Self-efficacy's influence on persistence on a physical task: Moderating effect of performance feedback ambiguity

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A B S T R A C T

Objectives: The present investigation was designed to test the predictions of a control theory based view of self-regulation on the complex effects of self-efficacy on persistence. Specifically, self-efficacy was predicted to have a positive effect on persistence given unambiguous feedback, but a weak, negative effect given ambiguous feedback. Moreover, the research was designed to replicate an influential set of studies on self-efficacy.

Design: A 2 (self-efficacy: low, high) × 2 (feedback ambiguity: low, high) between-groups ANOVA was conducted to examine the interaction between self-efficacy and feedback ambiguity in two trials of an isometric hand-grip competitive endurance task.

Method: Participants (87 females and 67 males) competed on a hand-grip strength task against confederates who claimed to have overworked their hand (high manipulated self-efficacy) or to be tennis players (low manipulated self-efficacy). The competition occurred either in the presence (high feedback ambiguity) or absence (low feedback ambiguity) of a physical barrier between the individuals. Persistence was how long individuals could grip at 50% of their maximum voluntary contraction.

Results: The interaction was significant and in the predicted direction. Self-efficacy was also found to negatively relate to self-reported effort regardless of condition.

Conclusions: The results from the current study confirm that self-efficacy can foster persistence when one is aware of one's current state of performance. However, consistent with a control theory view of self-regulation, self-efficacy was unrelated to persistence when feedback was ambiguous. The results have implications for understanding the role of self-efficacy in sports and highlight the importance of replications with extensions.

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Self-regulation involves creating and achieving goals, which are internal representations of desired states and central to most contemporary theories of motivation (Diefendorff & Chandler, 2011). More specifically, goal choice and goal striving are the processes that describe motivated behavior in self-regulation theories (Austin & Vancouver, 1996). A concept highly related to why individuals choose and persist on specific goals, as well as possibly how individuals pursue goals, is self-efficacy. Self-efficacy is defined as individuals’ belief in their ability to accomplish a specific outcome (Bandura, 1994). The field of applied psychology has long been fascinated by the effects of self-efficacy on motivation and performance (Bandura, 1997). Indeed, there is a plethora of research indicating that self-efficacy is positively related to performance across several domains (Bandura & Locke, 2003). The domain of sports psychology is no exception, with several classic (e.g., Weinberg, Gould, & Jackson, 1979) and recent publications describing a positive self-efficacy effect (e.g., Gilson, Chow, & Feltz, 2012; Hutchison, Sherman, Martinovic, & Tenenbaum, 2008). Because of these positive findings, scholars often suggest boosting self-efficacy beliefs to improve performance (e.g., Colquitt, LePine, & Noe, 2000). For example, sports psychologists frequently pronounce the importance of increasing confidence and efficacy in athletes (e.g., Short & Short, 2005).

However, self-efficacy has recently become a controversial element in self-regulation theories (Bandura, 2012; Vancouver, 2015). In particular, Bandura (1997) has argued that self-efficacy should positively affect motivation and performance indirectly via goal choice by increasing the probability of choosing to engage or remain engaged in goal pursuit and directly during goal striving by positively determining effort applied. Although endorsing the indirect, positive goal-choice effect for self-efficacy, Vancouver...
suggested that self-efficacy is likely uninvolved in directly affecting the goal-striving process unless feedback regarding goal progress is absent or ambiguous. Moreover, in that latter case, Vancouver suggests that self-efficacy might negatively affect performance, though the effect is likely weak.

The reasons for Vancouver’s (2008) predictions regarding self-efficacy and performance during the goal-striving process stem from a control theory view of self-regulation. Control theory (Powers, 1973), like social cognitive theory (Bandura, 1986), describes goal striving as a discrepancy-reducing process where actions by the individual occur until the discrepancy between a perception of the current state of a variable and the desired goal state for the variable is eliminated (Vancouver, Putka, & Scherbaum, 2005). In control theory, self-efficacy plays no role during goal striving provided the state of the variable is knowable (e.g., feedback on the effects of one’s actions is unambiguous), which is in contrast to Bandura’s view. However, when feedback is not available or ambiguous, biased self-efficacy beliefs might negatively affect performance.

The explanations for the complex effects predicted by Vancouver (2008) are largely related to the role of self-efficacy beliefs on estimates of the resources (e.g., effort; time) needed to accomplish the goal and estimates of the effects of applying these resources. Specifically, higher self-efficacy leads one to believe that fewer resources are needed to achieve the goal as compared to lower self-efficacy (e.g., Beck & Schmidt, 2012; Hutchinson et al., 2008). Indeed, if one’s self-efficacy reflects one’s capacity, then the assessment of resource need is largely accurate. That is, individuals with higher capacities are likely to need fewer resources to achieve some level of performance than individuals with lower capacities (Beck & Schmidt, 2015; Vancouver, Gullekson, Morse, & Warren, 2014). Yet, how that assessment of resource need affects motivation (i.e., resource allocation) and performance will depend on the goal process involved and the nature of feedback.

