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Conceptions of Ability Affect Motor Learning

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ABSTRACT. The authors examined the effects of induced conceptions of ability on motor learning. Participants in 3 groups practiced a balance task, after receiving instructions suggesting that the task would reflect an inherent ability (IA group), represent an acquirable skill (AS group), or no ability-related instructions (control group). Across 2 days of practice, the AS and IA groups showed greater improvement in performance compared with the control group. For the retention test on Day 3, the AS group tended to demonstrate generally more effective balance performance than the control group and increasingly greater effectiveness compared with the IA group. Moreover, AS group participants made higher-frequency (reflexive) movement adjustments than participants of the other 2 groups, indicating a greater automaticity in the control of their movements. Thus, learning was enhanced by instructions portraying the task as a learnable skill, rather than revealing a fixed, inherent capacity or no instructions (control group).

Keywords: automaticity, balance, entity theory, incremental theory, performance

The phrases *natural athlete* and *athletic talent* are common and describe what many people would value in a description of themselves. Motor abilities are assumed by many to determine an individual's potential for achieving success in sport and movement endeavors (e.g., Magill, 2007; Schmidt & Lee, 2005). As such, they are viewed as factors that limit the skill level an individual can achieve. Research related to motor abilities—examining questions such as their specificity or generality or whether they are predetermined or can be developed through practice—seems to have lost its appeal several decades ago (e.g., Fleishman, 1964; Henry, 1968). However, more recently, another question has increasingly intrigued researchers: How do people's beliefs or conceptions of ability affect their motivation and performance? And further, can the learning of motor skills be affected by the ways in which individuals conceive of or think about motoric ability? The construct of conception of ability concerns how people think about the generic, genetic, or inherited nature of the ability in question and whether or not it is believed in effect to be an attribute fixed at birth (and revealed in subsequent performances) or amenable to change with experience or practice.

In other achievement domains, people's beliefs about the malleability or stability of key abilities have been shown to affect their performance and learning. For example, Dweck and colleagues have demonstrated that individuals' conceptualizations of or implicit theories about ability influence their level of success on certain tasks (e.g., Dweck & Leggett, 1988; Mangels, Butterfield, Lamb, Good, & Dweck, 2006) as well as their motivation to continue to perform those tasks (e.g., Cimpian, Arce, Markman, & Dweck, 2007). For example, Cimpian and colleagues found that in 4-year old children, even subtle differences in the wording of feedback—either implying ("You are a good drawer") or not implying ("You did a good job drawing") that their performance reflected an inherent ability—influenced the children's self-evaluation and persistence on a drawing task. When confronted with mistakes, children in the former condition showed more negative self-evaluative responses and less inclination to continue drawing. Thus, beliefs that task performance is determined by a stable, inherent ability can have detrimental effects when mistakes occur. As Cimpian et al. note, because poor performance reflects on the person's underlying ability, motivation and interest in the activity are dampened.

Conceptions of ability can be shaped early in life and presumably reflect a person's past experience (e.g., success and failure histories, feedback) in relevant achievement situations. As a consequence, adults tend to differ in their beliefs as to whether abilities are generally stable and fixed (*entity theorists*) or learnable and malleable (*incremental theorists*; e.g., Dweck, 1999; Dweck & Leggett, 1988). In achievement contexts, individuals who subscribe to entity theories are concerned with demonstrating or proving ability or outperforming others. They are likely to perceive negative feedback as a threat to the self, and they show less effort and persistence in difficult situations that may expose the extent of their ability or even avoid situations in which they do not perform well. In contrast, incremental theorists are more focused on learning the task and improving their performance. They are more intrinsically motivated and likely to seek challenging situations. When confronted with difficulties, they try to overcome them by increasing their effort.

