

## The Impact of Conceptions of Ability on Self-Regulatory Factors and Motor Skill Acquisition

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This study tested the hypothesis that conceptions of ability affect self-regulatory processes and the acquisition rate of a perceptual-motor skill. Subjects performed a rotary pursuit task under induced cognitive sets that task performance reflected inherent aptitude or acquirable skill. Their perceived self-efficacy, affective self-reactions, and performance attainments were measured over a series of trials. Subjects who performed the task under the inherent-aptitude conception of ability displayed no growth in perceived self-efficacy across phases, negative self-reactions to performances, low interest in the activity, and a limited level of skill development. In contrast, those who performed the task under the conception of ability as an acquirable skill displayed growth in perceived self-efficacy, positive self-reactions to their performances, widespread interest in the activity, and a high level of skill acquisition. The stronger the positive self-reactions, the greater the subsequent performance attainments.

In analyses of athletic skill development and performance, much attention has been given to physical factors such as ability level, conditioning, and practice effects. Recent years have witnessed a growing recognition of the influential role played by cognitive and self-referent influences in the rate of motor skill acquisition and the quality of athletic performance (Anderson, 1983; Fitts & Posner, 1967; Mahoney, 1979; Welford, 1988; Wilkes & Summers, 1984). These cognitive factors include such diverse processes as cognitive representations of the structural properties of motor skills (Carroll & Bandura, 1987, 1990), mental rehearsal (Feltz & Landers, 1983; Woolfolk, Murphy, Gottesfeld, & Aitken, 1985), mental imagery (Epstein, 1980), cognitive style strategies (Saint-sing, Richman, & Bergey, 1988; Silva & Applebaum, 1989), and cognitive strategies normally grouped under the term *psyching-up* (Caudill, Weinberg, & Jackson, 1983; Shelton & Mahoney, 1978).

Preexisting belief systems can affect self-regulatory factors that govern the development and execution of complex skills. One such belief system is the way in which people construe ability. Recent research has identified two major conceptions of ability (M. Bandura & Dweck, 1987; Dweck & Elliott, 1983; Nicholls, 1984). Some people regard ability as an acquirable skill that can be increased by gaining knowledge and perfecting competencies. They adopt a functional learning goal, which is ideally suited for skill development. They seek challenges that provide opportunities to expand their knowledge and competencies. They regard errors as a natural part of the skill-acquisition process. They

learn from mistakes. They judge their capabilities more in terms of personal improvement than by comparison with the achievement of others. For people who view ability as a more or less fixed inherent aptitude, performance level is regarded as diagnostic of inherent capacities. Errors and deficient performances carry a high evaluative threat. Therefore, they prefer tasks that minimize errors and permit a ready display of proficiency at the expense of expanding their competencies. High effort is also threatening because it presumably can reveal low ability. They judge their ability extensively by social comparison so that the successes of others belittle their own ability. These findings contradict attribution theory, which typically regards ability as an internal, stable factor. The results of other studies have also called into question the generality of the notion in attribution theory of inverse compensation in judging ability (Surber, 1984). People who construe ability as a changeable attribute view effort as creating ability rather than compensating for low ability.

Research on the acquisition of complex decision-making skills has attested to the powerful impact of differential conceptions of ability on psychosocial functioning (Wood & Bandura, 1989a). Individuals who were led to believe that performance on the cognitive task reflected their basic cognitive aptitude experienced increasing self-doubts concerning their personal efficacy as they encountered difficulty. They became more erratic in their analytic thinking, they lowered the performance goals they set for themselves, and their performance plummeted. In contrast, individuals who were led to believe that performance on the task reflected an acquirable skill displayed a highly resilient sense of personal efficacy. Under this belief system, the performers remained steadfast in their perceived self-efficacy even when performance standards were difficult to fulfill. They continued to set challenging goals for themselves, they used analytic strategies in efficient ways, and they achieved high performance attainments. Conceptions of ability biased from the outset whether substandard performances were construed as indicants of inherent deficiencies or as instructive guides for improving capabilities.

