

Altering Mindset Can Enhance Motor Learning in Older Adults

Gabriele Wulf
University of Nevada, Las Vegas

Suzete Chiviawowsky
Federal University of Pelotas

Rebecca Lewthwaite
Rancho Los Amigos National Rehabilitation Center, Downey, California and University of Southern California

Beliefs about personal capability have been shown to affect performance. Lowered ability expectations due to older age may themselves contribute to a decline in performance. In the present study, we investigated whether enhancing older adults' performance expectancies would facilitate the learning of a novel balance task. In Experiment 1, providing older women (71 years) with fabricated feedback indicating that their performance was above average reduced their ability-related concerns and nervousness, and resulted in more effective balance learning, compared with a control group. In Experiment 2, also involving older women (64 years), a simple statement made at the beginning of practice, suggesting that their peers usually do well on that task, enhanced participants' self-efficacy and learning of the task. These results demonstrate that motor performance and learning in older age can be influenced quickly and positively by enhancing individuals' ability perceptions.

Keywords: aging, balance, normative feedback, expectancy, self-efficacy

Aging coincides with declines in functioning and performance, including memory, and learning, and physical capabilities such as balance and mobility. Recent work on self-efficacy (e.g., Sabol et al., 2011; West, Bagwell, & Dark-Freudeman, 2008) and stereotype threat (Hausdorff, Levy, & Wei, 1999; Levy, 2003) in older individuals, however, suggests that psychological perspectives contribute to the level of observed age-related debilitation.

Evidence from various lines of research has demonstrated that expectations and mindsets of varying task specificity and personal or more general relevance can impact performance in a variety of domains, including motor skill performance and learning. For instance, numerous studies have shown that individuals' conceptions of ability influence their level of success on a given task (e.g., Dweck & Leggett, 1988), as well as their motivation to continue to perform those tasks (e.g., Cimpian, Arce, Markman, & Dweck, 2007). Beliefs about the malleability or stability of key abilities affect the extent to which new information is acquired (e.g., Mangels, Butterfield, Lamb, Good, & Dweck, 2006), and how motor skills are controlled and learned (e.g., Jourden, Bandura, & Banfield, 1991; Wulf & Lewthwaite, 2009). Specifically, viewing a task as learnable and performance as modifiable through prac-

tice, as opposed to seeing it as something that reflects inherent and stable ability, can enhance task performance. In a recent study examining the learning of a balance task as a function of induced ability conceptions (Wulf & Lewthwaite, 2009), young adults showed more effective learning of the task, which required them to keep an unstable platform horizontal, and greater automaticity in the control of their movements when they had been informed that the task was learnable as opposed to task performance reflecting their inherent balance ability. It is interesting to note that a control group's performance was similar to that of the inherent ability group, suggesting instructions emphasizing potential for learning provided a relief from ability- or self-related concerns that may have hampered performance.

Any performance context that is implicitly or explicitly evaluative in nature—including those in which performers must demonstrate their ability relative to standard task demands, to others, or to their own previous abilities—may create a state of self-consciousness and invoke self-regulatory activity that, in turn, reduces people's ability to perform to their potential (Baumeister, 1984; Carver & Scheier, 1990). This state of jeopardy is presumably similar to the operation of stereotype threat (e.g., Schmader, Johns, & Forbes, 2008; Steele & Aronson, 1995). When a negative stereotype about a social group is activated in achievement contexts, concerns about confirming the validity of the stereotype can interfere with performance. Negative effects of stereotype threat on performance have been found in a variety of domains, including academic performance (e.g., Martens, Johns, Greenberg, & Schimel, 2006), financial decision making (Carr & Steele, 2010), and memory performance (Hess, Aumann, Colombe, & Rahhal, 2003). A few studies have also demonstrated detrimental effects on the performance of motor tasks, such as walking when age stereotypes were invoked (Hausdorff et al., 1999), golf putting when racial or gender stereotypes were made salient (Beilock, Jellison,

This article was published Online First October 10, 2011.

Gabriele Wulf, Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas; Suzete Chiviawowsky, Department of Physical Education, Federal University of Pelotas, Pelotas, Brazil; Rebecca Lewthwaite, Rancho Los Amigos National Rehabilitation Center, Downey, California, and Division of Biokinesiology and Physical Therapy, University of Southern California.

Correspondence concerning this article should be addressed to Gabriele Wulf, Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, 4505 Maryland Parkway, Las Vegas, NV 89154-3034. E-mail: gabriele.wulf@unlv.edu

Rydell, McConnell, & Carr, 2006; Stone, Lynch, Sjomeling, & Darley, 1999), or soccer dribbling when gender stereotypes were activated (Chalabaev, Sarrazin, Stone, & Cury, 2008).

A growing population whose performance and learning of new skills may be affected negatively by their beliefs about ability is older people. While mental and physical abilities tend to decline with age, assumptions about the loss of abilities in older adults may themselves contribute to a decline in performance (Levy, 2003). Indeed, memory performance has been shown to suffer in older adults when age stereotypes are activated (Hess et al., 2003). Levy and Leifheit-Limson (2009) found that cognitive and physical performance of older adults was affected negatively or positively when negative versus positive age stereotypes were invoked, respectively. Also, the effects were stronger when performance was assessed in the respective domain. That is, when physical stereotypes were activated, physical (i.e., balance) performance was more affected than cognitive performance, and vice versa. Yet, even without the explicit induction of a stereotype threat, older adults may feel threatened when they are confronted with a task that they see as challenging. Among the tasks that may be viewed as particularly difficult by older adults are those that involve balance. It is well known that balance capabilities decline with age (e.g., Woollacott, 2000). Furthermore, balance tasks carry the inherent risk of falling, presumably increasing older adults' apprehension when faced with tasks requiring balance. Can changing the mindset of older persons facilitate their performance, and perhaps learning (i.e., retention), of a new balance skill?

