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Effects of a Strategic Self-Talk Intervention on Attention Functions and Performance in a Golf Task under Conditions of Ego Depletion

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Abstract: States of reduced self-control described as ego depletion have been shown to impair sport task performance. Recently, self-talk has emerged as a successful method to counteract ego depletion effects in cognitive tasks. Extending this line of research, the present study examined the effects of a self-talk intervention on attention functions and performance in a golf-putting task under conditions of ego depletion. Two studies were conducted; the first involved a simple putting task, whereas in the second, a divided attention factor was introduced in addition. Participants in the first experiment were 62 sport science students (30 females and 32 males, M_{age} = 18.58, SD = 1.03) who were randomly assigned into experimental (n = 31) and control (n = 31) groups. Participants in the second experiment were 54 sport science students (27 females and 27 males, M_{age} = 19.91, SD = 1.04) who were randomly assigned into experimental (n = 27) and control (n = 27) groups. Both experiments were completed in a single session that lasted approximately 60 min. All participants were tested individually. The procedures included (a) baseline performance assessment consisting of two sets of ten putts, (b) practice period, consisting of six sets of five putts, during which the experimental group was also introduced to the use of strategic self-talk, (c) an ego-depleting task, and (d) final performance assessment, which was identical to the baseline. The results showed that in both experiments, performance of the experimental group increased from baseline to final assessment (experiment 1, $p < 0.001$; experiment 2, $p = 0.023$), whereas that of the control group had no significant change (experiment 1: $p = 0.241$; experiment 2: $p = 0.407$). The findings showed that self-talk is an effective strategy for buffering the effects of ego depletion and suggest that improved attention functions are a viable mechanism for explaining the facilitating effects of self-talk on sport performance tasks.

Keywords: self-talk mechanisms; focused attention; divided attention; self-control; golf putting

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1. General Introduction

Volitional self-control may determine much of the success of executive actions. Numerous essential executive functions of the self contain volition [1]; for example, making decisions and choices, taking responsibility, initiating as well as inhibiting behavior, and carrying out those behavioral actions. Individuals able to exert volitional self-control in a particular motion of action are more likely to succeed in this specific execution [2]. In contrast, inability to exert self-control at specific moments can lead to an inability to perform at an optimal level [2]. Thus, deliberate self-control is a valuable resource.

The strength model of self-control [3] has given theoretical insight by suggesting that self-control refers to the capacity for triggering one's acts of volition and enables a person to alter them by restraining or overriding an initial act, thereby making a different

response possible. It has been argued [4] that in order to engage in self-control, efforts of deliberation, attention, and vigilance must be produced by the individual. Acts that employ self-control seem to interfere with other such acts that follow soon after, hence taking use of the same resource and making the implication that an essential reserve of the self becomes depleted by such acts of volition [5]. This lessened state of self-control strength has been referred to as ego depletion [1]. The term ego depletion can be therefore used to describe a temporary reduced capacity or willingness of the self to engage in various volitional actions (controlling the self, making choices, and initiating action) as a consequence of a prior act of self-control [1]. The core idea that ego depletion entails is that the self's acts of volition rely on a limited reserve, akin to strength or energy. Thus, one act of engagement in self-control has a detrimental impact on the subsequent act that applies self-control.

Research has examined ego depletion effects in sport performance, including reaction time trials, impulse control, and performance accuracy measurements. In a study with darts [6], it was found that participants who were conditioned to reduced self-control strength were less accurate as well as slower in initiating the dart-throwing motion after a green flash was displayed, and thereby less adept in controlling their impulses. In another study with darts, decreased accuracy scores in depleted participants were linked to increased anxiety levels [7]. In a study examining basketball free throws under distracting conditions, it was reported that depleted participants performed worse than non-depleted ones [8]; the authors attributed the difference to the greater distractibility of depleted participants by the irrelevant stimuli. Additionally, in an investigation of reduced self-control strength on impulse regulation in sprint reaction times, it was found that following a depletion task, reaction times were slower [9]. A follow-up study also indicated that ego-depleted participants without any track-and-field experience had a significant increase in false starts, meaning that the regulation of the initiative impulse for start also requires self-control [10]. Collectively, in a review summarizing the relevant literature [11], it was suggested that in the sport field, ego depletion has been quite consistently linked with reduced performance. Interestingly, attentional processes have been identified as a key factor explaining sport performance deficits under conditions of ego depletion [8,10,12].