Conceptions of ability can also affect the extent to which new information is learned. In a study by Mangels and colleagues (2006), groups of participants were selected on the basis of their extant theories of intelligence: Entity theorists believed that abilities were relatively fixed and stable versus incremental theorists who endorsed the perspective that abilities were learnable and malleable. Both groups were

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first given a general knowledge test in which feedback about the correctness of their answer and the correct answer were provided after each question. The second phase consisted of a surprise retention test consisting of questions that they had not answered correctly in the first phase. Of interest, incremental theorists showed greater improvements on the retest compared with entity theorists—indicating that they learned more from their errors on the first test. Mangels et al. also found electroencephalographic evidence that event-related potentials differed between the two groups. Entity theorists responded to errors (i.e., negative feedback) with a great anterior frontal P3 waveform, which was correlated with their self-reported concerns about performing better than others. In addition, entity theorists showed less activity related to the processing of corrective feedback (left temporal negativity), which presumably contributed to their benefiting less from the feedback that indicated failure.

Although most adults already have certain dispositional ability conceptions that they bring to the laboratory, some researchers have manipulated those conceptions through instructions to assess their influence on individuals' motivation and performance of motor skills (e.g., Belcher, Lee, Solmon, & Harrison, 2003; Jourden, Bandura, & Banfield, 1991; Li, Lee, & Solmon, 2005, 2008). For example, Li et al. (2008) examined the interaction of dispositional and induced ability conceptions on the performance of a novel motor task that involved spinning a baton with a handle. Even though persons who had a strong dispositional view of ability as incremental were more intrinsically motivated than those with entity conceptions, neither dispositional nor manipulated ability conceptions had a direct influence on motor performance in that study (see also Belcher et al; Li et al., 2005). A possible reason for the lack of effect of ability conceptions on performance is that the overall duration of the practice phase was relatively short (15 min). Also, to assess persistence, participants were "free to practice as much or as little as they desired" (Li et al., 2008, p. 55), leaving open the possibility that the groups differed with respect to the actual amount of practice they experienced. Furthermore, the final test consisted of a single 1-min trial performed on the same day as the practice phase.

Jourden and colleagues (1991) also examined the influence of conceptions of ability, induced through instructions, on individuals' motor performance. The task used was a pursuit rotor, requiring participants to track a moving cursor with a stylus. Participants in an inherent aptitude condition were told that the apparatus measured their natural capacity for processing dynamic information. In the acquirable skill condition, participants were informed that the task represented a learnable skill. Those who approached the task as an acquirable skill showed greater self-efficacy and more positive affective self-reactions and expressed greater interest in the task. Moreover, individuals in the acquirable skill group also demonstrated a greater improvement across trials than those in the inherent aptitude group.

Unfortunately, like Li et al. (2008), Jourden et al. (1991) used a very short practice period (six 1-min trials) and, more importantly, did not assess learning in delayed retention or transfer tests without instructions (see Schmidt & Lee, 2005). Thus, it remains unclear whether the influence of the instructed conception of ability on performance was only temporary in nature and if individuals' ability conceptualizations can have more permanent effects on the learning of motor skills. It is possible that the observed group differences in the Jourden et al. (1991) study reflected a short-term influence on performance—perhaps caused by an initial jolt of ego involvement or concern about proving ability in the inherent aptitude condition, which may have resulted in a temporary performance decrement. Alternatively, it is conceivable that the construal of a task as something that reveals one's inherent capacity acts as a more constant threat to one's ego. This, in turn, may hinder the learning process, compared with a situation that is regarded by the performer simply as a learning opportunity. In recent years, several variables have been identified that appear to affect the extent to which individuals become self-evaluative or self-conscious and that have concomitant effects not just on motor performance but also on learning (e.g., feedback after good vs. poor trials [Chiviacowsky & Wulf, 2007; Chiviacowsky, Wulf, Wally, & Borges, in press], normative feedback [Lewthwaite & Wulf, in press; Wulf, Chiviacowsky, & Lewthwaite, in press]). Therefore, it seemed important to determine whether individuals' conceptions of ability would impact their learning. If this were the case, it would not only be important for theoretical views of motor learning, but it would also have interesting implications for practical settings.

