



University of Thessaly

Department of Physical Education and Sport Sciences

Greece

**The effects of self-talk in a golf putting task under the condition of
ego depletion**

by

Laur Nurkse

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Approved by supervising committee:

Prof. Antonis Hatzigeorgiadis, PhD

Prof. Nikos Comoutos, PhD

Prof. Yannis Theodorakis, PhD

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Main supervisor 1: Antonis Hatzigeorgiadis, PhD

Supervisor 1: Nikos Comoutos, PhD

Supervisor 2: Yannis Theodorakis, PhD

Abstract

The effects of ego depletion have shown negative consequences on various sport tasks. Recently, self-talk emerged as a successful method to counteract ego depletion in a cognitive task (Gregersen et al., 2017). Thus, the current study aimed at extending this line of research and examined the effects of a self-talk intervention on a golf putting task in a state of ego depletion. Sample consisted of 61 undergraduate students ($M_{\text{age}} = 18.59$, $SD = 1.04$). The mixed between-within design with repeated measures experiment was conducted in a single session with four phases. Upon completion of the baseline measurement, participants were randomly assigned into control and experimental groups. Subsequently, both groups went through a training phase, during which the participants of the experimental group received a self-talk training intervention. The ego depletion manipulation took place prior to the final measurement, where participants performed a golf putting task with a weakened self-control strength. The two-way ANOVA analysis revealed a marginal time by group interaction effect, $F(1, 39) = 3.89$, $p = .056$. Furthermore, pairwise comparisons revealed that experimental group participants significantly increased their golf putting performance ($p < .001$), whereas the performance for the control group remained stable ($p = .37$). The results of the study suggest that self-talk can be a viable method to facilitate sport performance in a state of ego depletion.

Keywords: self-talk mechanisms, self-talk intervention, golf performance, self-control strength

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Literature review

Mechanisms of self-control strength and ego depletion

Volitional self-control may determine much of the success of executive actions. According to Baumeister, Bratslavsky, Muraven and Tice (1998), numerous essential executive functions of the self contain volition. For example, making decisions and choices, taking responsibility, initiating as well as inhibiting behaviour and carrying out those behavioural actions. However, not all human actions involve deliberate initiation and control of the self, as much of the human behaviour is considered to be influenced by automatic or non-conscious functional processes (e.g. Bargh, Chen & Burrows, 1997). Nevertheless, a share of the self involves deliberate, conscious and controlled reactions by the self and hence it is important to manage that share effectively (Baumeister, Muraven & Tice, 2000), as people able to exert volitional self-control in a particular motion of action are more likely to succeed in this specific execution (Baumeister & Heatherton, 1996). In contrast, inability to exert self-control at specific moments can lead to an inability to perform at optimal level (Baumeister & Heatherton, 1996). Thus, deliberate self-control is a valuable resource.

Research has further noted that self-control is associated with self-regulatory mechanisms. Van Damme, Crombez, Goubert and Eccelston (2009) claim that the definition of self-regulation is explained by the capability of a person to exert control over the self. Earlier self-regulation theory findings have suggested that some form of energy or strength could be involved in the acts of volitional self-control. Based on a review of multiple research literatures, Baumister, Heatherton and Tice (1994) proposed that the evidence about deterioration of controlled self-regulation fits a model of mental strength depletion, resembling a muscle that can get fatigued. The implication noted that deliberate self-regulation depends on a limited resource of self-control that is vulnerable to deterioration over repeated exertions (Baumister, Heatherton & Tice, 1994). Besides this, Muraven and Baumeister (2000) propose that self-

regulatory failure is associated with many daily life problems and difficulties that people encounter and therefore, according to Hagger, Wood, Stiff and Chatzisarantis (2009), physical health related behavior may also result from the current state self-regulatory determinants. Thus, as there is a diminished capacity of self-control available for a specific time period, this can elicit a poor condition for the upcoming performance that also requires self-control.

The strength model of self-control (Baumeister, Vohs & Tice, 2007) has given theoretical insight by suggesting that self-control refers to the capacity for triggering one's acts of volition, as well as enables a person to alter them by restraining or overriding an initial act, thereby making a different response possible. Baumeister and Vohs (2007) continued 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 (Muraven, Tice & Baumeister, 1998). Baumeister et al. (1998) referred to a lessened state of self-control strength as ego depletion. The term ego depletion can be therefore used to define a notion of 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 (Baumeister et al., 1998). The core idea that ego depletion entail 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.

Several lab-controlled experiments have examined ego depletion by applying a two task paradigm design. Studies indicate that in cases where participants are given two consecutive tasks, that both require an act of self-control, the first one drains most of the available self-control power and subsequently the performance on the second task is impaired (Baumeister et al., 1998; Vohs, Baumeister & Ciarocco, 2005). Additionally, it is a global resource, as this also

occurs when the second task demands an entirely different type of self-regulation, therefore meaning it is not domain specific (e.g. Vohs & Schmeichel, 2003). For example, Muraven, Tice and Baumeister (1998) showed that when participants were suppressing a forbidden thought, they gave up more quickly on a subsequent anagram task than the control group. Furthermore, Baumeister et al. (1998) showed in their multi experimental study that all four experiments indicate a pattern of negative effects of exerted self-control reserve. They found that (a) an initial act of countering autonomous choice impaired subsequent self-control in a puzzle task, (b) a responsible decision impaired self-control in the following persistence task, (c) prior use of self-control in affect alteration decreased performance in a problem solving task and (d) prior act of self-control led to increased passivity. These convergence of findings suggest that prior exertions of self-control do entail a psychic cost and deplete some scarce resource. More recently, Martin Ginis and Bray (2010) suggested that the limited cognitive strength model approach should be closely considered as this might explain why people flop with exercise precision, intensity and duration, in other words decreased performance.