A mental strategy that has been shown to facilitate sport task performance through enhanced attentional functions is self-talk. Strategic self-talk refers to the use of cues addressed to the self that aim to enhance performance and self-regulation through triggering appropriate action [13]. Meta-analytic evidence has supported the beneficial effects of strategic self-talk for sport task performance, particularly for fine motor tasks requiring precision and accuracy [14]. For example, research has supported the effectiveness of strategic self-talk in studies assessing tennis stroke accuracy [15], dart-throwing [16], and also golf-putting [17]. Finally, in an experiment assessing pistol-shooting performance it was reported that performance of the strategic self-talk group increased significantly more than that of the control group [18]. In addition, it was found that stability indices improved for the self-talk group, whereas no changed were recorded for the control.

In recent years, research focusing on the attentional aspects of self-talk has provided direct and indirect evidence for an attentional interpretation of strategic self-talk effectiveness. Direct evidence has been provided in a study examining the effects of strategic self-talk on different attention dimensions [19], based on Strum's conceptualization [20], in a series of lab experiments involving cognitive attention tests. The study provided consistent support for the attentional effects of strategic self-talk in tests assessing intensity and selectivity of attention and also spatial attention. Indirect evidence has been provided by a study exploring the effects of strategic self-talk on sport task performance under conditions of distraction. In a field experiment [21], the effectiveness of strategic self-talk on basketball free-throw performance under conditions of external distraction, introduced by sudden, loud, intermittent noise, was examined. The results showed that performance of the self-talk group was superior to that of the control group. Indirect evidence has also been provided in a study employing two water-polo tasks, where it was found that improvement of performance was related to decreases in cognitive interference (internal distractions) [22].

The authors postulated that strategic self-talk assisted performance through the reduction of internal distractions.

Summarizing the above, on the one hand, ego depletion has a detrimental effect on sport task performance which can be attributed to attentional deficits and in particular distractibility, while on the other hand, strategic self-talk has facilitating effects on sport task performance that can be partly attributed to attentional mechanisms, and in particular, reduced distractions. Subsequently, the potential link between attentional losses due to depletion and attentional gains due to strategic self-talk becomes apparent. Considering this rationale, the effects of strategic self-talk on a selective attention computerized test under conditions of ego depletion were examined in a lab experiment [23]. The results showed that participants in the experimental group performed significantly better than the participants in the control group. The researchers argued that strategic self-talk helped the participants in the experimental group to direct attention to task-relevant cues even when there was a limited amount of self-control strength.

The present research aimed to explore the potentially facilitating effects of strategic self-talk under conditions of ego depletion through a study employing a sport task and further explore attentional aspects of task performance. In this way, the study would add ecological validity to the findings of [23], provide further evidence regarding the attentional interpretation of strategic self-talk, and extend the line of research exploring the effectiveness of strategic self-talk under adverse conditions. For that purpose, two experiments involving a golf-putting task were conducted. In the first experiment, the effects of strategic self-talk on golf-putting performance under conditions of ego depletion were examined, whereas in the second experiment, a divided attention factor was introduced to the putting task to further explore attentional aspects of performance. For both experiments, it was hypothesized that under conditions of ego depletion, performance of the control groups would decrease, whereas performance of the self-talk groups would not be influenced.

2. Experiment 1

2.1. Materials and Methods

2.1.1. Participants

Power analysis (G*Power 3.1.9.7) was conducted for the estimation of an appropriate sample size for ANOVA with repeated measures involving within- and between-subject interaction effects. The estimated effect size was drawn from a study examining the effects of self-talk on attention under conditions of ego depletion [23]. The analysis showed that to achieve a minimum power of 0.80, based on an average estimated effect size of 0.39 [23], 54 participants were required in total. Sixty-two sport science students (30 females and 32 males, M_{age} = 18.58, *SD* = 1.03) were recruited and randomly assigned into experimental (n = 31) and control (n = 31) groups. None of the participants had prior experience in golf at a competitive or recreational level. Participants received course credit for their participation in the study.

2.1.2. Procedures

The institution's ethics committee granted permission to conduct this research (ref: 1321). Prior to the onset of the experimental procedures, participants were informed about the overall protocol and the procedures of the experiment and signed informed consent. The experimental procedures took place in a controlled laboratory environment. Participant were tested individually in single sessions that lasted approximately one hour. The experiment was divided into four phases: baseline assessment, golf practice, ego depletion manipulation, and final assessment.