The present experiment was designed to test the generality of the influence of conceptions of ability in a markedly different domain of functioning, namely, the development of perceptual-motor skills. The issue of inherent talent versus an acquirable skill frequently arises in the judgment of athletic capabilities. Sports commentators are quick to ascribe the distinguished performances of prominent athletes to their "natural talents" as if athletic skills come preset by biological inheritance. For example, sportscasters frequently comment on the so-called natural batting swing of a leading baseball hitter but fail to recognize the countless hours spent perfecting that swing. During the off season, this player practices hitting about 500 pitches, day in and day out, to master any weaknesses. Athletic attainments are obviously partly dependent on physical endowment, but intricate athletic skills are not inborn; they must be developed by intensive training fostered by facilitative and supportive belief systems. In this study we investigated the contribution of conceptions of ability to the rate and level of acquisition of a perceptual-motor skill.

The findings of the prior study revealed that the effects of conceptions of ability on performances are mediated through self-regulatory mechanisms (Wood & Bandura, 1989a). These include perceived self-efficacy, personal goal setting,

and analytic strategies. In path analyses, perceived self-efficacy influenced performance directly and indirectly through its strong effects on personal goal setting and effective use of analytic strategies. Further research has shown that affective self-reactions also operate in conjunction with these self-regulatory factors in the causal structure, especially during earlier phases of cognitive skill acquisition (A. Bandura & Jourden, 1991). Negative self-reactions detract from effective performance.

There is reason to believe that the same self-regulatory mechanisms would mediate the effects of conceptions of ability on acquisition of perceptual-motor skills. Perceived self-efficacy has been shown to affect thought processes, the amount of effort expended in an endeavor, level of perseverance in the face of obstacles, affective reactions to stressors, and choice of challenges (A. Bandura, 1989). A high sense of efficacy also fosters interest in the activity (A. Bandura & Schunk, 1981).

Some progress has been made in verifying the relation of self-efficacy beliefs to different types of athletic performances (Barling & Abel, 1983; Feltz, 1988; Feltz & Albrecht, 1985; Leland, 1983; McAuley & Gill, 1983; Morelli & Martin, 1982). Laboratory studies in which the level of perceived self-efficacy is altered have corroborated the contribution of self-efficacy beliefs to motor performances under competitive conditions (Weinberg, 1985; Weinberg, Gould, Yukelson, & Jackson, 1981; Weinberg, Yukelson, & Jackson, 1980) and non-competitive ones (Gould & Weiss, 1981; McAuley, 1985). High perceived self-efficacy enhances motor skill performance and reduces vulnerability to the debilitating effects of defeat.

A vast body of research, reviewed by Locke and Latham (1990), documents that explicit, challenging goals enhance performance. There is some evidence that goal-enhancement effects are generalizable to the domain of physical and athletic activity (A. Bandura & Cervone, 1981, 1986; Hall & Byrne, 1988; Locke & Latham, 1985; Weinberg, Bruya, Longino, & Jackson, 1988). Individuals who adopt challenging goals outperform those who set no goals for themselves or who are urged to do their best.

However, studies of the effects of goal setting on physical activity have been less consistent in their findings than in applications in other domains (Hall & Byrne, 1988; Hall, Weinberg, & Jackson, 1987; Miller & McAuley, 1987; Weinberg, Bruya, & Jackson, 1985; Weinberg, Bruya, Longino, & Jackson, 1988). Many possible explanations have been proposed for the variable results, including performance ceilings, fatiguing performance durations, inclusion of competitive inducements, modeling and social-comparison confounds in assessment procedures, insufficient experimental control in field studies, and spontaneous goal setting. Spontaneous goal setting is an especially critical factor given evidence that most subjects set goals for themselves when not instructed to do so (A. Bandura & Cervone, 1983; Weinberg et al., 1985; Weinberg et al., 1988), and even under assigned goals they often adopt self-set goals that account for a substantial share of the variance in their performance (A. Bandura & Cervone, 1986).