For example, Vancouver, More, and Yoder (2008) examined the effect of self-efficacy (or expectancy) on the option to choose to pursue a goal and the resources allocated to the goal if it were chosen. They found that self-efficacy positively related to goal choice (i.e., accounting for more than 40% of the within-person variance in choices), but negatively related to resources allocated (i.e., accounting for more than 50% of the within-person variance in resources allocated). The presumed reason for the positive effect during goal choice is because one expects to reach the goal with relatively less effort when self-efficacy is high compared to when it is low (Vancouver, Weinhardt, & Schmidt, 2010). Said another way, a goal is seen as more likely to pay off when self-efficacy or expectancies are higher (Kirsch, 1985; Vancouver et al., 2008). This effect is the indirect (i.e., via goal) positive effect predicted for self-efficacy across theories of self-regulation (e.g., Bandura, 1997; Vancouver, 2008). The reason for the negative effect is because one estimates that fewer resources need to be allocated to achieve the goal when it is relatively easier (i.e., higher self-efficacy) for the person. That is, self-efficacy is used to estimate resource need and that need is estimated to be lower when self-efficacy is higher (e.g., Hutchinson et al., 2008).

An important element of the Vancouver et al. (2008) study was that participants allocated resources prior to goal striving. That is, individuals were asked to allocate some amount of time to trying to achieve each goal. This protocol allowed the researchers to measure resource allocation based on belief, rather than actual need because feedback regarding goal success or progress is absent prior to engagement in a task. Moreover, because participants were required to determine how much of a scarce resource to allocate prior to engagement, they likely used their self-efficacy beliefs to estimate what was needed to succeed on the goal. It is this type of condition (i.e., lack of feedback) where self-efficacy is expected to play a role in goal striving. Otherwise, according to the control theory view of self-regulation (Vancouver, 2008), one would simply use information about the state of the variable vis-a-vis the goal (e.g., asking if the goal is achieved yet or not). Indeed, self-efficacy was manipulated primarily in terms of the difficulty of achieving the goal and, as shown during the practice trials where resources available were constant, more resources were needed to achieve the more difficult goals. Likewise, more resources were needed by the less capable participants for each level of goal difficulty. Thus, if resource allocation (i.e., time on task) was measured by how long an individual pursued a goal, it would be more reasonable to assume that actual need stemming from an unachieved goal, not belief in capacity, would determine how long individuals pursued a goal.

However, because resource allocation was determined prior to goal striving in the Vancouver et al. (2008) study, that protocol did not examine self-efficacy’s role during goal-striving. Indeed, examining self-efficacy’s influence during goal striving is a challenge. For one thing, individuals with higher self-efficacy beliefs are likely more capable and thus their performance is likely to be higher. This alignment occurs because self-efficacy develops largely as a function of capacity indexed via performance (Bandura, 1997). However, given that differences in capacity or ability typically lead to differences in performance, a positive association between self-efficacy and performance may simply be reverse causality.

To address the confound of actual capacity and belief in capacity, Vancouver, Thompson, and Williams (2001) suggested using within-person designs to mute individual differences in capacity. That is, within-person designs examine how changes in performance and self-efficacy relate across repeated measures of self-efficacy and performance within an individual across performance episodes. Analytically, performance is regressed on self-efficacy assessed prior to the performance to determine the effect of self-efficacy on performance. Self-efficacy measures are also regressed on the prior performance to assess the effect of performance on self-efficacy. In meta-analyzing designs of this sort, performance was shown to have a strong effect on self-efficacy, but self-efficacy had no effect, on average, on performance (Sitzmann & Yeo, 2013). Moreover, these effects were found across cognitive tasks (e.g., Vancouver et al., 2001) and physical tasks (e.g., Woodman, Akehurst, Hardy, & Beattie, 2010).

Yet, the within-person design can still be vulnerable to the capacity confound if capacity changes over time (Sitzmann & Yeo, 2013) and the operation of different goal processes (e.g., choice; striving) can interfere with the ability to interpret the findings clearly (Vancouver et al., 2008). A possible example of the capacity confound in a within-person design may be observed in the sports domain. Specifically, Gilson et al. (2012) measured self-efficacy and performance on a maximum squat test for Division I collegiate American football players. The researchers found a positive relationship between self-efficacy and subsequent performance, even when addressing the changing capacity issue by controlling for past squat performance. However, the measure of past performance was taken several months prior to the measure of self-efficacy and subsequent performance. In the time between the researchers’ observations of squat performance, the athletes likely engaged in squats and other conditioning exercises that changed squat capacity. Moreover, the athletes were able to observe the results of these exercises, which likely informed (i.e., updated) their self-efficacy beliefs. Thus, the athletes’ self-efficacy beliefs at the time of the second measure of self-efficacy likely reflected change in ability and performance since the previously measured level.