Ego depletion effects in sport task performance

Numerous studies have investigated persistence in performance and adherence to exercise in relation to maintaining self-control at the task. In particular, several studies have explored ego depletion phenomenon by using an exercise-related task, namely a hand grip task, where self-control strength needs to be maintained to resist the urge to stop the task. Ego depletion effects were measured by the duration and strength of sustaining a hold on an isometric handgrip (Bray, Graham, Ginis & Hicks, 2012; Bray, Ginis, Hicks & Woodgate, 2008; Ciarocco, Sommer & Baumeister, 2001; Graham & Bray, 2015; Muraven & Shmueli, 2006). Even though the manipulation of ego depletion culminated in performance decrements in each of the post-manipulation task, it cannot be generalized to aerobic or fitness exercises that may require even more cognitive self-control in order to be consistently performed.

Wagstaff (2014) revealed in his study that mentally depleted participants completed a cycling task significantly later and demonstrated higher ratings of perceived exertion than the control group participants. In support, Englert and Wolff (2015) and Marcora, Staiano and Manning (2009) have found similar results in a cycling power output persistence task. Moreover, a repeated measure design study showed that competitive athletes completed fewer press-ups and fewer sit-ups in the state of ego depletion, even though these exercises were well established in their weekly exercise routine (Dorris, Power & Kenefick, 2012). Martin Ginis and Bray (2010) found that participants who were cognitively depleted using a Stroop task, planned to exert significantly less effort and intensity in an upcoming cycling task compared to the control group. Additionally, the decreased planned workload predicted a reduced adherence for a subsequent 8-week period. They concluded that all together these results reveal how ego depletion can negatively influence exercise effort and planning for the imminent aerobic exercises in the future as well as explain episodes of exercise non-adherence in everyday life (Martin Ginis & Bray, 2010). Similar studies examining self-control strength and exercise adherence have found corresponding results (Bertrams & Englert, 2013; Schöndube, Bertrams, Sudeck & Fuchs, 2017; Toering & Jordet, 2015). In summary, the proposed literature reveals conclusive results how performing under ego depletion limits exercise persistence and adherence.

Research has also examined ego depletion effects in sport performance including reaction time trials, impulse control and performance accuracy measurements. For example, in a study by McEwan, Ginis and Bray (2013), 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, thereby less adept in controlling their impulses. Another study regarding dart throwing demonstrated that when one's self-control is depleted prior to the perceptual-motor task the performance is impaired and attention regulation cannot be

maintained (Englert, Zwemmer, Bertrams & Oudejans, 2015c). In addition, decreased accuracy scores in darts along with increased anxiety levels were found by Englert and Bertrams (2012). As suppressing thoughts and images require cognitive resource and consequently deplete self-control, a study regarding golf performance showed that attempting to suppress negative performance related images prior to each shot resulted in debilitating behavioural manifestation as the golf putting performance decreased (Beilock, Afremow, Rabe & Carr, 2001).

Furthermore, a study examining basketball free-throw performance showed that participants with depleted self-control strength displayed higher inaccuracy in performance scores (Englert et al., 2015c). Additionally, investigation of reduced self-control strength on impulse regulation in sprint reaction times indicated that participants in the experimental group had a significant decrease in their reaction times (Englert & Bertrams, 2014). A follow-up study also indicated that ego depleted participants with-out 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 (Englert, Persaud, Oudejans & Bertrams, 2015b). Overall, a meta-analysis of 83 studies revealed that ego depletion has a significant effect ($d = 0.62$) on tasks that include self-control performance (Hagger, Wood, Stiff & Chatzisarantis, 2010). Despite a recent multilab replication of the ego depletion effect revealed a smaller effect (Hagger et al., 2016), a subsequent review paper by Englert (2016) insisted that findings from sport and exercise psychology are more appropriate to conceptualize the moderation effect, but still requested for more in-depth research for clarification.

Methods of counteracting ego depletion

Nevertheless, as the numerous studies thus far notably indicate that a depletion of self-control strength can impair subsequent self-control demanding performance in several various domains, it highlights the necessity for strategies that could prevent or neutralize the detrimental effect and consequently facilitate the following performance. In particular, training self-control

capacity, implementing rest, increasing glucose in the bloodstream and providing some cognitive support have been proposed by research as potentially effective methods.

With regard to self-control practice, Muraven and colleagues (1999; 2000) found improved self-control performance after series of self-control training sessions and repeated exercise. Moreover, a meta-analysis (Hagger et al., 2010) across seven studies examining the effects of self-control training on subsequent self-control performances reported a large positive significant effect. These findings demonstrate that practice should be considered in terms of attenuating the ego depletion effect. Periods of relaxation could also help to restore the self-control resource as a function of time of rest, similar to a muscle that requires a period of recovery after a workout. Few studies have tested this hypothesis by applying a period of rest (Englert & Bertrams, 2016; Tyler & Burns, 2008) or mindfulness meditation (Friese, Messner & Schaffner, 2012) in-between the two self-control acts and revealed that participants who had the opportunity to rest or meditate exhibited significantly greater second-task performance. Studies have also provided evidence that glucose supplement intake increases depleted participants' performance in the final task opposed to receiving sweet placebo (DeWall, Baumeister, Gailliot, & Maner, 2008; Gailliot et al., 2007). However, multiple studies have more recently provided contrasting evidence and therefore questioned the importance of blood glucose in the ego depletion research domain (Beedie & Lane, 2012; Molden et al., 2012).

Furthermore, based on the positive establishment of the benefits of autonomy support in psychological research literature, few studies have examined this in regard to ego depletion. For instance, it has been found that by inducing depletion through autonomous choice participants perform better in a tennis accuracy task than the control group (Englert & Bertrams, 2015). This finding is in line with Muraven (2008), who noted that high perceived autonomy in the depleting task is more beneficial for the upcoming task than externally enforced procedure. On the other hand, autonomy-supportive instructions for the second task may assist self-control

performance in the short term, but not in long term (Graham, Bray & Ginis, 2014). In addition, implementation intentions also seem to provide a strategy to prevent ego depletion effects, as they had a positive significant effect on depleted participants' Stroop test performance (Webb & Sheeran, 2003). Taken together, the findings suggest that there are methods that might aid the process of a depleted mind.