Induction of differential conceptions of ability places severe constraints on assessment of self-regulatory influences. Adequate self-efficacy measurement must encompass a wide range of performance attainments, including decrements

from the prefatory trial as well as varying increments above it. However, in the present experiment, the range of self-efficacy levels had to be severely restricted because the inclusion of decrements from the prefatory trial could negate the induced conception of ability as an inherent, unchangeable attribute. Efficacy levels describing vast improvements beyond the prefatory-trial level could similarly undermine the previously instated conception. However, some increments above the prefatory levels had to be included to preserve the credibility of the induced acquirable-skill conception of ability.

Nevertheless, it was of interest to determine whether the different conceptions of ability would manifest themselves even in perceived self-efficacy for a restricted range of performance attainments. For similar reasons, personal goal setting was not assessed. To convince subjects that performance on a given task reflects a more or less fixed aptitude and to probe for the goals they set for themselves to enhance their performance attainments runs the risk of converting the inherent-aptitude condition to an incremental-skill condition. However, there were no constraints on assessing subjects' affective self-reactions to their performances.

Although the present experiment did not lend itself to a full analysis of the mediating self-regulatory mechanisms, the pattern of self-regulatory influences in the causal structure described earlier has been replicated across a series of prior studies involving markedly different treatment conditions (A. Bandura & Jourden, 1991; A. Bandura & Wood, 1989; Wood & Bandura, 1989a, 1989b). Therefore, evidence that conceptions of ability affect development of motor skill would not leave one entirely in doubt as to how they may have done so.

In the present experiment, subjects performed a perceptual-motor task over a series of trials under instated conceptions of physical ability as either an acquirable skill or as a more or less fixed, inherent aptitude. At periodic intervals, we measured subjects' perceived self-efficacy and their self-evaluative reactions to their performance attainments. We also measured the rate at which they gained proficiency in the perceptual-motor activity and their level of interest in it. For reasons given earlier, it was predicted that conception of ability as an acquirable skill would foster higher growth of perceived self-efficacy, more positive self-evaluative reactions, higher interest in the activity, and greater improvement in performance than would conception of ability as an inherent aptitude.

## Method

### *Subjects*

The subjects were 24 females and 24 males drawn from an introductory psychology course. They ranged in age from 17 years to 39 years, with a mean of 20.1 years. The subjects were randomly assigned, balanced for sex, to the treatment conditions.

### *Apparatus*

A pursuit-rotor tracking task was selected because it provides a sensitive measure of motor skill learning (Jensen, 1975). The instrument was a Marietta illuminated-target pursuit apparatus, model 5-100-A, with a circular template. The instrument was set at the midpoint sensitivity level. The target, which was

approximately 10 cm in diameter, rotated in a nonvariant circle at a constant speed in a clockwise direction for a duration of 1 second per rotation. The instrument was attached to a Marietta digital timer, model 14-15-MS, which registered the total time on target in milliseconds. The instrument also emitted a tone when the light-sensitive stylus was in contact with the target. The subject's task was to track the moving light source with a light-sensitive stylus. Each trial lasted 60 seconds. Subjects were instructed to begin each trial by resting the stylus on the point of light so that all subjects began each trial from the same position.

### *Induction of Conceptions of Ability*

The introductory orientation to the experiment emphasized the influential role played by visual-guidance capability in many occupational pursuits. The work of airline control operators was given as one such example. The pursuit rotor device was described as a sensitive instrument for measuring ability to translate cognitively processed visual information rapidly into coordinated action. Subjects were told that they should track the moving light and try to maximize the time they keep the stylus on the target. Following the orientation instructions, subjects were given the differential information about the nature of the ability being measured by the perceptual-motor device.

The inherent- and acquirable-skill conceptions of ability were instated by written instructions to insure comparability across subjects. In the *inherent aptitude* condition, subjects were led to believe that the pursuit rotor device measures one's basic natural capacity for processing and translating dynamic information into proficient action.

In the *acquirable skill* condition, subjects were informed that, like many other activities, intricate visual guidance is a learnable skill in processing and translating dynamic information into proficient action. At the outset, it is common to make errors. One can learn from errors how to perform the task better.