The solution to the above capacity confound might be to manipulate self-efficacy. For example, Weinberg et al. (1979) had
participants compete against confederates on a muscular endurance leg extension task where the two competitors had weights attached to their legs. The confederate was described as either a varsity athlete (low manipulated self-efficacy) or having just had knee surgery (high manipulated self-efficacy). The task was rigged so that participants would lose the competition on two trials (i.e., the weights on the confederates’ legs were much lighter than the weights on the participants’ legs). The primary dependent variable was the time it took before the participant lowered his or her leg. Across both trials the high self-efficacy group persisted longer than the low self-efficacy group. They also found a stronger effect in the second trial due to the low self-efficacy group’s performance dropping significantly from the first trial. Overall, a correlation of 0.68 was found between self-efficacy and performance, though this correlation appears based on the measure, as opposed to the manipulation, of self-efficacy. Of note regarding the Weinberg et al. (1979) study was that persistence was the variable of interest given that the confederate might use one’s self-efficacy more consistent with an ambiguous feedback condition, where one feedback regarding goal progress (1) indicates the goal has not been achieved, (2) indicates the goal has been achieved, (3) indicates the goal partially achieved, and (4) indicates the goal has not been achieved. However, in a follow-up study, Weinberg, Yukelson, and Jackson (1980) used the same self-efficacy manipulation, except that they placed the competitors back-to-back so that the performance of the confederate could not be readily observed by the participant. This scenario is more consistent with an ambiguous feedback condition, where one might use one’s self-efficacy belief to gauge performance. It is in this situation where self-efficacy is likely to have a null or negative influence on performance (Vancouver, 2005). Weinberg et al. (1980) found a positive self-efficacy effect, but only for men and it was much weaker (r = 0.19) than in the 1979 study. Weinberg et al. (1980) interpreted the stronger effect to be credited to the face-to-face arrangement making the competition salient and sensitizing the participants to the efficacy cues. However, there is another interpretation of the differences between the findings of the two Weinberg et al. studies. In particular, the control theory view of self-regulation describes two conditions where self-efficacy might play a role on a persistence task: where feedback regarding goal progress (1) indicates the goal has not been met as one’s resources are becoming taxed, or (2) is absent or ambiguous (Vancouver, 2008). The former condition, which represents the 1979 study, can trigger a goal-choice process that determines whether to abandon the goal or not (i.e., give up or continue striving). Here self-efficacy is expected to have its positive, indirect influence (i.e., via goal). In contrast, in the condition where feedback is ambiguous or absent, like that found in the 1980 study, self-efficacy beliefs may be used, along with other cues (e.g., perceived fatigue), to estimate one’s progress toward a goal. Here, because higher self-efficacy would lead one to estimate further progress per unit of resource applied (e.g., time acting), one would estimate reaching the goal more readily with higher self-efficacy. Thus, self-efficacy would negatively relate to effort (i.e., resources applied) and possibly performance because one might mistakenly estimate reaching the goal sooner the higher the self-efficacy belief. Of some import, the interaction between feedback ambiguity and self-efficacy on performance described above was recently found on a cognitive task in a study by Schmidt and DeShon (2010). Specifically, they found a negative within-person effect for self-efficacy on subsequent performance on an anagram task when feedback regarding performance was ambiguous and a positive within-person effect when feedback was unambiguous.

In the current study, we sought to confirm an interaction between self-efficacy and performance feedback ambiguity using a physical task. To a large extent, our study was designed to replicate and combine the protocols of the 1979 and 1980 Weinberg et al. studies, though with some modifications to facilitate interpretations. The first change was to use a hand gripping task (e.g., Hutchinson et al., 2008) instead of the leg extension task. A hand gripping task allowed us to obtain a maximum voluntary contraction (MVC) for every participant. Participants were then asked to maintain a grip of 50% of their maximum grip for a longer time than their competitor. This protocol helped reduce ability differences of the participants by calibrating the task to each individual’s MVC. A second protocol difference was to place a wall between the competitors in the ambiguous feedback condition to make sure participants were unable to know the state of their competitor, which seemed purer than the back-to-back set up of the Weinberg et al. (1980) study. Finally, we included two trials for all conditions. Only the 1979 study included two trials.

Given the above changes and the arguments described above, our main hypothesis was the following:

**Main Hypothesis.** Self-efficacy and performance feedback ambiguity will interact such that self-efficacy will positively affect performance only in the unambiguous condition.