The purpose of the present experiments was to examine whether enhancing the ability beliefs of older persons would affect their learning of a balance task. Balance has been shown to be influenced by a variety of social-cognitive and affective variables, including conceptions of ability (Wulf & Lewthwaite, 2009), anxiety (e.g., Pijpers, Oudejans, & Bakker, 2005), mental load (e.g., Huxhold, Li, Schmiedek, & Lindenberger, 2006), normative feedback (e.g., Lewthwaite & Wulf, 2010b), and attentional focus (e.g., Wulf, Landers, Lewthwaite, & Töllner, 2009). In the present studies, we wanted to examine whether older people's balance performance could be enhanced by increasing their perceived competence or performance-related expectancies. In Experiment 1, we provided participants with (false) social-comparative feedback, which suggested their performance was above average. In Experiment 2, we informed participants at the beginning of practice that their peers usually performed well on that task. We examined whether such information about the performance of peers would result in a changed mindset that, in turn, enhanced balance learning. In addition to assessing immediate effects on performance, if any, we were mainly interested in determining whether our manipulations would have longer-term effect on skill learning, which is typically measured by delayed retention tests (e.g., Lin, Wu, Udompholkul, & Knowlton, 2010; Schmidt & Lee, 2011).

Experiment 1

Studies with young adults have demonstrated that social-comparative information such as normative feedback, in which information about a peer group's (false) performance scores is provided in addition to the learner's own scores, can have effects on motor performance and learning (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008; Lewthwaite & Wulf, 2010b; Wulf,

Chiviawsky, & Lewthwaite, 2010). Hutchinson and colleagues (2008), for example, showed that feedback indicating above-average relative to below-average performance increased self-efficacy, task enjoyment, and performance on a hand-grip isometric force production task. Social-comparison information can also have more permanent effects on motor learning. In one recent study, the learning of a balance task was enhanced by positive, relative to negative, normative feedback (Lewthwaite & Wulf, 2010b). It is interesting that a control group without normative feedback showed similar learning as the negative normative feedback group—suggesting that positive feedback can provide a boost that has a facilitating effect on learning.

In the present experiment, we examined whether normative feedback, indicating above-average performance, would enhance motor learning in older adults (about 70 years of age). Participants practiced a novel balance task (stabilometer) and were given veridical feedback about their time in balance (i.e., platform position within ± 5 degrees) after each practice trial. In addition, participants in the normative feedback (normative FB) group were provided with the "average" time in balance of others—which was in fact calculated based on the participant's time on a given trial and was 20% worse (shorter) than the participant's time. All participants practiced the balance task on Day 1, with veridical and normative feedback (if applicable) provided after each trial. Learning was assessed in a retention test without augmented feedback on the second day.

To assess if and how the positive normative feedback influenced participants' motivation, ability-related thoughts, and nervousness compared with no such information, participants completed a customized questionnaire at the end of each day (see Table 1). For example, participants were asked to indicate how much their thoughts concerned their performance or ability, and how nervous they were before or while balancing, on a scale from 1 (*not at all*) to 10 (*very*). We hypothesized that positive normative feedback would allay ability-related concerns and nervousness, compared to the control group.

Method

Participants

Twenty-nine healthy older adults (all females; age range: 61–81 years; average age: 71.1 year, *SD*: 5.25) were recruited from a physical activity group that was part of a university extension program in the southern part of Brazil. All participants were healthy and physically active, and they typically walked or took the bus to the university to participate in physical activity classes. All participants volunteered for the study, and none of them were excluded. They had no prior experience with the task, and all gave their informed consent before participating in the study. The study was approved by the university's institutional review board.

Apparatus and Task

The task required participants to balance on a stabilometer. The apparatus consisted of a wooden platform, 130-cm long \times 140-cm wide, with a maximum deviation of 18 degrees to the left and right sides. The participant's task was to try to keep the platform as close to horizontal as possible during each 30-s trial. A safety

Table 1

Means (Standard Deviations) of Motivational Questions Completed at the End of Each Day (Experiment 1)

Questions	Normative FB		Control	
	Day 1	Day 2	Day 1	Day 2
Task-related Responses				
How motivated were you to learn this task?	9.1 (1.19)	9.1 (1.03)	8.2 (2.42)	9.4 (0.85)
How much did you enjoy practicing this task?	9.4 (1.18)	9.6 (0.83)	9.1 (1.66)	9.4 (0.85)
Ability-related Responses				
How satisfied were you with your performance?	8.3 (1.84)	8.6 (1.64)	7.4 (2.13)	8.9 (1.96)
How concerned were you about your performance?	2.8 (2.86)*	3.7 (2.96)	5.8 (3.02)*	3.9 (2.43)
How much did your thoughts concern your ability on this task while balancing today?	3.8 (3.47)*	4.7 (4.08)	6.3 (2.79)*	5.1 (3.58)
Nervousness-related Responses				
How nervous were you before the start of each trial?	0.9 (1.53)*	0.9 (2.12)	3.1 (3.42)*	1.5 (2.21)
How nervous were you while balancing on the platform?	1.9 (2.05)	1.3 (2.58)	3.9 (3.43)	1.9 (2.87)
How nervous were you while waiting for the feedback?	0.7 (1.94)	—	2.5 (3.23)	—

Note. Significant differences on each day are indicated by *. Responses for each question ranged from 1 = *not at all* to 10 = *very*.

harness that was suspended from the ceiling above the stabilometer was used to prevent participants from falling if they lost their balance. A millisecond timer measured time in balance (i.e., platform angle within ± 5 degrees).