Baseline Assessment

Participants were informed about the main aim of the task, which was to putt the ball into the white circled hole. Furthermore, they received standardized instructions about the basic setup of golf putting: stance, posture, alignment, distance to the ball, position of

the hands, and golf club grip. They were then asked to perform two familiarization sets consisting of 10 putts each; scores for this session were not recorded. Next, participants executed two sets of 10 putts at 2 m line from the golf course with 30 s of pause between the sets. After every putt, one research assistant cleared the ball off the course, while a second assistant was placing a new one on the 2 m line; participants did not make any unnecessary movements nor had any physical contact with the ball except for the actual putt. The baseline assessment lasted approximately eight minutes.

Golf Practice

Participants were subsequently engaged in a short practice session. The purpose of the training was to (a) enhance participants' golf-putting skills, and (b) to get participants of the experimental group familiar with the use of strategic self-talk. The practice protocol for both groups consisted of three series of putting sets from various distances. Each series consisted of two sets of five putts with 30 s of pause between the sets. Each series had 45 s of pause between them. The first series were taken from 2.5 m line, second series from 3 m line and third series from 2 m line. This sequence was applied to allow participants to practice in a similar but not identical task, attempting to minimize the learning effect, but give participants one set from this exact distance of the final putting performance measurement to readjust their putting.

Experimental group. Participants of the experimental group were first reminded of the instructions regarding the fundamentals of golf putting. They were then introduced to the use of self-talk [24]. They were explained what strategic self-talk is about and how self-talk plans can be developed. Subsequently, they were asked to perform the golf-putting sets using self-talk prior to each putt. Two cues-words were selected by the experimenters, "in" and "steady"; these were selected based on prior piloting with an independent group where a variety of alternate cues were tested. Participants were instructed on when to use the cues (just prior to the putt) and why to use them (their meaning). They were asked to use each cue for each set of the first series, and thereafter the one they preferred for the remaining series of sets. During practice they were provided feedback on how to improve their putting. Upon completion of the practice phase, a self-talk manipulation check was administered to the participants of the experimental group.

Control group. Participants of the control group were also reminded of the instructions regarding the fundamentals of golf putting. They were then provided a short talk regarding golf equipment. Subsequently they were asked to perform the golf practice sets, during which they were provided feedback on how to improve their putting.

Ego Depletion Manipulation

Following the practice phase, participants were guided to an isolated laboratory room for the ego-depleting task, which involved a computerized attention test. Before the onset and following the completion of the task, participants completed the ego-depletion manipulation check.

Final Assessment

Participants were guided back to the laboratory room with the golf course. The time interval between finishing the depletion task and final assessment was approximately one minute. The final assessment was identical to the baseline assessment. Participants of both groups received no further instructions before or during the final assessment about the fundamental mechanics and techniques of golf putting. However, participants of the experimental group were asked to use the cue word of preference before each putt. The duration of the final assessment was approximately eight minutes. After the completion of the final test, participants of both groups were asked to complete the self-talk self-report again.

2.1.3. Apparatus and Measures

Golf Performance

An indoor golf course was constructed for the performance of golf-putting. The course was covered with special synthetic grass for indoor golf. In total, the straight-lined golf putting green was 5 m long and 1 m wide throughout the course. The course had an inclination of 10% (5.71 degrees) between second and third meter from the end of the course. Thus, meaning that the hole (∅ = 108 mm and depth 10 cm) was on a level ground exactly in the center of the last square meter of the course and circled with white colored chalk. There were no other obstacles on the course, beside the inclination. The first indicator of distance was marked on the green with white tape at 2 m line from the hole, followed up with another indicator every half a meter. A putter type golf club was used for putting the golf ball; however, a tee was not provided upon putting. Golf performance was calculated as the average of successful putts over two sets of 10 putts.

Ego Depletion Task

The ego-depletion manipulation involved a computer-based attention task (WAFG) from the Test Battery for Perception and Attention Functions (WAF tests) of the Vienna Test System (Schuhfried, Mödling, Austria) [20]. For this test, participants were asked to attend a sequence of changes to two stimuli (shapes) and to react when consequent changes occurred on any of these stimuli. Participants were also informed that their reaction time and the correctness of their responses would be recorded. Their reactions were recorded through a designated test panel (Universal Response Panel; Schuhfried). The duration of the depletion task was approximately 15 min.