We might expect the relationship to be negative in the ambiguous condition, but the negative effect is typically small and difficult to detect (Sitzmann & Yeo, 2013). Rather, to assess the control theory based view of self-regulation (Vancouver, 2008) regarding self-efficacy more directly, we measured the participants’ perception of the effort they expended during the task. In particular, the control theory view holds that effort is used to compensate for lower capacity. Thus, those with higher self-efficacy will not see the need to use as much effort as those with low self-efficacy. For this reason, we expected self-efficacy to negatively relate to reported effort on the hand gripper task across conditions and trials. Note that this prediction is directly opposite the prediction from Bandura’s (1997) social cognitive view of self-regulation.

**Supplementary Hypothesis A.** Self-efficacy will negatively relate to reported effort.

Finally, we wanted to reexamine Weinberg et al.’s (1979) finding of a stronger effect of self-efficacy on the second trial. They predicted this effect because of Bandura’s (1977) claim that self-efficacy would be particularly useful in the face of failure. Yet, our position is that self-efficacy might prolong performance while facing failure, not following it. Rather, we expected the uniform failure feedback after the first trial to undermine the self-efficacy manipulation. Specifically, we predicted a three-way interaction between self-efficacy, feedback ambiguity, and trial.

**Supplementary Hypothesis B.** Self-efficacy, feedback ambiguity, and trial will interact such that the effect of the interaction between self-efficacy and feedback ambiguity will be significantly weaker in the second trial.

**Method**

**Participants**

In return for course credit, 192 undergraduate students participated in the study. After obtaining informed consent, participants were told that the study was about muscular endurance. A total of 38 participants were removed from the final data analysis due to participant suspicion of the confederate (n = 9), failure to follow study instructions (n = 30), and/or not completing the study (n = 4), with some exhibiting multiple issues. Thus, the final sample...
included 154 participants, including 87 females and 67 males. The average age was 19.02 (SD = 1.24). There were no differences between those included and excluded from the analysis on gender, age, or feedback condition. However, there was a significant difference between those included and excluded on manipulated self-efficacy \( \chi^2(1, N = 192) = 6.43, p = 0.011 \). Disproportionally more of the removed individuals were in the high self-efficacy condition (26 of the 38 individuals).

**Apparatus**

The muscular endurance task was assessed via a computer program called Biopac, which used electronic hand grip dynamometers. The computer recorded and displayed hand gripper force during the entire experiment and in real time. The display could be manipulated by adjusting the Biopac program's gain setting. Moreover, because the scale for the grip force display was not provided, participants could not know that different scales were being used. Specifically, for participants the gain was set such that 0.2 mV of additional force was needed to move up a line on the display. For the confederates, the gain was doubled so that only 0.1 mV of force was needed to move up a line on the display. The display was visible to the participant.

**Manipulations and measures**

**Self-efficacy manipulation**

Participants were randomly assigned to high or low self-efficacy. The manipulation included variations of elements used in Weinberg et al. (1979). The first element involved confederates in the high self-efficacy condition claiming to have overworked their hand by taking a long essay test earlier that morning or afternoon (or, if during the first few weeks of school, by taking copious notes in class earlier that morning or afternoon). Confederates in the low manipulated self-efficacy condition claimed to be a lifelong tennis player with a strong grip. The second element took place while “calibrating” the hand grippers (described more fully in the Procedure section). Specifically, participants and confederates were asked to squeeze the hand gripper as hard as they could for 10 s. Confederates, who always followed the participants, gripped at a slightly lower level than the participants when the participant was in the high self-efficacy condition and at a slightly higher level than the participants when the participant was in the low self-efficacy condition. Confederates could control their grip level easily because the recalibration of the display made the task twice as easy for the confederate as compared to the participant. Indeed, it was never the case that a confederate could not operationalize this element of the protocol. Finally, the experimenter asked the participant and the confederate how long each thought they could maintain a grip. After the participant answered, the confederates answered that they could maintain their grip for a time period 50% shorter than the participant’s answer or 150% longer than the participant’s answer in the high and low self-efficacy conditions, respectively.

**Feedback ambiguity manipulation**

Feedback ambiguity was manipulated via a physical barrier. For the ambiguous condition, participants competed with a barrier between the participant and the confederate that prevented them from observing the confederate’s performance both directly and via the computer display. For the unambiguous condition, there was no physical barrier and both displays showing performance were visible to the participant.

**Self-efficacy manipulation check**

Participants used a 100-point scale to answer “How likely do you think it is that you will outlast the other participant on the hand gripper task?” where 0 was labeled “not at all likely” and 100 was labeled “extremely likely.”