Procedure

Participants were assigned randomly to one of two groups, a normative FB group (15 participants) and a control group (14 participants). All participants were informed that the task was to keep the platform in the horizontal position for as long as possible during each 30-s trial. They were also told that after each trial they would be informed of their time in balance. In addition, participants in the normative FB group were told that they would also be provided with the average time in balance on the respective trial produced by participants in previous experiments. To prevent participants from falling, they were placed in a harness during each trial. Approximately 15 seconds before the beginning of each trial, the participant was instructed to step on the platform. Once a start signal was given, the participant began to move the platform and data collection began. After each trial, participants were given feedback about their time in balance on that trial. In addition, in the normative FB condition, the experimenter provided participants with the “average” time in balance, which was 20% lower than the participant’s time in balance. (The calculation process was performed very quickly, and without the participants’ becoming aware of it, by entering the actual time into an Excel spreadsheet, which was set up to calculate the time minus 20% in another cell.) For example, if the participant’s time in balance was 8.4 s, he or she was informed that the average time on that trial was 6.7 s. As previous studies have shown, participants generally do not notice that the veridical and normative feedback differ by 20%, or that both numbers increase or, occasionally, decrease concurrently (e.g., Lewthwaite & Wulf, 2010b). Thus, the normative FB implied that the participant’s performance was above average. The practice phase consisted of 10 30-s trials, with a 90-s rest interval between trials. To assess the relatively permanent, or learning, effects of our feedback manipulation (Schmidt & Lee, 2011), a retention test without feedback was conducted one day later. It consisted of 5 30-s trials with 90-s breaks. Participants filled out a

questionnaire (see Table 1) at the end of practice on Day 1 and after the retention test on Day 2. The questionnaires were identical, with the exception of the last question (“How nervous were you while waiting for the feedback?”), which was omitted on the second day. After filling out the questionnaire on Day 2, participants were debriefed.

Data Analysis

Time in balance on each trial was analyzed in a 2 (groups: normative FB vs. control) \times 10 (trials) analysis of variance (ANOVA) with repeated measures on the last factor for the practice phase. Retention data were analyzed in a 2 (groups: normative FB vs. control) \times 5 (trials) repeated-measures ANOVA. Questionnaire responses were analyzed in separate one-way ANOVAs.

Results

Time in Balance

Practice. Time in balance increased in both groups across practice trials (see Figure 1, left). The main effect of trial was

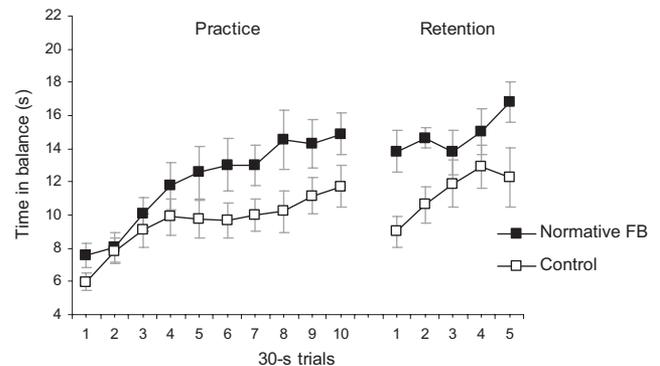


Figure 1. Balance performance (time in balance) of the normative FB and control groups during practice and retention (Experiment 1). Error bars indicate standard errors.

significant, $F(9, 234) = 13.58, p < .001, \eta^2 = .33$. The normative FB group tended to show overall more effective performance, but the main effect of group just failed to reach significance, $F(1, 27) = 3.46, p = .074, \eta^2 = .11$. The interaction of group and trial was not significant, $F(9, 234) = 1.15, p > .05$.

Retention. On the retention test without veridical or normative feedback, the normative FB group demonstrated significantly longer times in balance than the control group, $F(1, 27) = 6.15, p < .05, \eta^2 = .19$ (see Figure 1, right). Also, both groups continued to increase their time in balance, $F(4, 108) = 3.78, p < .01, \eta^2 = .12$. The interaction of group and trial was not significant, $F(4, 108) = 1.21, p > .05$.