In the present study, we examined the influence of (manipulated) conceptions of ability on the learning of a motor skill by using an extended practice period and delayed retention testing. Participants were asked to practice a balance task (stabilometer; e.g., Hartman, 2007; Wulf, Höß, & Prinz, 1998). An interesting aspect of this task is that performance can be measured not only in terms of the deviations of the balance platform from the horizontal (root mean square error; *RMSE*); spectral frequency analyses of the platform movements can also reveal subtle frequency differences between experimental conditions. A higher frequency of movement adjustments (mean power frequency; MPF) is seen as an indication of a greater degree of automaticity in movement control (e.g., McNevin, Shea, & Wulf, 2003; Wulf, McNevin, & Shea, 2001). Higher MPF values are thought to reflect a greater utilization of reflexive (i.e., automatic) control processes. In previous studies, automaticity in the performance of this task has been shown to be susceptible to manipulations of attentional focus (e.g., Wulf et al., 2001) or normative feedback (Lewthwaite & Wulf, in press). Instructions inducing an internal focus of attention, or feedback indicating below-average performance, have been demonstrated to interfere with automatic control processes, as reflected by low-frequency and high-amplitude postural adjustments. An advantage of this measure is that it can reveal subtle performance differences between conditions that are not always discernible by overall performance measures, such as *RMSE* (McNevin & Wulf, 2002; Wulf, 2008).

Thus, the purpose of the present study was to determine whether individuals' conceptions of ability can affect the learning of motor skills. Ability conceptions were induced through instructions depicting performance on the balance task as something that reflected either an inherent capacity or a learnable skill. We were interested in overall balance performance (*RMSE*) as well as potentially more subtle influences of ability conceptions on degree of movement automaticity (MPF). Participants practiced the task on 2 days, with conception-of-ability instructions and reminders provided at the beginning of each of those days. Learning was assessed in a retention test without instructions on the 3rd day.

Method

Participants

Participants were 58 undergraduate students (37 women, 21 men) with a mean age of 22.1 years ($SD = 3.16$ years). Informed consent was obtained from all participants. Participants had no prior experience with the experimental task, and they were not aware of the specific purpose of the study. The university's institutional review board approved the study.

Apparatus and Task

The task required participants to balance on a stabilometer (*stability platform*; Lafayette Instrument, Lafayette, IN) and to try to keep it in a horizontal position for as long as possible during each 90-s trial. The stabilometer consists of a 65 × 105-cm wooden platform. The platform moved in the medial–lateral plane of the participants, with the maximum possible deviation of the platform to either side being 26°. DataLab 2000 software (Lafayette Instrument, Lafayette, IN) was used for data acquisition and analysis.

Procedure

Participants were randomly assigned to the inherent ability (IA), acquirable skill (AS), or control group. There were 19 participants in the IA group, 20 in the AS group, and 19 in the control group. The IA and AS groups differed with respect to the instructions given to participants. Those instructions were designed to induce entity or incremental ability conceptions, respectively. Specifically, before the beginning of the practice phase, participants in the IA group read the following instructions: "The balance platform (stabilometer) measures people's basic natural capacity for balance. You will be asked to perform several trials on each of 3 days. The scores you will be given after each trial, as well as how easy it is to improve, will reflect your inherent balance ability." Participants in the AS group read the following instructions: "The balance platform (stabilometer) measures people's balance performance. Like many other skills, balance is a learnable skill. At the beginning, it is common to have relatively large platform excursions. You will be asked to perform several trials on each of 3 days. The scores you will be given after each trial, as well as your improvement across trials, will reflect your learning and your 'getting the hang of it'." Participants were asked to read these instructions again at the beginning of the 2nd day of practice. Control group participants were not given instructions related to the nature of the task or skill.