**Effort**

Effort was measured by asking participants how much effort they put into the muscular endurance task they just completed on a scale from 0 (no effort) to 100 (maximum effort). Participants also answered how much they tried during each trial on a scale from 0 (did not try hard) to 100 (tried very hard). These items correlated 0.79 and 0.88 in Trials 1 and 2, respectively. Consequently, they were combined to form scales for each trial \((\alpha = 0.88 \& 0.93,\) respectively).

**Performance**

Performance was measured by how long participants could maintain a grip at 50% of their maximum performance. Failure to maintain 50% occurred when the grip dropped by 0.2 mV of force (i.e., dropped at least one line below the person’s 50% line).

**Suspicion and goal check questions**

After the instructions and after implementing the self-efficacy manipulations, participants were asked if they accepted the goal of outlasting the other participant (by indicating “yes” or “no”). At the end of the experiment, participants were asked a series of questions to determine suspicion of the deceptions. These were: “What do you think the real purpose of this study was?” “At any point, were you suspicious of the purpose of this study?” and “Do you think you were deceived at any point during the study? If so, how?” Participants were removed from the analysis if they indicated they suspected the other participant was a confederate or that the programs were rigged so that the confederate would win.

**Procedure**

To increase the believability of the self-efficacy manipulation, confederates were always the same sex as the participant. The confederate entered the room first and sat at the computer station on the left, followed by the participant who sat at the remaining computer station. Both participants and study confederates then read and signed a consent form. At this point, the experimenter explained that the participant and the confederate were to compete against each other to see who could hold a grip longer using their dominant hand. To implement the self-efficacy manipulation, the experimenter asked about special circumstances that may affect performance on the hand gripping task, “calibrated” the hand grippers, and asked for a prediction of how long participants/confederates thought they could sustain their grip during the upcoming task. The experimenter also explained that the reason for calibrating the hand grippers was because it was the first use of them that day. In reality, the experimenter needed to determine the participant’s MVC. Thus, both the participant and then the confederate were asked to help calibrate the hand gripper by squeezing the electronic hand gripper as hard as they could for 10 s. During this procedure, the experimenter noted the grid line that best represented the participant’s maximum performance. Each grid line on the display represented an additional 0.2 mV of force for the participants and 0.1 mV for the confederate. An examination of the force data after the sessions were run confirmed that the researchers were accurate in their assessments of MVCs.

Given all the self-efficacy manipulation elements had been applied at this time, participants (and ostensibly, confederates) completed the self-efficacy manipulation check items and the goal manipulation check item. The participant and confederate were
instructed to pick up the hand grippers and begin gripping to the grid line indicated by the experimenter when instructed to begin. The grid line indicated was the one closest to the 50% of the MVC of the participant noted during the calibration procedure. The experimenter explained that each trial would last a set amount of time after which the experimenter would announce who won the trial. Experimenter stood in a place where it was clear they could monitor both the participant and confederate during the trials. In both conditions, the experimenter waited 3 min after the participant ceased to maintain their grip, which was specifically operationalized as falling at or below the grid line below the indicated grid line. This 3-min period was used so that participant in the performance ambiguous condition would be completely unaware of their status (i.e., the participant would not know if they won or lost in this condition until the experimenter announced the confederate won). After the winner was announced following both trials, participants filled out the effort questionnaire pertaining to the appropriate trial that was just completed.

Results

**Manipulation and randomization checks**

An independent samples t-test was conducted to compare self-efficacy in the high and low manipulated self-efficacy conditions. Self-efficacy was significantly, $t(152) = 1.99, p = 0.049, d = 0.33$, higher on average for participants in the high self-efficacy condition ($M = 55.93, SD = 19.51$) as compared to those in the low self-efficacy condition ($M = 48.48, SD = 25.86$).

We also checked to determine if gender was confounded with condition given evidence that women typically outlast men in physiological endurance tasks, but that men are typically stronger (Hunter, 2014). Indeed, women ($M = 141.55; SD = 120.65$) persisted longer, $t(102.79) = -4.35, p < 0.001$, than men ($M = 82.49; SD = 33.55$) across the trials. Also, men typically needed to maintain a grip at the third grid line ($M = 2.94; SD = 0.77$), whereas women tended to need to maintain a grip at the first or second grid line ($M = 1.49; SD = 0.45$), which was significantly different, $t(99.3) = 13.39, p < 0.001$. However, gender was not distributed unevenly across the self-efficacy, $\chi^2(1, N = 154) = 0.02, r = -0.01, p = 0.88$, or feedback ambiguity, $\chi^2(1, N = 154) = 1.99, r = -0.11, p = 0.16$, conditions. Likewise, gender did not interact with other variables in the study, indicating that gender was not a confound.

Finally, we sought to confirm that participants accepted the goal of beating the challenger, which we measured prior to the implementation of the self-efficacy manipulation. Unfortunately, only 69 individuals (44.8%) endorsed the item. However, neither the self-efficacy condition, $\chi^2(1, N = 154) = 1.18, p = 0.27$, nor the feedback ambiguity condition, $\chi^2(1, N = 154) = 2.92, p = 0.09$, were related to the probability of endorsing the item.