Questionnaire

Practice. Questionnaire results are summarized in Table 1. At the end of the practice phase on Day 1, the normative FB and control groups did not differ in terms of how motivated they were to learn the task, $F(1, 27) = 1.72, p > .05$, or how much they enjoyed practicing it, $F(1, 27) < 1$. Furthermore, even though the normative FB tended to be somewhat more satisfied with their performance than the control group, the group effect was not significant, $F(1, 27) = 1.75, p > .05$. However, the normative FB group participants were significantly less concerned about their performance, $F(1, 27) = 7.49, p = .001$, and reported having fewer thoughts concerning their ability while balancing, compared to the control group, $F(1, 27) = 4.49, p < .05$. There were also differences between groups in their reported degree of nervousness. Particularly before a trial, normative FB group participants indicated that they were less nervous than control group participants, $F(1, 27) = 5.17, p < .05$. The group differences in terms of nervousness while balancing on the platform, $F(1, 27) = 3.67, p = .066$, or while waiting for feedback, $F(1, 27) = 3.24, p = .083$, did not reach conventional levels of significance, though. [When all nervousness-related questions (Cronbach's $\alpha = .76$) were analyzed in a 2 (group) \times 3 (question) ANOVA, the group main effect was significant, $F(1, 27) = 6.32, p < .05$.]

Retention. On Day 2 (without feedback), group differences generally decreased. This was mainly due to the fact that control group participants appeared to be less concerned about their performance and ability, and expressed less nervousness, relative to Day 1. None of the group differences were significant.

Discussion

Providing older adults with fabricated feedback indicating that their performance was above average resulted in more effective learning compared with veridical feedback only (control group). This effect is consistent with the findings of previous studies in which young adults demonstrated enhanced motor performance (Hutchinson et al., 2008) and learning when given positive normative feedback (Lewthwaite & Wulf, 2010b; Wulf et al., 2010). It is interesting to note that in the Lewthwaite and Wulf study, participants (young adults) had considerably more practice on the stabilometer task (14 90-s trials or 21 min) than participants in the present study (10 30-s trials or 5 min). The fact that a relatively short intervention resulted in significant group differences on the retention test seems to underscore the potency of positive feedback for learning.

Positive feedback also had an effect on the learners' level of nervousness and their concerns about their performance and ability. The assumption that they were performing above average reduced participants' nervousness before a trial and, to some extent, also while balancing and while waiting for feedback, at least while the normative information was available during practice. Moreover, participants reported being less concerned about their performance and their ability, compared with the control group. When veridical and normative feedback was withdrawn on the retention test, group differences in reported nervousness and concern were no longer significant. This may have been due to the small increase in the normative FB group participants' uncertainty regarding their performance (relative to others), as well as a decrease in the level of nervousness and performance/ability-related concerns in the control group due to increased practice and familiarity with the task. It is interesting, however, that the normative FB group's advantage in balance performance remained—suggesting that reducing individuals' nervousness and concern through positive feedback during practice had a relatively permanent effect on the learning of the task.

While the provision of normative feedback enables a strong test of the impact of a social-cognitive variable on motor learning (e.g., Lewthwaite & Wulf, 2010b), it does not serve as the kind of intervention that might be used to raise older adults' expectancies and alter their performance and learning of motor skills in daily life. An interesting question is whether there are other, perhaps more subtle, ways of enhancing motor learning by affecting ability beliefs, particularly in older adults. Could more general information about a peer group's experiences on a given task enhance individuals' performance expectancies and, in turn, influence their learning? We examined this question in Experiment 2.

Experiment 2

We attempted to boost participants' expectancy regarding their performance by informing them before the beginning of practice that their peers (i.e., active persons with their experience) typically do well on that task. The task, design, and measurements were similar to those used in the first experiment, with the exception that only veridical feedback was given. We also assessed participants' self-efficacy through questionnaires administered at the beginning of practice and before the retention test on Day 2. We hypothesized that an influence of enhancing older people's performance expectancy would be seen in increased self-efficacy ratings as well as performance on the retention test compared with a control group.

Method

Participants

Twenty-eight healthy and physically active older women (age range: 60–74 years; average age: 63.6 years, SD : 3.40) participated in the present study. As in Experiment 1, they were recruited from a physical activity class that was part of the university's extension program. None of the participants had prior experience with the task, and all gave their informed consent before participating. The study was approved by the university's institutional review board.

Apparatus, Task, and Procedure

The apparatus and task were the same as in Experiment 1. Participants were randomly assigned to either the enhanced-expectancy (EE) group or control group (14 participants each). Before the first practice trial, the experimenter informed participants of the EE group that “active people like you, with your experience, usually perform well on this task.” Control group participants were not given that information. As in the first experiment, the practice phase consisted of 10 trials, with veridical feedback after each trial, and the retention test without feedback on Day 2 consisted of 5 trials. To determine if the information provided to the EE group at the beginning of practice had an effect on their self-efficacy, all participants were asked to rate how confident they were that they would be able to stay in balance for 10 s, 15 s, or 20 s. The scale ranged from 0 (*not confident at all*) to 10 (*extremely confident*). Self-efficacy ratings were performed after the first practice trial to provide them with a basis for their judgments about their expected future performance, as well as before the retention test.

Data Analysis

Time in balance on each 30-s trial was analyzed in a 2 (groups: EE vs. control) \times 10 (trials) analysis of variance (ANOVA) with repeated measures on the last factor for the practice phase. Retention data were analyzed in a 2 (groups: EE vs. control) \times 5 (trials) repeated-measures ANOVA. Self-efficacy ratings were analyzed in 2 (groups: EE vs. control) \times 3 (time intervals: 10 s, 15 s, 20 s) ANOVAs for each day.