Ego Depletion Assessment

To assess whether the cognitive task induced a state of ego depletion, a four-item ego depletion manipulation check was used (e.g., "How effortful did you find the task?", "How depleted do you feel at the moment?") [25]. Participants' responses were given on a seven-point scale from 1 (not at all) to 7 (very).

Self-Talk Manipulation Check

Participants of the experimental group were asked following each practice session and the final assessment (a) if they used the designated cue-words, and (b) if yes, to which extent they used them on a scale from 1 (not at all) to 10 (all the time).

2.1.4. Data Analysis

A series of preliminary analyses addressing manipulation checks and baseline difference were conducted to attest the integrity of the experimental findings. Regarding the manipulation checks, these involved (a) one-way MANOVA to test for differences on performance in the depletion task, (b) a two-way ANOVA with one repeated factor (time: before and after the task) and one independent factor (group: control and experimental) to test for differences in depletion scores from baseline to final assessment, and (c) descriptive statistics to assess the use of strategic self-talk from the experimental group in training and final assessment. Regarding baseline differences, a t-test for independent samples was performed to test for differences in golf-putting performance at baseline. For the main research hypothesis, two-way ANOVA with one repeated factor (time: baseline and final golf measurement) and one independent factor (group: control, experimental) was performed to test for differences in golf performance between baseline and final assessment for the two groups. In addition, following the identification of performance differences between the two groups at baseline, a one-way ANCOVA was also calculated with one dependent factor (final putting performance), one independent factor (group: control and experimental), and one covariate (baseline putting performance) to test for differences on performance in the final assessment between the two groups after controlling for differences at baseline.

2.2. Results

2.2.1. Preliminary Analysis

Regarding performance on the depletion task, one-way MANOVA showed a non-significant multivariate effect; $F(2, 59) = 1.08$, $p = 0.347$, $\eta^2 = 0.03$, power = 0.23. Examination of the univariate effects showed non-significant differences between the experimental and the control group on reaction time; $F(1, 61) = 0.15$, $p = 0.700$, $\eta^2 = 0.01$, power = 0.06, and number of mistakes; $F(1, 61) = 1.64$, $p = 0.206$, $\eta^2 = 0.02$, power = 0.24.

Regarding depletion scores, a two-way ANOVA with one repeated factor (time: before and after the task) and one independent factor (group: control and experimental) showed a significant time effect; $F(1, 60) = 56.25$, $p < 0.001$, $\eta^2 = 0.48$, power = 1, and a non-significant group by time interaction; $F(1, 60) = 0.66$, $p = 0.420$, $\eta^2 = 0.01$, power = 0.12, showing that ego depletion increased for both groups following the depletion task, but that no differences were identified between the two groups. Descriptive statistics for depletion task performance and depletion are presented in Table 1.

Table 1. Study 1: Descriptive statistics for control measures and golf putting performance.

	Control Group Mean (SD)	Experimental Group Mean (SD)
Preliminary measures		
Depletion task—Reaction time	0.37 (0.07)	0.38 (0.07)
Depletion task—Number of mistakes	14.65 (17.18)	9.90 (11.46)
Ego depletion before the task	2.07 (1.00)	2.19 (0.69)
Ego depletion after the task	3.11 (1.62)	3.03 (1.04)
Performance		
Baseline putting performance	3.74 (1.81)	2.85 (1.44)
Final putting performance	4.06 (1.55)	3.95 (1.46)

Finally, examination of the strategic self-talk intervention for the experimental group showed consistent use of self-talk in training ($M = 8.61 \pm 1.65$) and final assessment ($M = 8.84 \pm 1.21$).

Regarding baseline differences in golf-putting performance, *t*-test showed a significant effect, $t(60) = 2.14$, $p = 0.037$, with the control group scoring higher than the experimental group.

2.2.2. Hypothesis Testing

Two-way ANOVA with one repeated factor (time: baseline and final golf measurement) and one independent factor (group: control, experimental) was performed to test for differences in golf performance at baseline and final performance. The ANOVA analysis revealed a marginal time by group interaction effect; $F(1, 60) = 4.04$, $p = 0.049$, $\eta^2 = 0.06$, power = 0.50. Examination of the pairwise comparisons showed that performance of the experimental group was significantly increased ($p < 0.001$), whereas no significant change was recorded for the control group ($p = 0.241$). Descriptive statistics for golf-putting performance are presented in Table 1; the pattern of performance change is displayed in Figure 1.