After the differential conceptions of ability were instated, subjects performed the pursuit rotor in a prefatory trial to assess their initial level of perceptual-motor proficiency and to remove any quick-practice effects from the formal experimental trials. To reinforce the differential cognitive sets, the brief description of the task as measuring an inherent or an acquirable visual-guidance capability was verbally repeated. The first experimenter then left the room, and a second experimenter, who was blind to the condition to which the subjects were assigned, administered the performance trials. Separate experimenters were used for the induction of conceptions of ability and for the performance tests to control for any possible experimenter bias.

### *Self-Regulatory Factors*

Subjects recorded their *perceived self-efficacy* after the prefatory trial and after every two subsequent performance trials. Perceived self-efficacy was not measured before the prefatory trial because, in the absence of any knowledge of a pursuit rotor device, subjects would have no basis for making a self-efficacy judgment. The efficacy scale included only seven levels of performance attainments, ranging from a performance equal to the time achieved on the prefatory trial to 150% more time on target. The range of self-efficacy levels had to be curtailed for reasons given earlier. The ratings were made for each performance

level in terms of a 10-point scale ranging from *no confidence at all* (0), to *intermediate levels of confidence* (5) to *total confidence* (9). The strength of perceived self-efficacy was the mean level of confidence for the seven levels of performance attainments.

To assess *self-evaluative reactions*, subjects rated, on a 13-point scale, how self-satisfied or self-dissatisfied they were with their performance in the preceding trial and their affective self-reactions were they to attain the same performance on the next trial. The scale included a neutral point and 6 degrees of self-satisfaction above it and 6 degrees of self-dissatisfaction below it.

### *Perceptual-Motor Performance*

Subjects completed three blocks of two trials each on the pursuit rotor device with a 1-minute rest period after each trial. At the completion of each block of trials, subjects again recorded their perceived self-efficacy and self-evaluative reactions. Subjects' perceptual-motor performance was measured in milliseconds on target as recorded by the digital timer.

In everyday life, people's conceptions of ability operate under conditions in which they can observe their performances. If subjects had no information about their performance, the robustness and generalizability of the effect of the differential conceptions of ability would be in doubt. Demonstration that alternate conceptions of ability have differential effects on skill development under conditions of veridical performance information provides an especially stringent test of their power. Subjects therefore had access to two indicants of their performance, the actual milliseconds on target and the tone emitted by the apparatus during each trial.

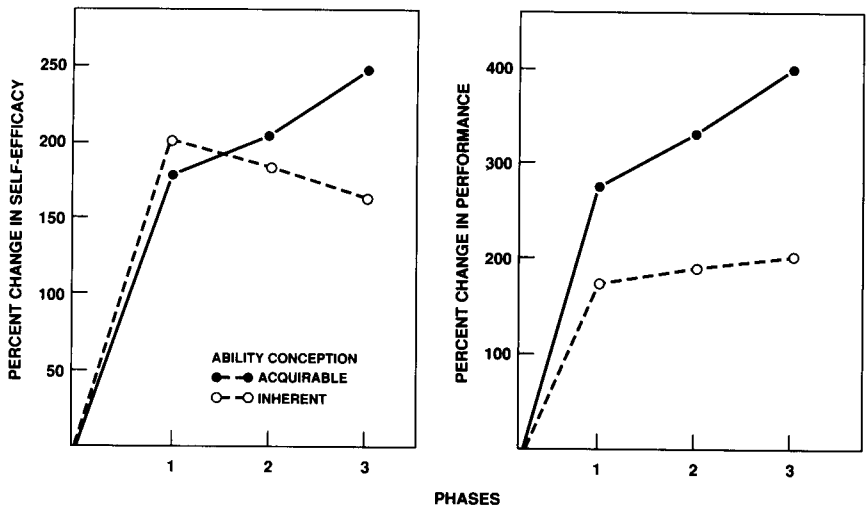
### *Interest Level*

After the performance trials had been completed, subjects were told that there were 5 minutes remaining. They could choose to continue working on the task or end the session. Those who expressed an interest in continuing the task recorded the number of additional trials they wished to complete. This measure was included as an index of the level of interest developed in the activity.

At the end of the session, subjects were given a full explanation of the nature and purpose of the study. They were also told of the difficult nature of the task and assured that it did not tap basic underlying aptitudes.