Results

Time in Balance

Practice. Both groups increased their time in balance across practice trials (see Figure 2, left), with the EE group demonstrating somewhat longer times than the control group. The main effect of trial was significant, $F(9, 234) = 13.58, p < .001, \text{Eta}^2 = .34$. The Group main effect approached significance, $F(1, 26) = 3.45, p =$

.075, $\text{Eta}^2 = .12$, while the interaction of group and trial was not significant, $F(9, 234) < 1$.

Retention. On the retention test without instructions or feedback, the EE group had significantly longer times in balance than the control group, $F(1, 26) = 5.60, p < .05, \text{Eta}^2 = .18$ (see Figure 2, right). Also, both groups continued to increase their time in balance across trials, $F(4, 104) = 9.08, p < .001, \text{Eta}^2 = .26$. The interaction of group and trial was not significant, $F(4, 104) < 1$.

Self-efficacy

Practice. After the first practice trial, participants rated their confidence of being able to remain in balance for 10 s, 15 s, or 20 s, respectively. As can be seen from Figure 3 (left), self-efficacy decreased with the increasing duration of the time interval, $F(2, 52) = 32.53, p < .001, \text{Eta}^2 = .56$. While there was no group difference for the shorter intervals (10 s, 15 s), the EE group participants (6.3) were more confident than control group participants (5.3) that they would be able to remain in balance for 20 s. This was confirmed by a significant interaction of group and time interval, $F(2, 52) = 3.31, p < .05, \text{Eta}^2 = .11$. The group main effect was not significant, $F(1, 26) < 1$.

Retention. Before the beginning of the retention test on Day 2, EE group participants demonstrated greater self-efficacy than those in the control group (Figure 3, right), with EE group ratings being higher for all 3 intervals by an average of 1.0 point. The main effect of group was significant, $F(1, 26) = 4.17, p = .05, \text{Eta}^2 = .14$. Self-efficacy ratings decreased with interval duration, as indicated by a significant main effect of time interval, $F(2, 52) = 25.17, p < .001, \text{Eta}^2 = .49$. The interaction of group and time interval was not significant, $F(2, 52) < 1$.

Discussion

A simple statement regarding their peers' performance significantly boosted the self-efficacy and learning of a challenging balance task in older adults. Recall that participants first rated their ability to remain in balance after the first trial, on which time in balance was similar for both groups and still less than 8 s, on average. Yet, EE group participants rated their ability to maintain their balance for 20 s significantly higher than did control group participants. This suggests that the induced prospective beliefs in the ability to perform the skill led to enhanced learning, rather than enhanced performance boosting self-efficacy. Self-efficacy ratings before retention testing on Day 2, where the EE group had significantly higher ratings in all 3 categories (10, 15, 20 s), were presumably influenced by their relatively greater performance gains on Day 1. Yet, both increased self-efficacy and balance learning, in effect, resulted from the enhanced abilities beliefs induced at the beginning of task practice. While it has previously been found that prospective beliefs in the ability to perform a specific skill have effects on subsequent performance (Feltz, Chow, & Hepler, 2008; Moritz, Feltz, Fahrback, & Mack, 2000), the present results show that those beliefs do not necessarily have to be based on one's own past experience with the skill. Rather, a general comment on a peer group's performance apparently alleviated the concerns older adults may have had (see Experiment 1) when confronted with a novel and relatively challenging balance

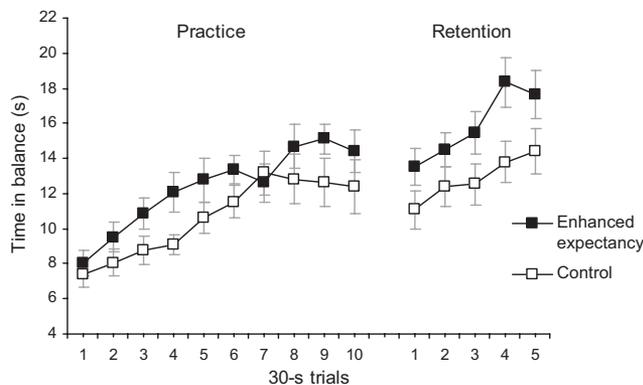


Figure 2. Balance performance (time in balance) of the enhanced expectancy and control groups during practice and retention (Experiment 2). Error bars indicate standard errors.

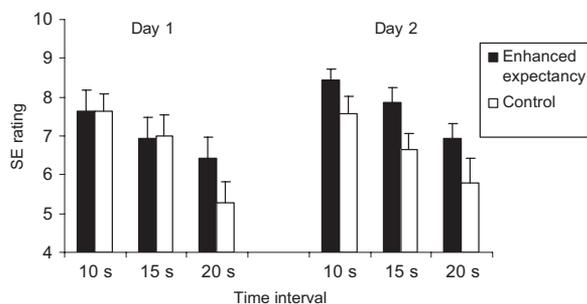


Figure 3. Self-efficacy ratings of the enhanced expectancy and control groups after Trial 1 on Day 1, and before the retention test on Day 2 (Experiment 2). Error bars indicate standard errors.

task, and facilitated their performance and learning. It is interesting to note that a recent study by Brownlow, Janas, Blake, Rebadow, and Mellon (2011) found that women's performance on a mental rotation task was enhanced—by nullifying gender-related stereotype threat—when they were informed that their peers (i.e., female students) had described the task as “challenging, but fun,” “non-stressful,” or as using “abilities that I use in everyday life.” Moreover, their results suggested that confidence in their mental rotation ability mediated performance. Thus, these and the present findings provide converging evidence that information about the successful performance of peers can provide a boost to individuals' own performance in situations that are perceived as threatening or challenging.