**Hypothesis tests**

The main hypothesis predicted an interaction between self-efficacy and performance feedback condition on performance. This interaction was significant, $F(1, 149) = 5.00, p = 0.027, \eta^2_p = 0.032$, and in the predicted direction for Trial 1 (see Fig. 1). That is, in the unambiguous condition performance was higher for those in the high self-efficacy group ($M = 182.00, SD = 189.82$) as compared to those in the low self-efficacy group ($M = 119.85, SD = 68.76$); whereas, in the ambiguous condition, performance was lower for those in the high self-efficacy condition ($M = 114.23, SD = 62.53$) as compared to those in the low self-efficacy condition ($M = 130.30, SD = 88.01$). Pairwise comparisons also showed a significant difference between the high and low self-efficacy groups in the unambiguous condition, $F(1, 149) = 5.86, p = 0.017, r^2 = 0.051$, but not in the ambiguous condition, $F(1, 149) = 0.45, p = 0.501, r^2 = 0.011$.

![Fig. 1. Interaction between self-efficacy manipulation and performance ambiguity manipulation in Trial 1.](image1)

![Fig. 2. Interaction between self-efficacy manipulation and performance ambiguity manipulation in Trial 2.](image2)

Trial 2 showed a very similar pattern of results. Specifically, the hypothesized interaction was significant, $F(1, 149) = 4.08, p = 0.045, \eta^2_p = 0.026$, and in the predicted direction (see Fig. 2). That is, participants in the unambiguous condition performed better on average, $F(1, 149) = 6.95, p = 0.009, r^2 = 0.010$, when in the high self-efficacy group ($M = 142.68, SD = 144.26$) as compared to the low self-efficacy group ($M = 75.46, SD = 48.10$). In the ambiguous feedback condition, there was no significant difference, $F(1, 149) = 0.02, p = 0.897, r^2 = 0.000$, between the high ($M = 90.49, SD = 151.71$) and low self-efficacy groups ($M = 93.56, SD = 55.87$).

In line with the control theory argument regarding self-efficacy (Vancouver, 2008), we hypothesized (i.e., Supplementary Hypothesis A) that self-efficacy would negatively relate to self-reported effort. Consistent with the hypothesis, self-reported effort was significantly lower for the high self-efficacy group ($M = 80.51, SD = 17.11$) as compared to the low self-efficacy group ($M = 88.56, SD = 9.59$) for Trial 1, $t(137.0) = -3.89, p < 0.001, d = -0.60$. Likewise, in Trial 2 self-reported effort was significantly lower for the high self-efficacy group ($M = 80.82, SD = 19.41$) as compared to the low self-efficacy group ($M = 86.53, SD = 14.68$), $t(161.8) = -2.22, p < 0.05, d = -0.34$. There was no significant ($p < 0.05$) main effect for feedback condition or the interaction between the conditions in either trial.
The second supplementary hypothesis predicted that the effect of the interaction between self-efficacy and performance feedback ambiguity would weaken over trial, resulting in a three-way interaction. To assess the interaction, a repeated-measures ANOVA was conducted. The analysis was not significant, \( F(1, 150) = 0.06, p = 0.804, \eta^2_p = 0.000 \). There was, however, a significant main effect of trial, \( F(1, 150) = 20.33, p < 0.001, \eta^2_p = 0.119 \). On average, individuals performed better on Trial 1 \( (M = 133.86, SD = 109.65) \) than Trial 2 \( (M = 97.85, SD = 108.72) \), which would be consistent with a fatigue effect.

Discussion

The commonly held belief in sports psychology is that self-efficacy positively affects performance due to Bandura's (1997) claim that self-efficacy is key to motivating behavior (e.g., Hepler & Feltz, 2012). A classic study by Weinberg et al. (1979) is frequently cited in support of this position, and sometimes, a less frequently cited study by Weinberg et al. (1980) is also cited in support of the claim despite finding a much weaker positive effect and only for men. In the present study, we sought to replicate these studies in a single study and with some modifications. Moreover, we used a control theory view of self-regulation (Vancouver, 2008) as the basis for our predictions of an interaction between feedback ambiguity and self-efficacy on persistence and a negative effect for self-efficacy on effort. The interaction and negative effect on effort were found. The theoretical, methodological, and practical implications of these findings, as well as limitations of the study, are discussed below.