However, researchers have argued that self-control training only delays the time until the state of ego depletion occurs and athletes do not always have time to relax or consume glucose rich supplements during sport competitions and instead suggested another method (Gregersen, Hatzigeorgiadis, Galanis, Comoutos & Papaioannou, 2017). A particular cognitive strategy that has been suggested as a method to alter self-regulatory aspects of the self along with enhancing athletic performance is self-talk (Hatzigeorgiadis, Galanis, Zourbanos & Theodorakis, 2014). Specifically, the recent by Gregersen and colleagues (2017) examined whether strategic self-talk can offset ego depletion in a subsequent selective attention test. The results indicated that experimental group participants reached significantly higher percentage of correct answers and were able to accomplish significantly faster reaction times in the attention test compared to the control group. Thus, considering these results, self-talk may be an effective strategy and should be scrutinized further, as more in-depth examination is necessary in terms of replenishing self-control and countering the ego depletion effects, especially regarding performance in sport tasks.

Self-talk and its effects on sport task performance

A personal inner dialog of communication might consist of single words, fragments phrases or complete sentences. In the field of sport psychology, Hatzigeorgiadis and colleagues (2014) distinguished four aspects of self-talk – tone, content, generation and expression. To begin with, the tone of self-talk can be positive, negative or ever neutral. The second dimension of content refers that self-talk entail either motivational or instructional intrinsic management.

Specifically, motivational self-talk is aimed at reinforcing intentional activity or effort and instructional self-talk is aimed at guiding the technical, tactical or kinesthetic elements of the game for the benefit of the athlete. The generation aspect of self-talk can either be inherent or strategic. Inherent or automatically originated self-talk happens as a reaction to a situation and therefore is without any preparation or planning. Strategic generation however, is planned and self-initiated by the athlete in a systematic way as a mental self-regulatory strategy for the upcoming performance. With regard to the form of expression, self-talk can be expressed via audible external or inaudible internal messages to the self.

The relationship between self-talk and sport performance has been studied in a wide range of various sports and proven to be effecting in enhancing performance. The overall effect size of self-talk on individual athletic performance is moderate ($d=0.48$), as shown by a comprehensive meta-analysis with 32 studies (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011). Hatzigeorgiadis and colleagues (2011) additionally point out several moderating factors on the established effect size that are also relevant regarding the purpose of this study. For instance, studies that implemented a training phase reported higher effects than studies that only had a short familiarization with self-talk. They also found a significant difference in experience, as novel learners are more favoured to benefit from self-talk in comparison to more experienced athletes. Despite these results, the authors emphasize that self-talk is still considered an effective psychological skill even for the more experienced athletes. More specifically, regarding the purpose of this study, self-talk was more effective in fine tasks that require precision and accuracy as opposed to gross tasks that require more strength and endurance. Overall, the results and moderating factors regarding self-talk and athletic performance show a robust positive influence of this specific psychological skills (Hatzigeorgiadis et al., 2011).

Self-talk and golf performance

Types and frequencies of self-talk usage as a performance enhancing strategy has also been investigated specifically in golf. For example, Hayslip, Petrie, MacIntire, & Jones (2010) examined self-talk utilization among golfers in major national golf competition. The results indicated consistent differences in the use of psychological skill across skill level along with positive self-talk predicting higher scores in performance. Studies have also aimed to provide insight into the type and frequency of self-talk use among golfers (Arnold, Baltzell & Hayden, 2016; Dickens, Van Raalte & Hurlburt, 2017). Examining the concurrency of real-time verbalization and retrospective reports of self-talk use, Arnold, Batzel and Hayden (2016) found inconsistent results specifically with regard to the content and tone of self-talk by comparing the two sets of data. Nevertheless, instructional and neutral tone self-talk accounted for the largest percentage of the participants' verbalized self-talk during golf performance. Moreover, Dickens, Van Raalte and Hurlburt (2017) report by using descriptive experience sampling method that self-talk is a frequent mental strategy element of golfers with higher occurrence during competition than in training. Besides this, intrinsic expression of self-talk was reported as being more common than extrinsic expression (Dickens, Van Raalte & Hurlburt, 2017). This is in line with Bois, Sarrazin, Southon and Boiché (2009), who showed similar consistent use of self-talk strategies by professional golf players. In summary, research has an adequate overview about the types and frequencies of self-talk use in golf.

In addition to self-talk's prominence in golf, the effects of self-talk in golf performance have been under investigation as well. In particular, Harvey, Van Raalte and Brewer (2002) examined long-shot golf performance in regard to positive, instructional, negative and no self-talk. The participants had to self-select self-talk cues from a list of 20 items for each group and had 2 minutes to familiarize with the cues. The results revealed significant group effects for performance consistency, with the instructional self-talk group performing more consistently

than the negative and control group. Whereas, in terms of accuracy, there was no significant group effect. Moreover, negative self-talk was inversely correlated to consistency and accuracy of the golf performance. In contrast to Hayslip, Petrie, MacIntire and Jones (2010), the more positive self-talk golfers reported using the worst their performance accuracy (Harvey, Van Raalte & Brewer, 2002).

A study examining golf putting performance by Peluso, Ross, Gfeller & LaVoie (2005), found that participants who expressed internalized form of instructional self-talk scored better results in comparison to external and control group. The findings regarding self-talk and golf performance yield an interesting mix of effects. It has to be noted, that differences in golf task characteristics (putt vs long shot), self-talk expression (intrinsic vs extrinsic) and utilization (pre-determined vs self-selected) have to be considered when interpreting the results. Besides this, self-talk training versus short familiarization should also be taken into account, as Hatzigeorgiadis and colleagues (2011) notably point out in their meta-analysis. Nevertheless, the literature displays an interesting interpretation that self-talk should be considered as an essential feature of golf performance. Furthermore, there is one specific cognitive aspect of an athletic performance that self-talk is ought to facilitate.