General Discussion

We speculated that internalized stereotypes about aging could have an effect on older people's balance performance, which is generally assumed to decline with age. Even though age-related stereotypes were not explicitly activated in this study (e.g., Hess et al., 2003), they may well have been present (Levy, 2003), and we assumed that ability-related concerns or worries resulting from those stereotypes would act like a self-fulfilling prophecy and produce nonoptimal performance. This seemed to be the case. In contrast, alleviating participants' concerns through fabricated feedback suggesting above-average performance (Experiment 1) or fabricated information that peers typically do well on that task (Experiment 2) led to enhanced learning.

These findings support the notion that human performance, including motor performance, is influenced by a variety of social-cognitive and affective factors (Lewthwaite & Wulf, 2010a; Webber, Porter, & Menec, 2010). More specifically, they add to the growing literature showing that a person's motivation or mindset impacts motor performance (e.g., Chalabaev et al., 2008; Feltz et al., 2008; Hutchinson et al., 2008; Lewthwaite & Wulf, 2010b; Wulf & Lewthwaite, 2009). It is important that our results show that motor performance can be influenced almost immediately and positively by enhancing ability perceptions or self-efficacy. Moreover, these effects occurred without requiring previous experience with the situation (see particularly Experiment 2). It should also be noted that the performance advantages of the experimental groups (normative FB; EE) were still seen when feedback was withdrawn,

or reminders of the peer group's performance were not provided, in retention.

It is well known that concerns about ability—presumably present under “normal” or control conditions—tend to increase a focus on the self (e.g., Baumeister, 1984). In recent years, a number of variables related to the self—including anxiety, fear, performance pressure, and self-efficacy—have been found to influence neuromuscular coordination or control of movements (e.g., Adkin, Frank, Carpenter, & Peysar, 2002; Pijpers et al., 2005; Slobounov, Yukelson, & O'Brien, 1997; Williams, Vickers, & Rodrigues, 2002). Even instructions that direct attention to body movements have been shown to be detrimental to motor learning (Wulf, 2007). A self-related focus has been shown to be associated with more widespread, inefficient, activation of the muscular system, disruption of automaticity, and the use of more conscious control processes (e.g., Lohse, Sherwood, & Healy, 2010). As a result, the motor system is constrained and the ability to maintain one's balance, for example, is compromised, as can be seen by slower movement adjustments (e.g., Wulf, McNevin, & Shea, 2001).

In addition to the direct influence on motor control, performance-related concerns may also increase participants' need to control self-related thoughts and affective responses (Carver & Scheier, 1978)—perhaps resulting in “microchoking” episodes (see Wulf & Lewthwaite, 2010). Worries about task performance, for example, could direct attention to attempts at negative thought and emotion suppression. Efforts to manage those thoughts and emotions presumably tax the available attentional capacity and interfere with the processing of task-related information and hampering learning. It is likely that providing positive normative feedback or enhancing performance expectancy facilitated learning through increased automaticity in movement control and appropriately focused attention (Lewthwaite & Wulf, 2010b). Furthermore, our manipulations may have enhanced positive affect, and resulted in the setting of higher goals, or increased effort (Lewthwaite & Wulf, 2010a, Lewthwaite & Wulf, 2010b). Although affect was not directly assessed, recent studies have demonstrated, for example, that feedback about successful performance led to enhanced learning (Chiviawosky & Wulf, 2007), including throwing in older adults (Chiviawosky, Wulf, Wally, & Borges, 2009), as well as an increase in learners' self-confidence and intrinsic motivation (Badami, VaezMousavi, Namazizadeh, & Wulf, in press; Badami, VaezMousavi, Wulf, & Namazizadeh, 2011).

While these studies reflect parallels in older and younger adults and children in terms of the influence of expectancies or beliefs on performance, they may have special significance to older populations. The findings add support to research that recognizes more than minor contributions of psychological factors to age-related deficits demonstrated in older adults (e.g., Miller & West, 2010; Webber et al., 2010). Perhaps especially in the case of physical abilities such as balance and mobility, there may be a tendency to disproportionately assign causation to biological or physiological factors associated with aging, rather than to other social, cognitive, or environmental influences, such as beliefs, that may be precursors, coeffects, or amplifiers of inactivity or disordered movement (e.g., McAuley et al., 2006). A spiraling sequence of changes in activity opportunities, low self-efficacy, activity restrictions, avoidance, or poor performance, and even lower self-efficacy for such activity may lead to physical or biological effects due to lack

of practice or deconditioning. Thus, there can be value in exploring potentially unwarranted assumptions about true capabilities that affect quality of life in older age.

The present findings have implications for instructional support in physical activity and other settings for older adults (Miller & West, 2010; West et al., 2008) and interventions designed to enhance balance skills or prevent falls in older adults, as well as for studies designed to assess motor performance in older people. They may also indicate that, while age-related stereotypes may be pervasive (Levy, 2003), they may also be amenable to relatively brief interventions that target heightening individuals' expectations and related positive affect for successful performance and learning. These social-cognitive approaches may augment the often more intensive and expensive efforts to change physiological and cognitive parameters to alter capabilities such as balance and mobility through exercise, strategic skills, and environmental changes, though these interventions would arguably raise expectations as well.