Due to the baseline differences identified in the preliminary analysis, a one-way ANCOVA was also calculated with one dependent factor (final putting performance) one independent factor (group: control and experimental) and one covariate (baseline putting performance). The analysis showed a significant effect for baseline putting performance; $F(1, 61) = 23.94$, $p < 0.001$, and a non-significant group effect; $F(1, 61) = 23.94$, $p = 0.338$, suggesting that when controlling for differences in the baseline assessment, no significant performance differences were evident between the two groups in the final assessment; yet the estimated mean of the experimental group ($M = 4.17$) was higher than that of the control group ($M = 3.85$).

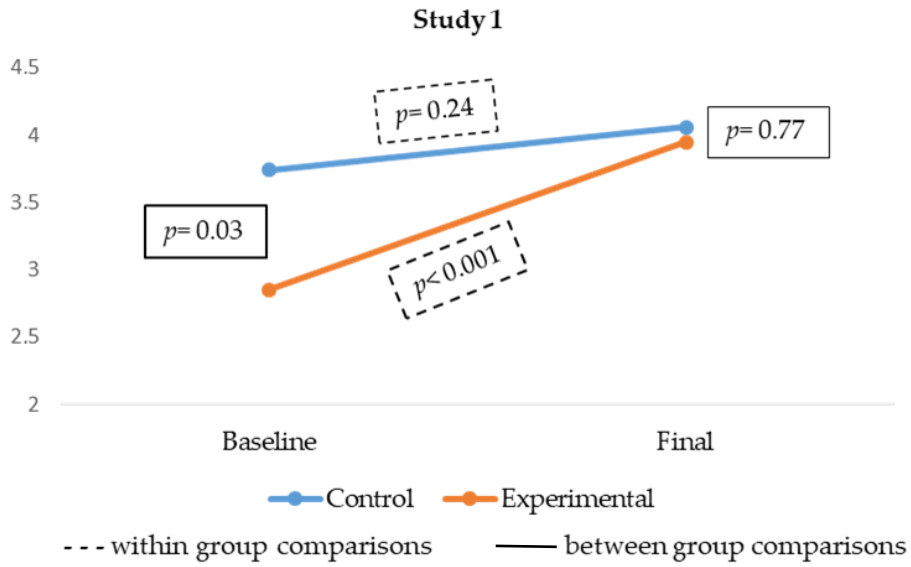

Figure 1. Study 1: Baseline and final golf-putting performance per group.

3. Experiment 2

3.1. Materials and Methods

3.1.1. Participants

Sixty-two sport science students (27 females and 27 males, M_{age} = 19.91, SD = 1.04), different to those in study 1, were recruited and randomly assigned into experimental and control groups. None of the participants had prior experience in golf at a competitive or recreational level. Participants received course credit for their participation in the study.

3.1.2. Procedures and Measures

The institution's ethics committee granted permission to conduct this research (ref: 1322). Prior to the onset of the experimental procedures, participants were informed about the overall protocol and the procedures of the experiment and signed informed consent. The procedures were almost identical with Experiment 1, including the same four phases. The only differentiation was the addition of the divided attention factor. In particular, to introduce divided attention demands to the task, a flag was placed at the side of the putting hole, within the peripheral vision range of participants. A fan was also placed further away and outside the peripheral vision of participants. The fan made the flag wave and not wave in a cycle of approximately eight seconds on (waving) and eight seconds off (not waving). The interval length was chosen after pilot testing to allow the participants enough time to make one shot per cycle, forcing them to shift their attention back to the flag after every shot. Participants were instructed to only attempt the putt when the flag was not waving, thus adding an extra attention parameter and turning the task into a divided attention task. With regard to the strategic self-talk, participants in the experimental group were asked to select one of cues as in the previous experiment and in addition use the word "flag" before the cue they had selected. The same measures with Experiment 1 were applied in addition to recording the number of flag errors, that is, the times that participants attempted the putt while the flag was waving.