Importance of attention in sport performance

Moran (2009) has identified the control over attention as one of the most essential cognitive skills to a successful athletic performance. Moreover, attention regulation holds an important influence over motor skills learning and performance overall (e.g. Wulf & Prinz, 2001). This is in line with Abernethy, Maxwell, Masters, Kamp and Jackson (2007), who also stressed the relevance of efficient attention regulation in cognitively demanding fine perceptual-motor tasks (e.g. golf), as irrelevant stimuli (e.g. negative thoughts) need to be blocked out, and instead, shift focus onto prioritized target (e.g. hole in golf putt). Since, the most important aspect of self-control is attention regulation with the supplementary control to regulate it

(Baumeister, Vohs & Tice, 2007), this essential variable needs to be closely looked at when defining lapses of self-control in sport performance. Accordingly, Inzlicht and Schmeichel (2012) report in their ego depletion overview that loss of attentional control in the shift of attentional regulation is one of the main reasons of performance decrement in the upcoming task. Furthermore, Baumeister et al. (1998) concluded that attention control is a variable of self-control and is determined by the strength of available self-control power an individual holds at a specific moment. Therefore, if self-control strength is temporarily depleted and these resources are unavailable, athletes seem to be more inattentive and absent-minded, leaving less attention available for the present task, which ultimately leads to impaired performance.

The assumption that efficient attention regulation cannot be maintained under the state of ego depletion in fine perceptual-motor tasks has received further empirical support from a recent study examining darts (Englert et al., 2015c). More specifically concerning golf performance, certain features of golf, especially the concentration aspects to the target and of the technical motor motions, clearly demand a rigorous management of attentional control. Findings by Bois, Sarrazin, Southon and Boiché (2009) support this, as attentional control was one of the psychological characters that was identified as an important determinant for performance success among professional golfers. Furthermore, golf performance requires continuous attentional monitoring for excellent skill execution (Beilock & Gray, 2012). This is in line with Beilock, Bertenthal, McCoy and Carr (2004) and Hellström (2009), who also emphasized the importance of attentional focus structures prior to a golf performance. Moreover, since target-shooting operations are under attentional control in golf, especially during the acquisition and the improvement phases, several cognitive activities may be activated simultaneously, guided by attention. According to Vickers (2012), who has studied the quiet eye in golf, one of the characteristics of elite putting performance is the ability to direct

the focus of the visual gaze to appropriate movement cues of the physical action at the right time. Thus, emphasizing again the crucial aspect of attentional control over movement systems.

Effects of self-talk on attention in sport performance

Most important for the present work is defined by Zimmerman (2000), describing the imperative role of self-instruction in altering attention functions in self-regulation. Interestingly, early studies of self-talk research (e.g. Ziegler, 1987) have already pointed to the attentional regulatory benefits of self-talk, as for instance, instructional self-talk has been held in respect of directing attention as well as changing the focus of attention when required (Mallett & Hanrahan, 1997). As the self-talk research grew, it became more evident with various studies and reviews that self-talk with its divergent forms has different effects of task performance and may hence operate via various self-regulatory mechanisms (Hatzigeorgiadis, Zourbanos & Theodorakis, 2007). Moreover, for a more sophisticated view encompassing potential self-talk mechanisms through which it operates and influences performance, Hardy, Oliver and Tod (2009) proposed a conceptual framework of clarification with four dimensions: cognitive, motivational, affective and behavioural. Among the consequences of self-talk, attentional mechanisms of cognition are mentioned with prominence. More specifically, the cognitive mechanisms entail information processing, concentration, attentional control and attentional style (Hardy, Oliver & Tod, 2009). Van Raalte, Vincent and Brewer (2016) support the attention regulating abilities of self-talk in their recent sport-specific model of self-talk. However, in their follow up overview of self-talk effects, Tod, Hardy and Oliver (2011) argued that despite the substantial support for positive effects of self-talk on performance factors, the precise rationale for self-talk effects for each of the self-regulatory mechanism is still to be clarified.

Nevertheless, the expanding evidence of self-talk and attention related research indicates multiple effects of self-talk on attentional functions. For instance, early preliminary evidence regarding self-talk effects on attention was provided by athletes in their self-reports

following self-talk interventions (e.g. Perkos, Theodorakis & Chroni, 2002; Thelwell & Greenlees, 2003). Furthermore, the beneficial effects of self-talk strategies on attention have been identified in case studies (Cutton & Hearon, 2014), qualitative inquiries (Miles & Neil, 2013; Wadey & Hanton, 2008) and numerous evidence from experimental studies (e.g. Galanis, Hatzigeorgiadis, Zourbanos, Papaioannou & Theodorakis (2016). In their review paper on self-talk and attention, Hatzigeorgiadis and Galanis (2017) suggested that the evidence of self-talk effects on attention functions can be categorized in two strongly related but distinguishable themes.

Firstly, findings supporting beneficiary effects of self-talk on attentional focus and improved overall attentional performance. For example, studies have shown how self-talk assists in directing attention efficiently in tennis and running (Landin & Hebert, 1999; Mallett & Hanrahan, 1997) and altering attentional foci in golf (Bell & Hardy, 2009). Additionally, athletes have noted implementing self-talk for variety of attention-based outcomes (e.g. enhancing concentration and attentional focus; Chroni, Perkos & Theodorakis, 2007; Theodorakis, Hatzigeorgiadis & Chroni, 2008). More specifically, Galanis et al. (2016) conducted series of experiments to examine the effects of self-talk on six attentional domains with the Vienna Test System, based on Sturm (2005) taxonomy of attentional dimensions: (1) intensity – alertness, sustained attention and vigilance; (2) selectivity – selective, focused and divided attention; (3) spatial attention. All together, the analysis showed that, in 16 out of 17 tests, the experimental group produced faster reaction times than the control group, encompassing a meta-analytic large effect size ($d = 0.91$).

Secondly, findings supporting how self-talk can help countering the aversive effects of internal and external distraction. In particular, Hatzigeorgiadis, Theodorakis and Zourbanos (2004) examined the occurrence of distracting thoughts (cognitive interference) during precision and power task performance. In both experiments cognitive interference declined for

the self-talk groups. Similar results have been replicated in a swimming task (Hatzigeorgiadis, Zourbanos & Theodorakis, 2007). Regarding external distractions, results from both the lab and field have found facilitating effects of self-talk on shifting attention away from the external distraction and enhancing attentional performance under the distracting conditions (Galanis, Hatzigeorgiadis, Comoutos, Charachousi & Sanchez, 2017).