## **Results**

Subjects in the inherent-ability condition performed slightly higher ( $M=4.41$  seconds) than those in the acquirable-skill condition ( $M=3.08$  seconds) in the prefatory trial,  $t(46)=2.35$ ,  $p<.05$ . However, the groups did not differ in either perceived self-efficacy or in affective self-reactions immediately after the prefatory trial. The significance of the changes produced by the treatment conditions was evaluated using a  $2 \times 3$  analysis of covariance (ANCOVA), with conception of ability as a between-subjects variable, phases as a within-subjects, repeated-measures variable, and the prefatory performance as the covariate. The differences between subsets of means were tested by the Bonferroni procedure.



**Figure 1 — Percentage changes in perceived self-efficacy (left panel) and perceptual-motor performance (right panel) across successive phases of the experiment under different conceptions of ability as an inherent aptitude or as an acquirable skill.**

### *Effects of Conceptions of Ability on Self-Regulatory Factors*

Figure 1 shows the mean percentage changes from the prefatory trial in strength of perceived self-efficacy as a function of conceptions of ability across phases of the experiment. Results of the analysis of variance show that only the interaction between conditions and phases,  $F(2,92)=3.19$ ,  $p<.05$ , was significant. This two-way interaction achieved a slightly higher significance level,  $F(2,92)=4.17$ ,  $p<.02$ , in the analysis of covariance.

Subjects in the inherent-aptitude condition did not gain any sense of efficacy beyond the prefatory trial. Subjects in the acquirable-skill condition demonstrated a progressive rise in perceived self-efficacy over the series of performance trials, although this change was only at a  $p<.09$  level of significance. Had the self-efficacy scales included performance gains that extended at least to the levels achieved by subjects in the acquirable-skill condition, the trajectories in self-efficacy growth would undoubtedly have been more divergent.

Subjects' self-evaluative reactions to the performance they had just completed and their self-reactions were they to attain the same level of performance on the next trial were highly correlated,  $r=.76$ . Therefore the two sets of self-reactions were combined. The analysis yielded a highly significant phases effect,  $F(3,144)=34.53$ ,  $p<.001$ . Initially, subjects were quite discontent with their performance, but after the prefatory trial they were more self-accepting of their achievements,  $p<.001$ , and did not show any further change across the trial blocks. However, the induced conceptions of ability also exerted a significant effect on the nature of subjects' affective reactions to their performances,  $F(1,45)=6.02$ ,  $p<.02$ . This main effect is shown in Figure 2. Subjects who

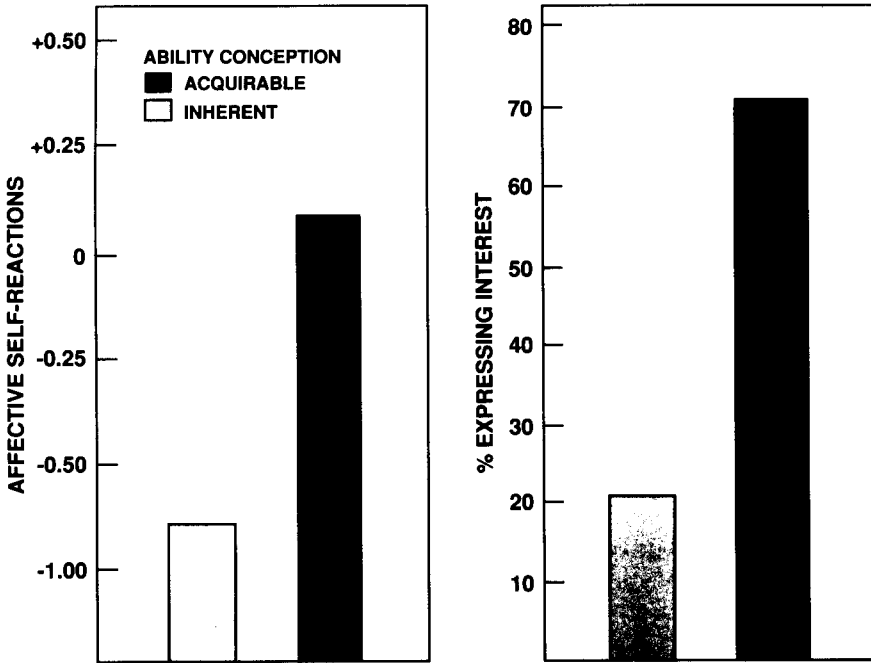


Figure 2 — Affective self-reactions (left panel) and percentage of subjects expressing an interest in the activity (right panel) as a function of conceptions of ability as an inherent aptitude or as an acquirable skill.