3.1.3. Data Analysis

Similarly to the previous experiment, data were analyzed by (a) one-way MANOVA to test for differences on performance in the depletion task, (b) a two-way ANOVA with one repeated factor (time: before and after the task) and one independent factor (group: control and experimental) to test for differences in depletion scores from baseline to final assessment, and (c) descriptive statistics to assess the use of strategic self-talk from the experimental group in training and final assessment. Regarding baseline differences, a t-test

for independent samples was performed to test for differences in golf-putting performance at baseline. For the main research hypothesis, two-way ANOVA with one repeated factor (time: baseline and final golf measurement) and one independent factor (group: control, experimental) was performed to test for differences in golf performance between baseline and final assessment for the two groups. In addition, a t-test for independent samples was calculated to examine differences in flag errors between the two groups.

3.2. Results

3.2.1. Preliminary Analysis

Regarding depletion task performance, one-way MANOVA showed a non-significant multivariate effect; $F(2, 51) = 1.15$, $p = 0.325$, $\eta^2 = 0.04$, power = 0.24. Examination of the univariate effects showed non-significant differences between the experimental and the control group on reaction time; $F(1, 53) = 1.20$, $p = 0.278$, $\eta^2 = 0.02$, power = 0.18, and number of mistakes; $F(1, 53) = 1.50$, $p = 0.226$, $\eta^2 = 0.02$, power = 0.22.

Regarding depletion scores, a two-way ANOVA with one repeated factor (time: before and after the task) and one independent factor (group: control and experimental) showed a significant time effect; $F(1, 52) = 52.91$, $p < 0.001$, $\eta^2 = 0.50$, power = 1, and a marginally non-significant group by time interaction; $F(1, 52) = 3.74$, $p = 0.059$, $\eta^2 = 0.06$, power = 0.47, showing that ego depletion increased for both groups following the depletion task, and that the increase for the experimental groups appeared higher than that of the control group. Mean scores for depletion task performance and depletion are presented in Table 2.

Table 2. Study 2: Descriptive statistics for control measures and golf putting performance.

	Control Group Mean (SD)	Experimental Group Mean (SD)
Preliminary measures		
Depletion task—Reaction time	0.38 (0.07)	0.37 (0.05)
Depletion task—Number of mistakes	13.37 (14.72)	8.96 (11.50)
Ego depletion before the task	2.48 (1.03)	2.13 (1.01)
Ego depletion after the task	3.24 (1.46)	3.46 (1.53)
Baseline putting performance	7.89 (3.26)	7.26 (3.43)
Performance		
Final putting performance	7.30 (3.79)	8.93 (2.82)
Flag errors	0.11 (0.32)	0.00 (0.00)

Finally, examination of strategic self-talk for the experimental group showed consistent use of self-talk in training ($M = 8.93 \pm 1.14$) and final assessment ($M = 9.11 \pm 0.97$).

Regarding baseline differences in golf putting performance, *t*-test showed a non-significant effect, $t(52) = 0.69$, $p = 0.49$.

3.2.2. Hypothesis Testing

Two-way ANOVA with one repeated factor (time: baseline and final golf measurement) and one independent factor (group: control, experimental) was performed to test for differences in golf performance at baseline and final performance. The ANOVA analysis revealed a significant time-by-group interaction effect; $F(1, 52) = 5.07$, $p = 0.029$, $\eta^2 = 0.08$, power = 0.59. Examination of the pairwise comparisons showed that performance of the experimental group was significantly increased ($p = 0.023$), whereas no significant change was recorded for the control group ($p = 0.407$). Descriptive statistics for golf-putting performance are presented in Table 2; the pattern of performance change is displayed in Figure 2.