These findings are consistent with early suggestions of Landin (1994) and Nideffer (1993) that verbal self-instructive cues may lead to enhanced attention, increased attentional focus as well as direct and redirect performers' attentions to task relevant aspects. Overall, the studies revealed insightful and valuable support for the proposed hypothesis of beneficial effects of self-talk on variety of attentional functions. The findings involving cognitive measures after self-talk manipulation of attentional regulation, examination of attentional focus during performance and direct measurements of attentional performance and its maintenance, even under distracting conditions, provide strong evidence that self-talk may be a viable cognitive strategy enhancing attentional regulation in attention thwarting conditions.

Aim of the study

In conclusion, self-control strength is a limited resource (Baumeister et al., 1998), which among other performance decrement consequences negatively influences attentional functions for the upcoming performance (Englert et al., 2015c). The lessened self-control strength or ego depletion even provides a stronger predisposition for the distractibility of external noise (Englert et al., 2015a). Attentional mechanisms have been reported as essential to a successful sport performance (Moran, 2009), as well in golf (Bois, Sarrazin, Southon & Boiché, 2009). Moreover, considering that self-talk has been proposed as a systematic strategy to facilitate athletic performance and attentional self-regulatory mechanisms (Hatzigeorgiadis et al., 2011; Hatzigeorgiadis & Galanis, 2017), even under external distracting and attention hampering conditions (Galanis et al., 2017), this cognitive strategy could provide a viable strategy to

counter ego depletion. Furthermore, as Gregersen et al. (2017) already demonstrated that self-talk counteracts ego depletion in a computer based attention task, this needs to be replicated in an authentic sport task. Thus, as ego depletion is shown to impair athletic performance and even more so attention functions regarding performance and given self-talk's strong enhancing theoretical and empirical links with performance and attention regulation, self-talk appears to be a potential mediatory strategy worthy of a closer examination regarding ego depletion in sport. Therefore, the present study aimed at exploring self-talk effects on counteracting ego depletion in a golf putting task. Based on previous literature, it was hypothesized that in the state of ego depletion the performance scores for the control group would decrease, whereas the performance scores for the experimental group would increase due to self-talk intervention.

Method

Sample and Apparatus

Participants were collected via convenience sampling. Overall, 61 students (30 females and 31 males, $M_{\text{age}} = 18.59$; $SD = 1.04$) from the undergraduate programs of physical education and sport science were invited to the study. 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.

Ego depletion task. The procedure of ego depletion was conducted through a divided attention task (unimodal visual test form S1 – standard form (WAFG)) on the Test Battery for Perception and Attention Functions (WAF tests; Sturm, 2006) of the Vienna Test System (Schuhfried, Mödling, Austria). Stimuli were presented on a 20-inch LCD widescreen computer monitor (screen dimensions of 1280x720 pixels). Participants were entering their responses on a designated test panel (Universal Response Panel; Schuhfried).

Golf course and equipment. 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 meters long and 1 meters 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 ($\varnothing = 108$ 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. First indicator of distance was marked on the green with white tape at 2-meter line from the hole, followed up with another indicator in every half a meter. A putter type golf club was used for shooting the golf ball, however, a tee was not provided upon putting. All balls were standard kind with similar white color and weighing approximately 45 grams.

Procedure

Institution's ethics committee granted a permission to conduct this research (reference: 1-4/7-2-2018). Whole experiment was completed in a single 1-hour-long session. A true experimental design was implemented in a laboratory setting. The experiment protocol consisted of baseline assessment, training intervention with or without self-talk, induction of ego depletion and a final assessment. According to the aforementioned experiment protocol the experiment was divided into four phases. Each participant was tested individually in a quiet and controlled laboratory environment.

First phase - baseline assessment. First, participants who agreed to participate received information for the requirements of the experiment, signed a consent form and filled in a short self-report of demographic data. All participants were informed about the overall protocol and the procedures of the experiment. Subsequently, the baseline assessment of golf putting performance took place. All participants were informed about the main aim of the task that was to put 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. Next, participants were informed about the protocol of the baseline assessment – 2 sets of 10 putts at 2-meter line from the golf course with 30 seconds of pause between the sets. Participants were told that the score of these two sets will be recorded as a summarized score. To keep the flow of putts, after every putt one research assistant cleared the ball off the course, while a second assistant was placing a new one on the 2-meter 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 8 minutes.

Second phase - training program and self-talk intervention. Upon completing the baseline assessment, the forthcoming procedure continued depending on the group the participants were involved with. The purpose of the training phase was to ensure the practical difference in the two groups by equipping the experimental group participants with essential information about self-talk and practicing self-talk in golf performance for the final assessment. The training protocol for both groups consisted of three series of sets from various distances. Each series consisted of 2 sets of 5 putts with 30 seconds of pause between the sets. Each series had 45 seconds of pause between them. The first series were taken from 2,5-meter line, second series from 3-meter line and third series from 2-meter line. This sequence was applied to allow participants to practice (with and without self-talk) 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. In a similar manner to the baseline measurement one assistant researcher made sure the golf course was clear of any balls and another set up a new ball for the participants before a subsequent putt.

Additionally, the participants were notified that their performance in training will also be recorded. Participants of the control group received further instructions about the fundamentals of golf putting. They were continuously given advice on how to improve their

performance. For example, detailed guidelines on how to rectify the positional stance and hand grip, as well as the alignment between the golf club and the ball in regards to improvement. In addition to receiving similar directive assistance, the experimental group acquired a self-talk training intervention. An educational approach to the intervention procedure (e.g., Hatzigeorgiadis, Galanis, Zourbanos, & Theodorakis, 2014; Hatzigeorgiadis, Zourbanos, Mpoumpaki & Theodorakis, 2009) intended to serve the purpose of acquiring experience with various types of self-talk, familiarizing participants on how to use self-talk. Accordingly, the intervention entailed that the participants obtained the knowledge of what is self-talk, along with why and how to implement this cognitive strategy to improve the golf performance. In particular, they had an option to use a motivational cue word “in” on the assumption of needing encouragement or instructional cue word “steady” supposing to discipline the preparation. Thus, the participants had freedom of choice in which of the provided cue word to use.