All participants were then informed by the experimenter that the task was to keep the platform in the horizontal position for as long as possible during each 90-s trial. They were also informed that after each trial, they would be given a score that represented the average deviation of the platform from the horizontal. Each trial started with the left side of the platform on the ground. At a start signal, the participant attempted to move the platform, and data collection began. At the end of each trial, the experimenter provided the participant with his or her score (i.e., the standard deviation from the horizontal, or *RMSE*, provided by the DataLab 2000 software). All participants completed 2 days of practice, with conception-of-ability instructions and reminders provided at the beginning of each of those days. Each practice day consisted of seven 90-s trials with feedback after each trial. On Day 3, a retention test consisting of seven trials without feedback was conducted. No instructions concerning conceptions of ability were given on this day.

Data Analysis

For each 90-s trial, the average deviation of the platform from the horizontal (*RMSE*) was calculated and used as a measure of overall balance performance. In addition, a spectral frequency analysis was conducted on the waveform created by the platform movements, using custom laboratory software. From that analysis, the MPF was computed. Both *RMSE* and MPF were analyzed in 3 (groups) × 2 (days) × 7 (trials) analyses of variance (ANOVAs) with repeated measures on the last two factors for the practice phase and in 3 (groups) × 7 (trials) repeated-measures ANOVAs for the retention test. Significant interaction effects were followed up by univariate tests, while adjusting the level of significance to correct for multiple comparisons and to control for the Type I error rate $[1 - (1 - \alpha)^c]$.

Results

Practice

RMSE. All three groups reduced their deviations from the horizontal across both days of practice (see Figure 1, left and center panels). In general, the groups performed similarly, although the AS and IA groups seemed to improve more than the control group on Day 1. The main effects of both day, $F(1, 55) = 572.53$, $p < .001$, $\eta^2 = .91$, and trial, $F(6, 330) = 233.59$, $p < .001$, $\eta^2 = .80$, were significant. Also, the interaction of Day × Trial was significant, with $F(6, 330) = 29.47$, $p < .001$, $\eta^2 = .35$, indicating greater

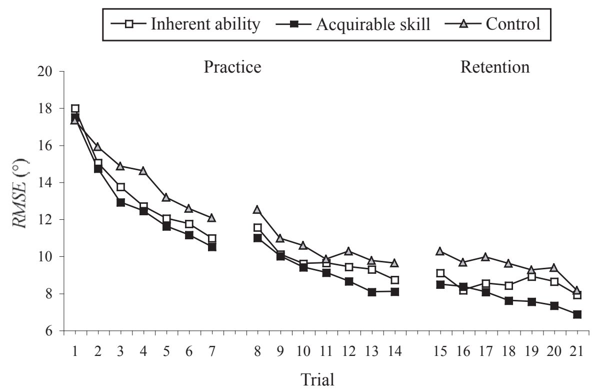

FIGURE 1. Root mean square error (*RMSE*) of the inherent ability, acquirable skill, and control groups during practice and retention.

performance gains on the first compared with the 2nd day of practice. Furthermore, there was an interaction of Group × Day × Trial, $F(12, 330) = 2.05$, $p < .05$, $\eta^2 = .07$. Post hoc tests indicated that this interaction reflected the increasingly more effective performance of both the IA and AS groups relative to the control group on Day 1 (ps < .001). The main effect of group, $F(2, 55) = 1.84$, $p > .05$, was not significant. None of the other interaction effects were significant.

MPF. MPF values during practice can be seen in Figure 2 (left and center panels). The groups' scores tended to diverge somewhat across practice. Throughout most of the practice phase, the AS group tended to have higher MPFs than both the IA and control groups. The main effect of group was significant, $F(2, 55) = 3.20$, $p < .05$, $\eta^2 = .10$. Post hoc tests revealed that the difference between the AS group and the control group was significant ($p < .05$), whereas the difference between the AS and IA group just failed to reach significance ($p = .087$). There was a significant Day × Trial interaction, $F(6, 330) = 2.31$, $p < .05$. Post hoc testing failed to identify the exact source of the interaction. None of the other main or interactions effects were significant.