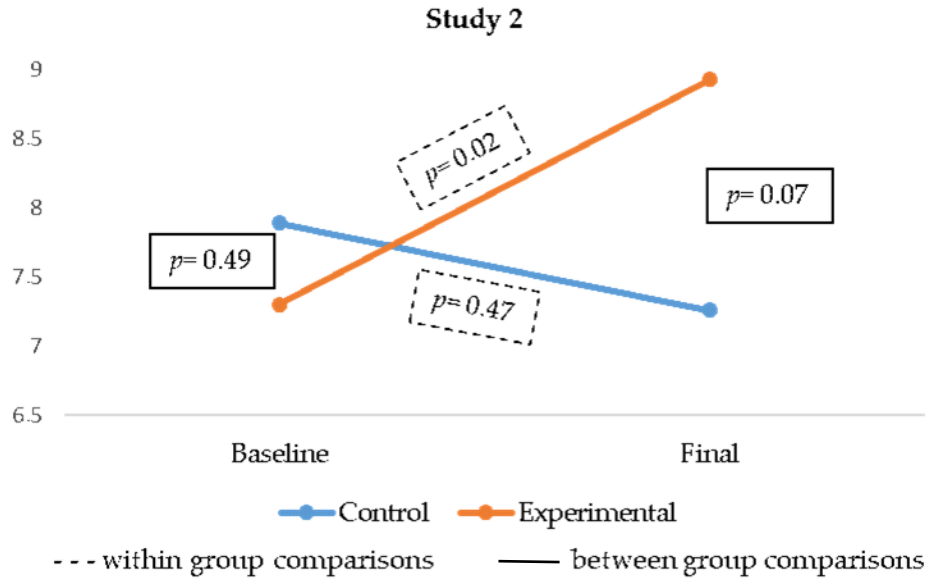

Figure 2. Study 2: Baseline and final golf-putting performance per group.

Finally, a *t*-test was calculated to examine differences in flag errors between the two groups. The analysis showed a non-significant effect; $t(52) = 1.80$, $p = 0.083$. Examination of the descriptive statistics showed no mistake for the experimental group and only three mistakes in total for the control group.

4. General Discussion

The purpose of the present research was to examine the effect of a strategic self-talk intervention on two variations of a golf-putting task under conditions of ego depletion. In the first experiment, a simple yet attentionally demanding golf-putting task was employed, whereas in the second, an additional divided-attention challenge was induced to add an ecologically valid factor to this laboratory-based research. The results, altogether, showed that performance of the experimental strategic self-talk groups improved in both experiments despite the induction of depleted states, whereas performance of the control groups did not change.

Several manipulation checks were used in both experiments to secure the methodological integrity. Two such checks involved the manipulation of ego depletion. First, performance in the ego depletion tasks, as recorded through reaction time and mistaken responses in a computerized attention task, was assessed to screen for individual differences in attentional skills. Second, changes in self-reported states of ego depletion before and after the task were assessed to ensure that the task had a depletion effect and that this effect was similar for the experimental and control groups. The analyses showed no differences between the study groups. The results indeed supported the effectiveness of the attention task to induce ego depletion and thus the integrity of the experimental manipulations. Finally, a manipulation check regarding the use of self-talk cues confirmed that through the intervention, participants became familiar with the use of strategic self-talk and used it consistently. This result is important since practicing self-talk has been identified as a significant moderating factor for effectiveness of strategic self-talk [14]. In combination, the results from the manipulation checks in the two studies enhance our confidence in the findings.

The results from both experiments showed that performance of the control groups remained unchanged, whereas that of the experimental groups improved. Although it was hypothesized that the control groups would show decreased performance and the experimental groups would display similar scores compared to their baseline measurement, these results are justifiable and still supportive of the buffering effects of strategic self-talk for ego depletion effects. In particular, the results may be explained by a learning effect

introduced during the baseline assessment and the practice that participants received in golf-putting. Participants had the opportunity to practice the skill, with 30 putts between the baseline and final assessment. Therefore, participants had the chance to improve their putting skills, which under non-depleted conditions, may have increased their scores. Thus, the learning effect in combination with the ego-depletion effects caused the control groups' score to remain unchanged and the experimental groups' scores to increase due to the added effect of strategic self-talk.

Recent research has examined the effectiveness of strategic self-talk on attention and performance under adverse conditions. In a study reporting two experiments, one lab-based involving a computerized task and one field-based involving a basketball free throw, it was found that participants using strategic self-talk performed better than control participants [21]. Similarly, two studies have explored the effects of strategic self-talk on task performance under conditions of physical fatigue. In the first, it was shown that strategic self-talk helped countering the negative consequences of physical exhaustion on a cognitive attention task [26]. In the second, it was found that strategic self-talk helped basketball players to maintain their free throw performance following a shuttle run task, whereas performance of players in the control group decreased significantly [27]. Mostly related to the present study, in a lab experiment it was found that participants using strategic self-talk performed better in a selective attention computerized task than controls [23]. In the ego depletion literature, several studies have evidenced the debilitating effects of ego depletion on sport-related performance [11]. Even though in the present experiments no debilitating effect was found, this, as argued, can be attributed to the learning effects. Therefore, it appears that the present research adds to the relevant literature evidence regarding the effectiveness of strategic self-talk to counter performance debilitating factors, in particular, ego depletion.