References

- Adkin, A. L., Frank, J. S., Carpenter, M. G., & Peysar, G. W. (2002). Fear of falling modifies anticipatory postural control. *Experimental Brain Research, 143*, 160–170. doi:10.1007/s00221-001-0974-8
- Badami, R., Vaez-Mousavi, M., Namazizadeh, M., & Wulf, G. (in press). Feedback after good versus poor trials: Differential effects on self-confidence and activation. *Research Quarterly for Exercise and Sport*.
- Badami, R., Vaez-Mousavi, M., Wulf, G., & Namazizadeh, M. (2011). Feedback after good trials enhances intrinsic motivation. *Research Quarterly for Exercise and Sport, 82*, 360–364.
- Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology, 46*, 610–620. doi:10.1037/0022-3514.46.3.610
- Beilock, S. L., Jellison, W. A., Rydell, R. J., McConnell, A. R., & Carr, T. H. (2006). On the causal mechanisms of stereotype threat: Can skills that don't rely heavily on working memory still be threatened? *Personality and Social Psychology Bulletin, 32*, 1059–1071. doi:10.1177/0146167206288489
- Brownlow, S., Janas, A. J., Blake, K. A., Rebadow, K. T., & Mellon, L. M. (2011). Getting by with a little help from my friends: Mental rotation ability after tacit peer encouragement. *Psychology, 2*, 363–370.
- Carr, P. B., & Steele, C. M. (2010). Stereotype threat affects financial decision making. *Psychological Science, 21*, 1411–1416. doi:10.1177/0956797610384146
- Carver, C. S., & Scheier, M. F. (1978). Self-focusing effects of dispositional self-consciousness, mirror presence, and audience presence. *Journal of Personality and Social Psychology, 36*, 324–332. doi:10.1037/0022-3514.36.3.324
- Carver, C. S., & Scheier, M. F. (1990). Principles of self regulation: Action and emotion. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 3–52). New York, NY: Guilford Press.
- Chalabaev, A., Sarrazin, P., Stone, J., & Cury, F. (2008). Do achievement goals mediate stereotype threat?: An investigation on females' soccer performance. *Journal of Sport & Exercise Psychology, 30*, 143–158.
- Chiviakowsky, S., & Wulf, G. (2007). Feedback after good trials enhances learning. *Research Quarterly for Exercise and Sport, 78*, 40–47.
- Chiviakowsky, S., Wulf, G., Wally, R., & Borges, T. (2009). Knowledge of results after good trials enhances learning in older adults. *Research Quarterly for Exercise and Sport, 80*, 663–668.
- Cimpian, A., Arce, H.-M., Markman, E. M., & Dweck, C. S. (2007). Subtle linguistic cues affect children's motivation. *Psychological Science, 18*, 314–316. doi:10.1111/j.1467-9280.2007.01896.x
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*, 256–273. doi:10.1037/0033-295X.95.2.256
- Feltz, D. L., Chow, D. M., & Hepler, T. J. (2008). Path analysis of self-efficacy and diving performance revisited. *Journal of Sport & Exercise Psychology, 30*, 401–411.
- Hausdorff, J. M., Levy, B. R., & Wei, J. Y. (1999). The power of ageism on physical function of older persons: Reversibility of age-related gait changes. *Journal of the American Geriatrics Society, 47*, 1346–1349.
- Hess, T. M., Aumann, C., Colombe, S. J., & Rahhal, T. A. (2003). The impact of stereotype threat on age differences in memory performance. *Journal of Gerontology: Psychological Sciences, 58B*, 3–11. doi:10.1093/geronb/58.1.P3
- Hutchinson, J. C., Sherman, T., Martinovic, N., & Tenenbaum, G. (2008). The effect of manipulated self-efficacy on perceived and sustained effort. *Journal of Applied Sport Psychology, 20*, 457–472. doi:10.1080/10413200802351151
- Huxhold, O., Li, S.-C., Schmiedek, F., & Lindenberger, U. (2006). Dual-tasking postural control: Aging and the effects of cognitive demand in conjunction with focus of attention. *Brain Research Bulletin, 69*, 294–305. doi:10.1016/j.brainresbull.2006.01.002
- Jourden, F. J., Bandura, A., & Banfield, J. T. (1991). The impact of conceptions of ability on self-regulatory factors and motor skill acquisition. *Journal of Sport & Exercise Psychology, 8*, 213–226.
- Levy, B. R. (2003). Mind matters: Cognitive and physical effects of aging self-stereotypes. *Journal of Gerontology: Psychological Sciences, 58B*, P203–P211. doi:10.1093/geronb/58.4.P203
- Levy, B. R., & Leifheit-Limson, E. (2009). The stereotype-matching effect: Greater influence on functioning when age stereotypes correspond to outcomes. *Psychology and Aging, 24*, 230–233. doi:10.1037/a0014563
- Lewthwaite, R., & Wulf, G. (2010a). Grand challenge for movement science and sport psychology: Embracing the social-cognitive-affective-motor nature of motor behavior. *Frontiers in Psychology*. doi:10.3389/fpsyg.2010.00042. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3153760/?tool=pubmed>
- Lewthwaite, R., & Wulf, G. (2010b). Social-comparative feedback affects motor skill learning. *Quarterly Journal of Experimental Psychology, 63*, 738–749. doi:10.1080/17470210903111839
- Lin, C.-H. J., Wu, A. D., Udompholkul, P., & Knowlton, B. J. (2010). Contextual interference effects in sequence learning for young and older adults. *Psychology and Aging, 25*, 929–939. doi:10.1037/a0020196
- Lohse, K. R., Sherwood, D. E., & Healy, A. F. (2010). How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. *Human Movement Science, 29*, 542–555. doi:10.1016/j.humov.2010.05.001
- Mangels, J. A., Butterfield, B., Lamb, J., Good, C., & Dweck, C. S. (2006). Why do beliefs about intelligence influence learning success? A social cognitive neuroscience model. *Social Cognitive and Affective Neuroscience, 1*, 75–86. doi:10.1093/scan/nsl013
- Martens, A., Johns, M., Greenberg, J., & Schimel, J. (2006). Combating stereotype threat: The effect of self-affirmation on women's intellectual performance. *Journal of Experimental Social Psychology, 42*, 236–243. doi:10.1016/j.jesp.2005.04.010
- McAuley, E., Konopack, J. F., Morris, K. S., Motl, R. W., Hu, L., & Rosengren, K. (2006). Physical activity and functional limitations in older women: Influence of self-efficacy. *Journal of Gerontology Series B: Psychological Sciences and Social Sciences, 61*, 270–277.
- Miller, L. M. S., & West, R. L. (2010). The effects of age, control beliefs, and feedback on self-regulation of reading and problem solving. *Experimental Aging Research, 36*, 40–63. doi:10.1080/03610730903418380
- Moritz, S. E., Feltz, D. L., Fahrbach, K. R., & Mack, D. E. (2000). The