Retention

RMSE. On the retention test without instructions or feedback, all groups continued to reduce their deviations from the horizontal (see Figure 1, right panel). The AS group tended to demonstrate generally more effective balance performance than the control group and increasingly greater effectiveness compared with the IA group. The Group × Trial interaction was marginally significant, $F(12, 330) = 1.77$, $p = .05$, $\eta^2 = .06$, although post hoc tests were not able to identify the exact source of the interaction. The main effect of group just failed to reach significance, $F(2, 55) = 2.86$, $p = .066$, but the main effect of trial was significant, $F(6, 330) = 12.24$, $p < .001$, $\eta^2 = .18$.

MPF. On Day 3, MPFs were generally higher for the AS group than for both the IA and control groups (see Figure 2, right panel). In addition, AS group participants showed an increase in scores across retention trials, whereas the other two groups demonstrated a decrease. The group main effect was significant, $F(2, 55) = 4.89$, $p = .01$, $\eta^2 = .15$. Post hoc tests indicated that the AS group had significantly higher MPFs than both the IA ($p < .05$) and control ($p < .01$) groups. Also, the increasing group difference across retention trials was confirmed by a significant Group × Trial interaction, $F(12, 330) = 2.07$, $p < .05$, $\eta^2 = .07$. Follow-up tests did not identify the exact origin of the effect.[1] Last, the main effect of trial was significant, $F(6, 330) = 3.68$, $p > .001$, $\eta^2 = .06$. According to post hoc tests, only Trials 1 and 5 differed significantly from each other ($p < .001$).

Discussion

The results of the present study show that motor learning can be affected by learners' conceptions of ability. Instructions intimating that performance reflected an inherent ability resulted in less effective learning than did instructions portraying the task as an acquirable skill. On the retention test, the AS group tended to outperform the control group and show greater improvement (i.e., *RMSE* reduction) across trials than the IA group. An even stronger effect of the induced ability conception was seen in the frequency of movement adjustments: The AS group had higher MPF values compared with both the IA and control groups that demonstrated similar performances, and the group difference increased across retention trials. Thus, although overall balance performance was somewhat affected by the manipulated ability conception, clearer differences were seen in the way balance was controlled. The greater sensitivity of MPF relative to *RMSE* is consistent with previous findings (e.g., McNevin & Wulf, 2002; Wulf, 2008). In those studies, differences between conditions were found in MPF, even in the absence of differences in *RMSE*.

A higher frequency of movement adjustments is viewed as an indication of greater automaticity in movement con-

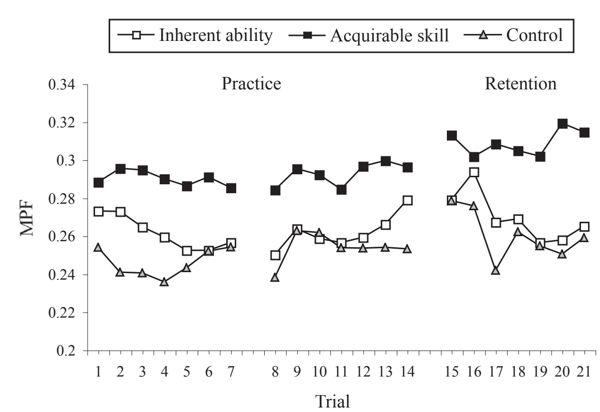

FIGURE 2. Mean power frequency (MPF) of the inherent ability, acquirable skill, and control groups during practice and retention.

trol and thus is thought to reflect a higher skill level (e.g., Fitts & Posner, 1967; Wulf et al., 2001, Wulf, 2008; for reviews, see Wulf, 2007a, 2007b). High MPFs indicate that balance is maintained via small, very rapid (reflexive) patterns of muscle activation that function at an automatic level (Gurfinkel, Ivanenko, Levin, & Barbakova, 1995). In previous studies, higher MPFs were associated not only with more effective overall balance performance (*RMSE*) but also with shorter probe reaction times to secondary tasks in dual-task paradigms, which are often used as a measure of attentional demands or automaticity (Abernethy, 1988; McNevin et al., 2003; Wulf et al., 2001; Wulf, Shea, & Park, 2001). Furthermore, MPF has been shown to increase with practice (Lewthwaite & Wulf, in press).[2]