Theoretical implications

Bandura (1977, 2012) has argued that self-efficacy positively influences motivation and performance both directly and indirectly via goals, though with some variations in degree. This claim is based on research like Weinberg et al. (1980), who interpreted the differences in the results of that study with the results of a 1979 study to be because competitors facing one another will pay more attention to their self-efficacy beliefs and that increased attention will increase the positive effect of self-efficacy on performance as compared to competitors unaware of each other's level of performance. More recently, Bandura (2012) argued that task ambiguity can weaken, or even make negative, the relationship between self-efficacy and performance. According to Bandura, this is because individuals will not know what courses of action to organize and execute much less have an accurate belief of their capacity for such action. Yet, the reason self-efficacy should play a greater role was never made clear by Weinberg et al., (1980), and the actions needed to perform their task were not ambiguous, even in the ambiguous condition, just the information about where one stood.

In the current paper, we used Vancouver's (2008; 2012) control theory view of self-regulation (Powers, 1973) to claim that self-efficacy is a belief that develops to help individuals manage resources. Given this view, self-efficacy's influences on motivation and performance will depend on the goal process involved. Our findings support the argument that individuals will choose to disengage from a goal that they know they are not achieving as resources are being taxed and that self-efficacy will negatively influence when that disengagement occurs (and thus positively relate to persistence on the goal). When making this goal choice decision, individuals with higher self-efficacy will likely persist longer because they expect fewer resources will be needed to realize the goal as compared to when beliefs are lower (Beattie & Davies, 2010). That is, when a goal-choice process is evoked, both Vancouver (2008) and Bandura (1997) predict the positive effect found.

However, Vancouver (2008) also argued that if one does not directly know one's state in progress toward a goal, self-efficacy will be used to estimate it based on the resources used. Higher self-efficacy beliefs will lead to a higher estimate of performance per level of resource used than lower self-efficacy beliefs. This effect may undermine performance when self-efficacy is relatively high, depending on the level of miscalibration between self-efficacy beliefs and actual capacity. In the present case, we found that self-efficacy was negatively related to performance when feedback regarding performance (i.e., goal progress) was unavailable, though the effect was not significant.

Perhaps more important, we found self-efficacy was negatively related to self-reported effort across the feedback conditions. This finding is consistent with the argument that self-efficacy represents a belief in the resources (e.g., effort) needed to achieve a goal, where fewer resources are needed the higher one's capacity (see also, Hutchinson et al., 2008). This also makes sense in terms of a reason for developing such beliefs because when individuals are more capable on a task, they need fewer resources to achieve given levels of attainment.

Methodological implications

Designing studies that allow clear interpretations of results is difficult (Shadish, Cook, & Campbell, 2002). Recently, scholars have called for more replication studies to help create a stronger science (Kahneman, 2012; Pashler & Wagenmakers, 2012). In the case of self-efficacy, we noted the complexities of effects due to the roles it played in different goal processes and the threats of reverse causality that plagued interpretations on the empirical record. We highlighted the Weinberg et al. (1979; 1980) studies as good examples of internally valid research, but that even these studies might benefit from replication. In particular, we wanted to be able to test statistically the interaction effect presumably found across the two studies. We also wanted to arrange a task that would minimize actual ability differences. Finally, we wanted to use a physical barrier to create an ambiguous feedback condition so that participants could not sense competitors' persistence. Indeed, it appears that one of these changes might account for the elimination of the positive self-efficacy effect in the ambiguous condition.

Of course, one replication is just one study and thus also subject to the irregularities and possible design flaws of any other study. Of particular concern are the more unusually negative self-efficacy-to-effort effect and the null self-efficacy-to-performance effect in the ambiguous feedback condition. However, there are growing bodies of research regarding both effects. For example, Sitzmann and Yeo (2013) conducted a meta-analysis of the effect of self-efficacy on performance, which showed that self-efficacy is, on average, null, where studies in sports psychology were included (e.g., Beattie, Lief, Adamoulas, & Oliver, 2011). Likewise, Vancouver et al. (2008) found a strong negative effect for self-efficacy on effort using an objective measure of effort, and other researchers (e.g., Beck & Schmidt, 2015; McAuley & Courneya, 1992) have found similar effects using subjective measures of effort like the one used here.

Nonetheless, we cannot eliminate all possible alternative explanations regarding the negative effect of self-efficacy on self-reported effort. For example, because individuals are motivated to protect and enhance their self-esteem (Baumeister, 2010), our participants may have claimed they did not put much effort into a task after being told they lost to the competitor. This motivation could be particularly strong in the low self-efficacy conditions where all present could see that they should have won given the way the manipulations were presented. Future studies might have
individuals to fill out the effort questionnaire before being told the results of the competition or performance.

A second limitation is that, besides gender, we did not attempt to control other features of the confederates (e.g., height and weight) that might signal ability differences. The reason was largely because we used several confederates of each sex and we used the 50% of MVCs to equate the task across participants. In contrast, Weinberg et al. (1979) included confederates that looked weaker or stronger and linked them to the self-efficacy conditions, which likely created a stronger manipulation. Fortunately, the manipulation check worked out as expected. Moreover, participants and thus sessions were randomly assigned. As such, confederate attributes might have added noise, but not systematic bias. Nonetheless, future studies should confirm that dummy codes representing confederates and experimenter not contaminate the data.