- relation of self-efficacy measures to sport performance: A meta-analytic review. *Research Quarterly for Exercise and Sport*, 71, 280–293.
- Pijpers, J. J., Oudejans, R. R., & Bakker, F. C. (2005). Anxiety-induced changes in movement behavior during the execution of a complex whole-body task. *Quarterly Journal of Experimental Psychology*, 58A, 421–445.
- Sabol, V. K., Resnick, B., Galik, E., Gruber-Baldini, A. L., Morton, P. G., & Hicks, G. E. (2011). Exploring the factors that influence functional performance among nursing home residents. *Journal of Aging and Health*, 23, 112–134. doi:10.1177/0898264310383157
- Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review*, 115, 336–356. doi:10.1037/0033-295X.115.2.336
- Schmidt, R. A., & Lee, T. D. (2011). *Motor control and learning (5th ed.)*. Champaign, IL: Human Kinetics.
- Slobounov, S., Yukelson, D., & O'Brien, R. (1997). Self-efficacy and movement variability of Olympic-level springboard divers. *Journal of Applied Sport Psychology*, 9, 171–190. doi:10.1080/10413209708406480
- Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African-Americans. *Journal of Personality and Social Psychology*, 69, 797–811. doi:10.1037/0022-3514.69.5.797
- Stone, J., Lynch, C. I., Sjomeling, M., & Darley, J. M. (1999). Stereotype threat effects on black and white athletic performance. *Journal of Personality and Social Psychology*, 77, 1213–1227. doi:10.1037/0022-3514.77.6.1213
- Webber, S. C., Porter, M. M., & Menec, V. H. (2010). Mobility in older adults: A comprehensive framework. *The Gerontologist*, 50, 443–450. doi:10.1093/geront/gnq013
- West, R. L., Bagwell, D. K., & Dark-Freudeman, A. (2008). Self-efficacy and memory aging: The impact of a memory intervention based on self-efficacy. *Aging, Neuropsychology, and Cognition*, 15, 302–329. doi:10.1080/13825580701440510
- Williams, A. M., Vickers, J., & Rodrigues, S. (2002). The effects of anxiety on visual search, movement kinematics and performance in table tennis: A test of Eysenck and Calvo's processing efficiency theory. *Journal of Sport & Exercise Psychology*, 24, 438–455.
- Woolacott, M. H. (2000). Systems contributing to balance disorders in older adults. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 55, 424–428. doi:10.1093/gerona/55.8.M424
- Wulf, G. (2007). *Attention and motor skill learning*. Champaign, IL: Human Kinetics.
- Wulf, G., Chiviacowsky, S., & Lewthwaite, R. (2010). Normative feedback effects on learning a timing task. *Research Quarterly for Exercise and Sport*, 81, 425–431.
- Wulf, G., Landers, M., Lewthwaite, R., & Töllner, T. (2009). External focus instructions reduce postural instability in individuals with Parkinson disease. *Physical Therapy*, 89, 162–168. doi:10.2522/ptj.20080045
- Wulf, G., & Lewthwaite, R. (2009). Conceptions of ability affect motor learning. *Journal of Motor Behavior*, 41, 461–467. doi:10.3200/35-08-083
- Wulf, G., & Lewthwaite, R. (2010). Effortless motor learning? An external focus of attention enhances movement effectiveness and efficiency. In B. Bruya (Ed.), *Effortless attention: A new perspective in attention and action* (pp. 75–101). Cambridge, MA: MIT Press.
- Wulf, G., McNevin, N. H., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *Quarterly Journal of Experimental Psychology*, 54A, 1143–1154. doi:10.1080/02724980143000118

Received June 18, 2011

Revision received August 18, 2011

Accepted August 21, 2011 ■