viewed the activity as one involving an acquirable skill expressed more positive self-reactions; those who regarded the activity as reflecting their basic aptitude responded with negative self-reactions to their performances.

### Performance Attainments

Figure 1 shows the mean percentage improvement in performance plotted as a function of conceptions of ability and performance phases. The analysis yielded highly significant main effects for conditions,  $F(1,45)=10.82$ ,  $p<.002$ , and phases,  $F(1,92)=20.41$ ,  $p<.0001$ . These effects were qualified by a highly significant interaction between treatment conditions and phases,  $F(2,92)=8.08$ ,  $p<.001$ .

In the intragroup contrasts, using the Bonferroni procedure, subjects in the inherent-aptitude condition achieved no performance gains across adjacent phases; their counterparts in the acquirable-skill condition raised their performance from the first to the second phase,  $p<.07$ , and achieved even larger performance improvements between the second and the third phases,  $p<.001$ . The intergroup differences in performance attainments were significant beyond the  $p<.001$  level at each of the three phases of the experiment.

### Level of Interest

The effects of conceptions of ability on level of interest were tested in terms of the number of subjects who chose to engage further in the activity and the



number of additional trials to which they committed themselves. As shown in Figure 2, 71% of the acquirable-skill subjects chose to continue the task, whereas only 21% of the inherent-aptitude subjects wished to do so. This difference in interest was highly significant  $\chi^2(1) = 10.15, p < .002$ .

Because only a few subjects in the inherent-aptitude condition expressed an interest in pursuing the activity further, differences in the number of additional trials subjects wanted to perform were analyzed with the nonparametric Mann-Whitney test. The medians for the inherent-aptitude and acquirable-skill conditions were 0 and 2, respectively. This difference was also significant,  $z = 2.52, p < .02$ .

### *Relation of Self-Regulatory Factors to Performance Attainments*

As previously noted, only a narrow range of performance gains was included in the self-efficacy scales so as not to nullify the induced conceptions of ability. This experimental constraint markedly reduced the sensitivity of the self-efficacy measure and precluded its use in correlational analyses. For example, subjects in the acquirable-skill condition improved their performance by more than 400%, but the highest item in the self-efficacy scale measured perceived capability to attain only a 150% gain. Therefore, these subjects could not register their full sense of efficacy, which far exceeded the upper limit of the scale. However, no constraints were imposed on the other self-regulatory factor, namely, affective self-reaction. Its predictive value could be meaningfully analyzed.

Correlations were computed between affective self-reactions and level of performance attainments in the subsequent phase. This predictive relation was examined separately for each of the three performance phases. Subjects' self-reactions to their performance in the prefatory test were not systematically related to their performance in the first phase. However, their first-phase affective self-reactions predicted their second-phase performances,  $r(46) = .36, p < .006$ , and their second-phase affective self-reactions predicted their third-phase performances,  $r(46) = .38, p < .005$ . The more positive their self-reactions, the higher their subsequent performance attainments.

## **Discussion**

The findings of the present study attest to the impact of conceptions of ability on the development of competencies. This influence is reflected in both the self-regulatory factors and the rate and level of skill acquisition. In accord with our prediction, construing ability as an acquirable skill fostered self-beliefs of physical capabilities, positive self-reactions to one's performance attainments, widespread interest in the activity, and progressive improvements in perceptual-motor skill. In contrast, construing performance as diagnostic of inherent aptitude conferred no self-efficacy benefits beyond the initial familiarization with the activity and left performers discontent with their performances, disinterested in the activity, and arrested at a relatively low level of perceptual-motor skill development.