Furthermore, during the training phase the participants were first advised to alternate between the two contrasting cue words in the first set for the purpose of choosing their preference. Whereas, in later sets instructed to concentrate on using one in order to have more practice putts with that specific cue word. The choice of the self-talk cue words was based on prior piloting with an independent group with a variety of alternate options being tested. In conclusion, the purpose of the self-talk cues was to trigger, or direct attention to appropriate stimuli, and in consequence initiating appropriate reaction in relation to the demands of the test. Upon completion of the training phase, a manipulation check (Hatzigeorgiadis et al., 2009) was administered to the participants in the experimental group. They were asked to (a) clarify which of the provided cue they implemented and to what degree on a 10-point scale (1 not at all, 10 all the time), (b) report whether they implemented any other self-talk cue not provided by us, (c) if so, clarify what this cue was and (d) report the degree to which they implemented this other cue on a 10-point scale (1 not at all, 10 all the time). At this stage no manipulation check

was administered to the control group in order not to impose to use of self-talk (Hardy et al., 2005) by raising awareness of the purpose of the experiment in the control group participants. In total, the training program for both groups lasted about 15 minutes.

Third phase - ego depletion. Next, the participants were guided to a specific laboratory room for computer tests. A depleting manipulation task was prepared, in which the participants had to undertake a computerized divided attention exercise. Before starting with the cognitive task, participants completed an ego depletion manipulation check questionnaire (Englert et al., 2015c) assessing their current state of mental fatigue. This ego depletion manipulation check asked participants to report their responses of their perceived available self-control strength on a 7-point Likert type scale from 1 (not at all) to 7 (very much). A divided attention test (unimodal visual test form S1 (WAFG)) from the Test Battery for Perception and Attention Functions (WAF tests; Sturm, 2006) of the Vienna Test System (Shuhfried, Mödling, Austria) served as the task for inducing ego depletion. Through the instructions participants were asked to respond to a certain visual stimulus by pushing a button on a designated test panel (Universal Response Panel; Schuhfried), and were informed that both the correctness and the reaction time will be recorded for the full duration of the test. Prior to starting the actual test, a fixed pre-test trial was completed with the experimenter sitting next to the participant to make sure the participant had understood the task. After successive pre-test and verbal confirmation of understanding the experimenter left the room and the participant completed the full version task individually. The ego depletion manipulation test took about 15 minutes to complete. Upon completion of the depletion task, the ego depletion manipulation check was again administered to assess the effect of the cognitive task on perceived state of ego depletion.

Fourth phase - final assessment. Following the induction of ego depletion and completing the manipulation check questionnaire, the 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 1 minutes. 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 8 minutes. After the completion of the final test, participants of both groups were asked to complete a standard self-talk manipulation check (Hatzigeorgiadis et al., 2009). The manipulation check for the experimental group was identical to the one administered after the training phase. Participants in the control group were asked to indicate (a) whether they deliberately and systematically implemented any form of self-talk during the execution of the final task and (b) if so, define the cue and to which degree they implemented this cognitive strategy on a 10-point scale (1 not at all, 10 all the time).

Results

Preliminary analysis and manipulation checks for ego depletion and use of self-talk

A series of preliminary analyses were conducted to attest the integrity of the experimental conditions. Regarding ego depletion, a number of participants from the control ($N = 7$) and experimental ($N = 4$) group were identified as outliers in reporting either very low (< 1.5) or too high (> 5) scores on the post ego depletion manipulation check, thus differing by more than two standard deviations in comparison to the mean. This was interpreted as interfering with the integrity of the study as well as intrusive to the main analysis and were therefore subsequently excluded from further analysis. Regarding self-talk, six participants from the experimental group reported relatively rare (< 7) use of self-talk strategies in the final assessment. Additionally, three participants from the control group reported relatively prevalent (> 7) use of self-talk strategies in the final assessment. Following the recommendation of

Gregersen et al. (2017) these participants were excluded from further analyses. The final sample for subsequent data analysis consisted of 20 participants in the control and 21 participants in the experimental group ($M_{age} = 18.66$, $SD = 1.20$). Participants of the experimental group reported a mean score of 8.61 ($SD = 1.65$) for the use of instructed self-talk cues during the training phase, and a mean score of 9.29 ($SD = 0.78$) for the use of instructed self-talk cues during the final assessment. Among them, 13 participants selected the “steady” and 8 participants the cue “in”. Control group participants reported a mean score of 2.25 ($SD = 2.71$) for the final assessment.

Table 1

Descriptive statistics for ego depletion task variables and manipulation check scores

	Control group <i>Mean (SD)</i>	Experimental group <i>Mean (SD)</i>
Reaction time	0.379 (0.06)	0.387 (0.72)
Number of mistakes	14.10 (15.94)	10.71 (13.51)
Pre-manipulation ego depletion	1.99 (0.87)	2.29 (0.72)
Post-manipulation ego depletion	2.77 (0.89)	3.27 (0.87)

Ego depletion manipulation

Two-way ANOVA with one repeated factor (time) and one independent factor (group) was calculated to test for the differences in depletion scores before and after the depleting task. The analysis revealed significant main effect for time $F(1, 39) = 56.72$, $p < .001$, and a non-significant group by time interaction $F(1, 39) = 0.79$, $p = .38$. Participants of both groups reported similar increase in depletion following the manipulation task, so the manipulation was deemed effective. One-way MANOVA was calculated to test for differences between the two

groups in reaction time and number of mistakes made in the cognitive depleting task. The analysis showed a non-significant multivariate effect, $F(2, 38) = 0.40, p = 0.67$. Descriptive statistics for the ego depletion are presented in Table 1.

Golf putting performance

Two-way ANOVA with one repeated factor (time) and one independent factor (group) was calculated to test for differences in golf performance at baseline and final performance. The analysis revealed a marginal time by group interaction effect $F(1, 39) = 3.89, p = .056$. Examination of the pairwise comparisons showed that performance of the experimental group was significantly increased ($p < .001$), whereas no significant change was recorded for the control group ($p = .37$). Descriptive statistics regarding the change in golf performance scores are shown on Figure 1.