In the present study, MPFs were reduced by informing participants that task performance would reflect their inherent (balance) ability (IA group) as opposed to a learning process (AS group) or no instructions (control group). That is, IA and control group participants never reached the level of automaticity shown by the AS group. How can the influence of individuals' conceptions of ability on the control of their movements be explained? The functioning of reflex mechanisms—which are reflected in higher frequency components of the stabilizing movements—can also be degraded, for example, by occluding vision (Gurfinkel et al., 1995), directing attention to the performer's movements (Wulf, 2007b), or providing feedback indicating poor performance (Wulf & Lewthwaite, 2008). We believe that a common mediator—a focus on the self—may be operating in all of those, and presumably similar, situations. The self construct has increasingly been recognized as a mediator of thoughts, actions, and behavior in social environments (see Bargh & Morsella, 2008; Stapel & Blanton, 2004). Motor performance often takes place in the presence of others and is, formally or informally, evaluated by them. This, in and of itself, may create a state of self-consciousness, or self-focus, and subsequent self-evaluation. This effect is presumably exacerbated when performance is made more difficult (e.g., when a balance task has to be performed without vision), performers are explicitly instructed to focus on their movements, they believe they are not doing well, or—as in the present case—the instructions invoke an ego-involvement (Nicholls, 1984). Constructing a task as something that reflects a fixed ability (IA group) establishes a performance context that is implicitly or explicitly evaluative in nature. The performers are put into a situation in which the goal is to demonstrate their ability (relative to standard task demands or to others)—with the looming possibility that poor performance can reveal low ability. This state of jeopardy is perhaps not dissimilar to the operation of stereotype threat in which expectations of superior or inferior performance are made salient for individuals in given achievement contexts with assumptions of gender or racial performance asymmetries (e.g., Chalabaev, Sarrazin, Stone, & Cury, 2008; Stone, Lynch, Sjomeling, & Darley, 1999). The emphasis on learning induced by the instructions provided to the AS group presumably resulted in a task-involvement (Nicholls) that directed participants' attention to mastering the task and freed them from self-related concerns.

Interestingly, the control group's performance was similar to that of the IA group, with the AS group showing more effective balance learning than both of these groups. This pattern of results is in line with that of other instructional or feedback manipulations that presumably induce, or bypass, a self-related focus. This includes studies in which the participants' focus of attention was directed to either their body movements (internal focus) or the effects of their movements on the environment (external focus; for reviews, see Wulf, 2007a, 2007b). In studies that also included control conditions, internal focus and control conditions consistently yielded similar performances, whereas external focus conditions resulted in superior performance and learning (e.g., Landers, Wulf, Wallmann, & Guadagnoli, 2005; Wulf et al., 1998; Wulf, Landers, Lewthwaite, & Töllner, 2009). Similarly, studies in which normative feedback was provided—(falsely) indicating to different groups of participants that their performance was either below or above average—have found equivalently inferior performance and learning for worse and control groups relative to normatively better groups (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008; Klein, 1997; Lewthwaite & Wulf, in press). The overall picture that emerges from these findings is that—without instructions or feedback that prevent a focus on the self—human beings seem to have a propensity to become self-evaluative in situations that, explicitly or implicitly, pose a threat to the self. The result is less-than-optimal performance or learning.