One essential interpretation of the facilitating effects of strategic self-talk on golf performance under the state of ego depletion can be drawn from elevated attention functionality. From the notion that attention regulation is a core element in self-control and its successful functionality is determined by the strength of available self-control power [1], experimental studies have shown that depleted participants are worse at paying attention to task relevant stimuli, as well as directing attention to task-relevant stimuli and more susceptible to external distractibility [8,10,12,28]. As previous studies have shown beneficiary effects of self-talk on improving attention functions [19], as well as countering internal [22] and external [21] distractions, the use of strategic self-talk in the current study might have helped participants to overcome the reduced attentional functions caused by ego depletion.

Stronger evidence for this assumption can be drawn from the second experiment, where a divided attention factor was introduced, thus making the task more demanding from an attentional perspective. Considering the assumptions of the strength model of self-control [3] and serial processing [29], attention is a limited-capacity resource and there is only one processing channel available in the brain to execute a task. Therefore, when an individual is asked to attend to different stimuli, the processing of these tasks will happen sequentially; for our experiment this would mean that participants were not able to focus on the golf-putting until they completed processing the flag stimulus. Further, serial processing postulates that in such a series, performance of the second task will be mostly affected. Indeed, in the second experiment, it was found that a negligible number of mistakes were made in relation to the sequentially first stimuli (flag mistakes), whereas subsequent performance for the control group was hindered. Considering these assumptions, the present findings seem to provide further support for an attentional interpretation of the beneficial effects of strategic self-talk on performance.

4.1. Limitations

Some limitations regarding this study have to be considered. First, the baseline differences for golf-putting performance. In the first study, an unexpected difference was identified, with participants of the control group scoring higher than the experimental

group. Even though the results showed that performance of the control group did not change whereas that of the experimental group increased, this finding should be considered with caution. Yet, in the second experiment, where no baseline differences were identified, the results were similar, thus increasing our confidence in the findings.

Another limitation involves the impact of the learning effect that concealed the negative effects of ego depletion on putting performance. The absence of a non-ego depletion control group means that it is not possible to establish the size of the learning effect; therefore, the exact effect of the ego depletion on the golf performance cannot be determined. This limits the conclusions that can be drawn from our research, as our interpretation is based on the assumption that the state of ego depletion had a negative impact on performance. Even though there is considerable empirical evidence regarding the detrimental effect of ego depletion in sport tasks that can justify our interpretation [11], further research could employ designs including non-depleting conditions to provide more robust evidence.

Regarding the research setting, the study, despite utilizing a sport task, was conducted in a controlled laboratory environment. As a consequence, the results cannot be generalized with confidence to the real golf field, as golf is usually played outdoors and several environmental factors can influence the golf-putting performance. For example, wind and land relief are among other factors that athletes need to pay attention to while performing a golf putt, and although wind was simulated in the second experiment to induce the divided attention factor, it did not influence the trajectory of the ball. Future experimental studies should aim towards higher ecological validity by conducting field experiments.

Finally, the boundaries of the implications evolving from this study when considering the nature of the sport task should be acknowledged. Golf-putting is a fine, closed task requiring skills like precision, accuracy, and hand-eye coordination, but also high levels of composure and attention. Thus, any postulations stemming from this research are limited within tasks with similar characteristics and should be cautiously interpreted within the wider sport sphere. Future research could test the premise of the present findings in task with different demands to enhance the generalizability of our findings.

4.2. Implications

In summary, the current study provides useful insights for research and applied practice, in particular for fine, closed sport skills and even more so for golf, with regard to the value of strategic self-talk for buffering the negative effects of diminished self-control states and assisting performance. The present findings extend the growing self-talk literature and assist the enhancement of self-talk theory, by adding evidence regarding the effects of strategic self-talk for countering the impact of ego depletion. Following-up the evidence regarding the positive effects of strategic self-talk on golf performance [17] but also on a cognitive attention task ego under condition of ego depletion [23], this study explored such effects on a golf-putting task. The results confirmed that applying strategic self-talk assisted golf-putting performance when in a state of ego depletion. Furthermore, as attention is regarded as imperative to golf performance and ego depletion diminishes the functionality of attention, the results support the interpretation of facilitating effects of self-talk on attentional functions under the state of ego depletion. Our findings suggest that sport psychologists, but also sport coaches and educators, should integrate strategic self-talk when developing golf skills, in particular when athletes gets depleted in training, to improve the learning process and further transfer such self-talk in competition to enhance performance.

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