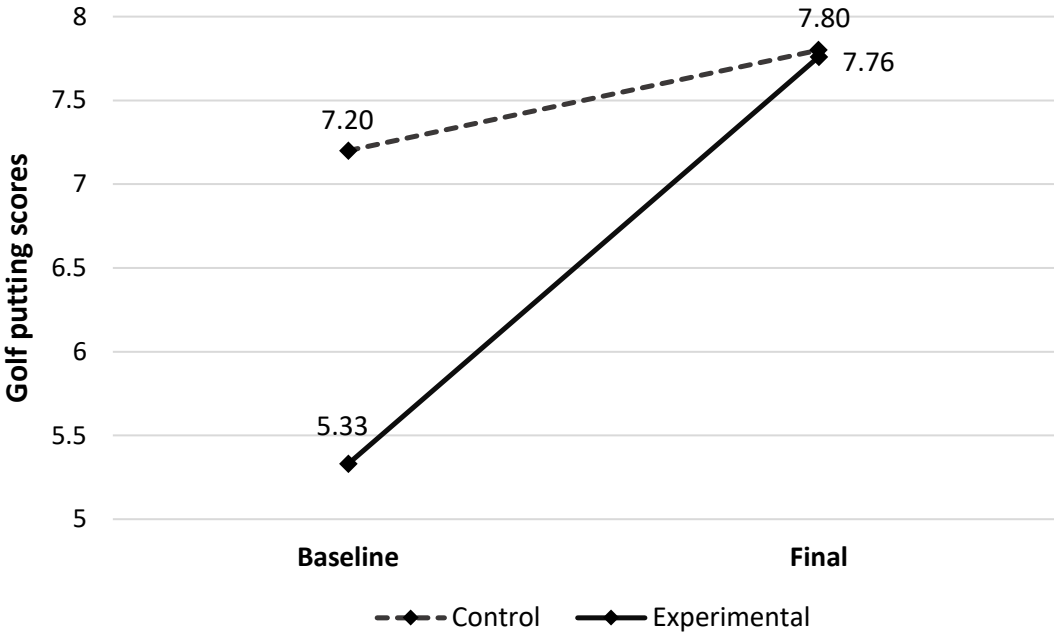


Figure 1. Golf putting performance change between baseline and final assessment

Discussion

The purpose of the present research was to investigate whether the use of self-talk facilitates a precision-based sport task performance in a state of ego depletion. Specifically, the study examined the effects of a self-talk intervention under the state of ego depletion in a simple golf putting task. As the baseline measurements were established in order to have a reference point of performance, the experimental group went through a self-talk training intervention. Before the final assessment, both groups received an ego depletion manipulation for the purpose of performing the final golf putting task under the state of ego depletion. Manipulation checks on the induction of ego depletion and self-talk utilization were used in the study in order to ensure the integrity of the study conditions and that these manipulations could be considered as influential in the interpretation of the results. Overall, the results showed that the utilization of self-talk cue words had a marginally significant positive effect on the golf performance under the state of ego depletion. Therefore, the results indicate that self-talk can be considered as an effective cognitive strategy to facilitate the depleted self-regulatory mechanisms in a sport task.

Golf putting performance

The findings regarding performance change between the baseline and final measurement demonstrated that the experimental group significantly increased their scores in golf putting, whereas the performance of the control group remained stable. Although, based on the literature (Englert & Bertrams, 2014; Englert & Wolff, 2015; Englert et al., 2015a; Englert et al., 2015c), and according to our hypothesis it was expected that ego depletion would decrease the performance scores for the control group. The pre and post manipulation check scores on ego depletion showed a significant difference, thereby confirming that the participants of both groups were indeed in an altered cognitive state. Additionally, the results of the current study are in accordance with previous research that has shown similar increase in pre and post levels of ego depletion in participants' self-reports (e.g. Gregersen et al., 2017; Englert &

Bertrams, 2014; Englert et al., 2015a). However, the reasoning for the opposite effect in golf performance can be explained by the design of the study protocol. Taking into account that the participants had a total of 30 shots of practicing the golf putting skill, the depletion effect was possibly attenuated by the learning effect introduced through the training of the golf putting task. Thus, during the training phase, the participants became more familiar with the task, which led to learning the skill execution movements for better performance in the final assessment.

Same reasoning can be attributed to the performance increase in the experimental group. However, it should be noted that as the increase in the control group was not significant, the learning effect definitely could not have attributed to all of the major significant change in the experimental group scores. Nevertheless, this aspect needs to be taken into consideration when interpreting the results. On the other hand, as the reported self-talk use was substantially different between the groups, favoring the experimental group, this has to be taken into account as a moderator to the major significant increase of the experimental participants' golf putt scores in the final assessment. The self-talk utilization scores on the manipulation check are in accordance with previous intervention studies, where self-talk training was implemented (e.g. Hatzigeorgiadis et al., 2007; 2014). Moreover, Hatzigeorgiadis and colleagues (2011) identified self-talk training as a moderating factor that enhances self-talks effect on subsequent performance. Our results support this implication, as participants reported using more self-talk in the final assessment than in the training phase and our main results show a marginal significant effect of self-talk on the final golf performance. In terms of interpreting the effectiveness of self-talk on our golf beginners, this study supports the meta-analytical results by Hatzigeorgiadis et al. (2011), who claimed that novel performers are more advantageous to benefit from self-talk than senior athletes.

Comparing the final assessment performance scores, the two groups did not significantly differ, which is in contrast to the only other study examining the counteracting

effects of self-talk on ego depletion (Gregersen et al., 2017). In their study, the final measurement scores were significantly different between the experimental and control group. However, the natures of the two studies are different, as Gregersen et al. (2017) applied a between-subject design with different baseline and training tasks for the practice phase and measured the performance in a cognitive task, whereas this study opted for a repeated measures design with the baseline assessment and training phase being conducted on a similar task as the final measurement in a physical sporting task.

Self-talk and attention in golf putting performance

One essential interpretation of the facilitating effects of 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 described by Baumeister et al. (1998), recent experimental studies regarding ego depletion and sport task have found that participants are worse at paying attention to task relevant stimuli (Schmeichel & Baumeister, 2010), as well as directing attention to task-relevant stimuli and more susceptible to external distractibility, which eventually leads to less quality in the performance (Englert et al., 2015a; Englert et al., 2015c; Furley et al., 2013). However, as previous studies have shown beneficiary effects of self-talk on directing and focusing attention to task relevant stimuli (Galanis et al., 2016), as well as countering internal and external distractions (Hatzigeorgiadis et al., 2004, 2007), even under distracting conditions (Galanis et al., 2017), self-talk strategies utilization in the current study might have helped to overcome the exhausted attentional functions caused by ego depletion.

