critical that you do not discuss the details of this study with anyone who might later participate in this study.

If you have any questions or concerns regarding your rights as a participant in this study, you may contact MSU's Office of Research Ethics and Standards at (517) 355-2180. If you are interested in receiving any additional information about this study, please contact Dan Watola at (517) 432-7752 or watolada@msu.edu, or read the journal article cited below.

THANK YOU again for your participation!

Hsee, C. K., & Abelson, R. P. (1991). Velocity relation: Satisfaction as a function of the first derivative of outcome over time. *Journal of Personality and Social Psychology, 60*, 341-347.

APPENDIX J

Motivational Measures

Motivational Measures

State Positive Affect Subscale (Times 1-3)
1. Enthusiastic
2. Interested
3. Determined
4. Excited
5. Inspired
6. Alert
7. Active
8. Strong
9. Proud
10. Attentive

Self-Satisfaction with Task Performance (Times 1-3)
1. I am satisfied with my overall performance on this task.
2. I am pleased with how I am doing.
3. My current performance satisfies me.
4. At this point, I am happy with my performance.

Goal Commitment (Times 1-3)
1. I am committed to pursuing this goal.
2. I am willing to put forth a great deal of effort to achieve this goal.
3. Quite frankly, I don't care if I achieve this goal or not.
4. It wouldn't take much to make me abandon this goal.
5. I think this goal is a good goal to shoot for.

Task Self-Efficacy (Times 1-3)

I am _____% confident that I can answer _____% of the items correctly in future trials.

1.	_____%	10%
2.	_____%	20%
3.	_____%	30%
4.	_____%	40%
5.	_____%	50%
6.	_____%	60%
7.	_____%	70%
8.	_____%	80%
9.	_____%	90%
10.	_____%	100%

Task Effort (Time 1)
Write down all of the words you can create using the letters found in the word:

BATHROOM

Task Effort (Time 2)
Write down all of the words you can create using the letters found in the word:

BACKPACKER

Task Effort (Time 3)
Write down all of the words you can create using the letters found in the word:

FOOTFALLS

New Task Effort (Time 3)
Write down all the words you can form by linking letters (left, right, below, above, and diagonally).

J	E	I	R
T	E	R	O
E	T	R	A
H	O	G	N

Manipulation Check (Time 3)

1. My performance on the task seemed to get better over time.
2. My performance on the task seemed to get worse over time.
3. I seemed to do better earlier as compared to more recently.
4. I seemed to do worse earlier as compared to more recently.

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