In recent years, a number of other social–cognitive variables with ties to the self—including anxiety, fear, performance pressure, and self-efficacy—have also been found to influence neuromuscular coordination or control of movements (e.g., Adkin, Frank, Carpenter, & Peysar, 2002; Gray, 2004; Pijpers, Oudejans, & Bakker, 2005; Slobounov, Yukelson, & O'Brien, 1997; Williams, Vickers, & Rodrigues, 2002). These findings show that a focus on the self (e.g., induced by demanding conditions, anxiety, or threat of evaluation) is associated with more widespread, inefficient, activation of the muscular system, disruption of automaticity, and the use of more conscious control processes. Even simple instructions to focus attention on one's movements have been shown to result in both novice and experienced performers to produce subtle interference in relatively automatic control processes. As a consequence, the motor system is presumably constrained in such a way that the effectiveness of the system to maintain a stable posture is compromised, resulting in lower-frequency movement adjustments (e.g., McNevin et al., 2003; Wulf et al., 2001). Thus, the function of automatic control processes can be easily overridden when performers consciously intervene in the control process—as would be the case when their self-worth is at stake (i.e., when performance supposedly reflects an inherent ability, or when the evaluative nature of the situation is more implicit, ambiguous, or uncertain [control condition]; e.g., Baumeister, 1984). As a result, performance and learning suffers.

In addition to the presumably direct influence on motor control processes, the self-evaluative focus that may be promoted by the inherent ability instructions may also increase participants' need to control self-related thoughts and affective responses (Carver & Scheier, 1978). Whereas this type of self-related processing may be unconscious at times (Bargh & Marosella, 2008; Chartrand & Bargh, 2002), it may also rise into consciousness and result in microchoking episodes (see Wulf & Lewthwaite, in press). For example, worries about task performance could direct attention to attempts at negative thought and emotion suppression. Efforts to manage self-related thoughts and emotions could tax the available self-control (Muraven & Baumeister, 2000) or attentional capacity to a degree that performance suffers. A study by Graham and Golan (1991) showed that instructions inducing an ego-focused motivational state (or inherent ability conception) resulted in a more superficial processing of task-relevant information (Craik & Tulving, 1975)—and consequently poorer recall—than did inducing a task-involved state (or acquirable skill conception). Thus, the processing of self-related thoughts appears to interfere with the processing of task-related information and, as a result, learning. In the future, researchers should attempt to measure cognitive activity and emotional reactions, as well as self-efficacy beliefs, as a function of ability conceptions to assess their impact in the process of motor learning.

Overall, the present results show that learners' conceptions of ability can influence the learning of motor skills. Learners who view a task as an acquirable skill presumably approach the learning situation with less apprehension than those who see task performance as a reflection of an inherent ability. As a consequence, learning was facilitated by invoking an incremental relative to an entity theory of abilities (Dweck & Leggett, 1988). Thus, the experimental instructions were able to override any dispositional conceptions of ability participants may have had. Nevertheless, it may be interesting to examine possible interaction effects of dispositional and manipulated ability conceptions (e.g., Li et al., 2008) on motor learning. Furthermore, the influence of feedback, indicating relative success or failure, would be expected to have differential effects on learning as a function of individuals' (dispositional or manipulated) ability conceptions (e.g., Mangels et al., 2006). Continued research into these and related questions will undoubtedly increase understanding of how subtle differences in people's motivational or attentional states impact the learning of motor skills. At any rate, future work should recognize that motivation has more than a temporary influence on motor performance and continue to address the interface of motivation and motor learning and control. These present findings also have important implications for instructional settings (e.g., physical education, sports, music). They suggest that practitioners should eschew insinuations of inherent abilities in motor performance, even under conditions of success. Rather, instructions or feedback should focus on learners' improvements or effort invested in practice. As Cimpian et al. (2007) have demonstrated, even simple differences in wording can have an important influence on individuals' motivation and continued interest in a task.

NOTES

1. Given the initial group differences, we included the first practice trial as a covariate in a subsequent analysis of covariance. However, this did not change the outcome of the analysis. The group main effect, $F(2, 54) = 3.53$, $p < .05$, $\eta^2 = .12$, and the Group × Trial interaction, $F(12, 324) = 1.80$, $p < .05$, $\eta^2 = .06$, were significant, confirming that the group differences in retention were the result of the conception-of-ability manipulation.

2. In the present study, there was also general increase in MPF across the 3 days of the experiment, $F(2, 110) = 6.26$, $p < .01$, $\eta^2 = .10$. Post hoc tests indicated that MPFs on Day 3 were significantly higher than those on Days 1 and 2 ($p < .01$).

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