A third limitation involves the goals of the participants in the study. Specifically, less than half the participants said that beating the other individual was a goal for them. Given that the self-efficacy measure focused on this specific performance, such a low level of endorsement was a concern. Of course, laboratory studies frequently have individuals who do not conform to the prescriptions of the experimenters or reframe goals in their own way. If the distribution of individuals pursuing the presumed goal was not evenly distributed across the experimental conditions, the uneven distribution might suggest a confound. However, we found no evidence of this. That is, the goal question was unrelated to condition, effort, or performance. Likewise, it did not moderate any relationships. Thus, if some participants were pursuing other goals, it likely only added noise, rather than systematic bias. Perhaps, future studies should seek to confirm that participants are pursuing the designated goal by using a multi-item measure and by using a protocol that encourages goal acceptance.

Practical implications

Evidence that self-efficacy positively relates to performance is often used to advocate that coaches and trainers enhance self-efficacy beliefs in athletes (e.g., Bandura, 2012). The findings from the current study replicate findings (e.g., Schmidt & DeShon, 2010; Weinberg et al., 1979) that self-efficacy increases persistence on a goal provided feedback about one's standing is available. Moreover, feedback-rich environments are likely common in sports contexts. Nonetheless, our findings do not necessarily mean that enhancing self-efficacy is a good strategy for enhancing performance. Certainly if individuals are under confident or performances are somewhat unpredictable and engagement has relatively low costs on resources, enhancing self-efficacy beliefs might be a good strategy. However, enhancing self-efficacy beyond true capacity runs the risk of encouraging the pursuit or persistence on unachievable goals where the resources used might be better spent elsewhere or reserved for a future attempt. For example, Vancouver et al. (2014) recently demonstrated the cost in terms of performance of engaging in too many low probability goals over the long run; these engagements were brought on by inflating self-efficacy beliefs.

In addition, research on self-efficacy's effect in ambiguous feedback contexts sometimes indicates that self-efficacy can negatively affect performance (e.g., Schmidt & DeShon, 2010), though that was not the case here. Interestingly, Bandura (1997) has said that "some self-doubt about one's efficacy provides incentives to acquire the knowledge and skills needed to function successfully" (p. 76) and that coaches "underscore deficiencies" (p. 76) during practices. Indeed, low self-efficacy has been shown to increase the level of resources committed to a goal, provided the goal is accepted (Vancouver et al., 2008) and it can increase persistence via effort applied (Schmidt & DeShon, 2010). However, unless self-efficacy beliefs are inflated or resources are unlimited, such an approach might be problematic in the long run (Vancouver et al., 2014). Rather, it seems the best advice is to provide opportunities and information such that individuals can develop accurate, calibrated self-efficacy beliefs. This calibration would allow for better self-regulation of behavior and resources (Vancouver, 2005).

Toward that end, coaches might accomplish increased calibration of their players by minimizing ambiguity during performance situations. For instance, a cross-country coach may be able to observe and study the ability of the team's opponents and convey this information to his or her own team. For example, if certain runners on another team tend to burn out closer to the end of races and other runners are excellent at keeping a steady pace, the coach could use this information to reduce performance ambiguity for his or her team members. As a result, the runners should be better calibrated given they have information about their opponents' performance and can adjust behavior during the race appropriately. It is also important for the athletes to understand their own running abilities. Information about opponents may not be helpful if an athlete has little idea that he or she tends to overtax resources early in a long race.

Conclusion

For us, the most important conclusion from the current study is that the results should give scholars and coaches pause when considering the role of self-efficacy on motivation. Carefully controlled research using cognitive tasks has shown that self-efficacy can play multiple roles, not all of which lead to positive performances (Vancouver et al., 2001, 2008). Likewise, some research with physical tasks demonstrates that self-efficacy can have null to negative effects on motivation and performance (e.g., Woodman et al., 2010). The current study illustrates when one might expect a positive effect versus null or possibly even negative effects when the motivation to persist matters. Moreover, the control theory view of self-regulation (Vancouver, 2008) explains why self-efficacy can positively affect persistence when feedback is unambiguous as well as how self-efficacy can adversely affect persistence when feedback is ambiguous or absent. Thus, the theory allowed us to reinterpret findings from an earlier set of studies (Weinberg et al., 1979, 1980). In this way, the current study provides an example of the value of replication, attention to design, and a strong, theoretical logic (Kahneman, 2012). We look forward to others replicating and extending this research.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.psychsport.2015.08.007.

References