A recent study by Gregersen et al. (2017) provided evidence indicating improved performance of selective attention under the state of ego depletion with a self-talk intervention. In fact, the importance of selective attention has been identified in the planning and executing

of a golf swing (Marteniuk & Bertram, 2009). Additionally, taking into account how necessary overall attentional functionality is in golf (e.g. Bois et al., 2009), self-talk might have altered the negative effects of ego depletion on attention by reinforcing the depleted attentional control and directed the attentional focus on golf putting relevant stimuli. Moreover, a moderator of skill level should be taken into consideration while interpreting the results, as none of our participants had had any previous training with golf and the self-talk - attention association has been suggested to be particularly salient especially for beginners (Landin, 1994). Hatzigeorgiadis and colleagues (2014) explained this with the importance of attention at the early stages of skill acquisition for tasks especially characterized by accuracy and precision. Even though, the current study does not provide any direct evidence to support the applicability of the ego depletion – self-talk – enhanced attention concept, it's worthy to point out that the current study indirectly supports the interpretations of the relatedness of the aspects in this concept.

Limitations and future suggestions

Limitations that should be considered while interpreting the results are presented along with suggestions for future research. First, screening of the manipulation checks on ego depletion and self-talk revealed outliers, which meant notable exclusion of participants from both groups. Participants were excluded if they were outliers in terms of not being or being too susceptible to the ego depletion manipulation. Being already depleted at the arrival to the study or underestimation of depletion could have led to these results for the excluded participants. Concerning self-talk, previous intervention studies with regard to self-talk have noted a tendency of utilization of self-talk strategies among non-experimental participant and inconsistent use of self-talk among experimental participants and consequently excluded those participants from the further analysis (e.g. Gregersen et al., 2017; Hatzigeorgiadis et al., 2009; Hardy, Begley & Blanchfield, 2015). In similar manner, these exclusion criteria were applied

for further data analysis and participants were therefore excluded from the control group for consistent and strategic along with participants from the experimental group for inconsistent and apathetic use of self-talk. The reasoning behind the exclusion of these participants was the principal of the integrity of the experiment protocol. As the previous authors have already implied, these guiding principles could be followed in future self-talk intervention studies for filtering and selecting participants.

Secondly, the experimental protocol foresaw that the participants had a freedom of choice which self-talk cue to adopt for the training and final assessment. Therefore, providing a choice relates to the autonomy support aspect of the self-determination theory (Ryan & Deci, 2000) that has been proposed to increase intrinsic motivation and ultimately overall performance (e.g. Gillet, Vallerand, Amoura & Baldes, 2010). A study by Graham, Bray and Ginis (2014) showed how autonomy supportive motivational environment increased task motivation and counteracted the negative effects of ego depletion on a physical task performance. Particularly, the results indicated that autonomy supportive instructions enhanced the self-control performance under ego depletion in the second trial, but performance declined again in the third trial. The authors concluded that if the task is performed subsequently after the ego depletion manipulation autonomy supportive instructions provide facilitation for the performance, yet this effect does not last in the long term. Even though, providing two options for preference does not signify a large support for autonomy and that the present study cannot calculate the exact proportion to which the autonomy supportive self-talk cue choice preference may have contributed to the overall performance scores, the notion of autonomy support should be taken into consideration while interpreting the results. No research to date has investigated the autonomy supportive instructions in self-talk and hence no parallels can be drawn. However, as researchers and practitioners suggest to utilize personalized self-talk and thus facilitating

autonomy, this could be an interesting idea to explore in future studies regarding self-talk in athletic performance.

Thirdly, an important aspect that limits the respective conclusions of this study is that the effect of ego depletion on golf performance cannot be precisely determined. The absence of a non-depletion control group restricts the conclusions that can be made on the effects of ego depletion on the golf task. Moreover, it is impossible to establish the degree to which self-talk countered the effects of ego depletion. The current study opted for a repeated measures design with the analysis comparing experimental and control group on a novel sport task. A suggestion for future investigations is conduct a repeated measures study design with a well learned skill in order to help to assess the effect of self-talk in a state of ego depletion more accurately and minimize the learning effect.

Finally, the study was conducted in a lab-controlled environment with a relatively simple sport task. As a consequence, the results cannot be generalized to a broader spectrum of golf due to the limited ecological validity. As golf is usually played outdoors, there are several environmental factors that could 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. These factors, concrete air flow to hinder the balls movement and rough landscape, were eliminated by the lab-controlled environment in our study. Future experimental studies should aim towards higher ecological validity by doing field experiments or simulate some of the outdoor environment factors indoors. Thus, future research should try to augment the ego depletion research direction with more field intervention studies to further enhance the applicability of cognitive strategies assistance in counteracting ego depletion.

Conclusion

In summary, the application of the current study provides insightful information to sport and especially to golf in counteracting the negative effects of the diminished self-control state

knows as ego depletion with self-talk and enhancing the upcoming athletic performance. Our results suggest that sport psychologists, physical educators and most of all novice golf professionals should attempt to integrate self-talk utilization to their teaching or to their golf performance. The present findings provide further evidence on the growing research on self-talk theory. In particular, the current results contribute to a relatively new line of research in regards to beneficiary effects of strategic self-talk on countering the effects of ego depletion. After clear evidence of positive self-talk effects on ego depletion in a cognitive task (Gregersen et al., 2017), this study aimed to explore the effects of self-talk in a sport task under the state of ego depletion. The results indicate that applying strategic self-talk assists in improving the golf putting performance in a state of ego depletion. Furthermore, as attention is regarded imperative to golf performance and ego depletion diminishes the functionality of attention, our results support the interpretation of facilitating effects of self-talk on attentional functions under the state of ego depletion. Extending the current line of research to field experiments is essential for future research, as well as exploring the potential of other mental skills effects on replenishing the state of ego depletion in a sport task.

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