The widespread effects of these differential conceptions of ability were also revealed in subjects' spontaneous remarks at the conclusion of the experiment. Those who approached the activity as involving an acquirable skill commented on their enjoyment of the challenge of the activity ("It was fun. I like it"), their

continued interest in it ("I would like to try some more. I was getting real good at it"), their increased sense of capability ("I got pretty good"), and their ability to exercise personal control over their performance ("If you concentrate, you can get it"). Those who regarded the activity as reflective of their inherent aptitude were more likely to express discouragement ("I tried harder and harder, and then I just gave up, especially when I got off target at the beginning of a try"), physical debility ("This really hurt my arm, and it was so tiring"), self-discontent ("I was dissatisfied"), difficulty with the task ("This was surprisingly hard"), inability to exercise control ("I thought that I'd do better, but I just couldn't"), and dispositional attributions of incapability ("I'm not very good at this sort of thing").

Several lines of evidence (M. Bandura & Dweck, 1988; Elliott & Dweck, 1988; Wood & Bandura, 1989a) are consistent in showing that construing ability as an inherent aptitude greatly increases vulnerability to the adverse effects of failure. Conversely, conceiving of ability as an acquirable skill enhances resiliency of self-efficacy that enables individuals to invest their performance difficulties with challenges for self-development.

Evidence that conceptions of ability affect self-beliefs of physical capability in the same way as they do self-beliefs of cognitive capability (Wood & Bandura, 1989a), extends the generality of this form of cognitive influence. In the present experiment, addressing markedly different competencies, subjects in the inherent-aptitude condition performed either as well as or slightly better initially than those in the acquirable-skill condition. Their growing divergence in perceived self-efficacy suggests that differential conceptions of ability biased how initial performance deficits were being cognitively processed. Construal of performance difficulties as indicants of personal deficiencies would eventually create a mediocre self-schema in the particular domain of functioning; construal of similar difficulties as instructive guides for improving one's competency would foster development of an efficacious self-schema.

Prior research has revealed that the nature of the relationship between affective self-reaction and subsequent performance depends upon the complexity of the activity and its vulnerability to intrusive disruption. In simple activities, where performance gains are attainable simply through dint of effort, self-discontent with deficient attainments is the major affective regulator of performance accomplishments (A. Bandura & Cervone, 1983, 1986). In complex activities that require heavy attentional and cognitive demands, high self-discontent has disruptive effects on performance, but positive self-reactions to personal progress provide the aidful motivational orientation for performance accomplishments (A. Bandura & Jourden, 1991; Cervone, Jiwani, & Wood, 1990).

The activity selected for study in the present experiment required close, continuous visual tracking and intricate perceptual-motor coordination, both of which are readily subject to disruption. Any lapse in attention, increased tenseness, or motoric disturbance instantly drives one off track. Given this high sensitivity to disruption, positive self-reactions are conducive to performance improvements.

Among other benefits, conception of ability as an acquirable skill created interest in the activity. Two complementary mechanisms may account for this effect. One possible explanation is in terms of enhancement of perceived self-efficacy. A sense of personal efficacy in mastering challenges is more apt to

spark interest in an activity than is self-perceived inefficacy (A. Bandura & Schunk, 1981; Zimmerman, 1985). A second possible mechanism operates through the affective reactions activated during the pursuit of an activity. When people strive for and achieve improvements in their performance, they experience a sense of self-satisfaction (A. Bandura & Jourden, 1991; Locke & Latham, 1990). The satisfactions derived from indicants of progress foster intrinsic interest.

The results of this experiment confirm that conceptions of ability differentially affect both of these mediating processes. Performers who viewed the task as an acquirable skill experienced a rising sense of personal efficacy and self-satisfaction with their attainments; those who regarded it as indicative of their inherent aptitude derived little self-efficacy or self-satisfaction from what they were doing.

In practical terms, those who would instruct others in gaining physical and motoric competencies should attend not only to the specific activity itself and the specific cognitions related to such a task (such as psyching up) but should also attend to the more global mind-sets with which individuals approach learning the task. This experimental investigation suggests that a positive approach, which emphasizes the learning nature of task acquisition, will be the most beneficial in speed and quality of skill acquisition.

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