Anxiety, Ego Depletion, and Sports Performance

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Abstract

In the present article, we analyzed the role of self-control strength and state anxiety in sports performance. We tested the hypothesis that self-control strength and state anxiety interact in predicting sports performance on the basis of two studies, each using a different sports task (Study 1: performance in a basketball free-throw task, $N = 64$; Study 2: performance in a dart task, $N = 79$). The patterns of results were as expected in both studies: Participants with depleted self-control strength performed worse in the specific tasks as their anxiety increased, while there was no significant relation for participants with fully available self-control strength. Furthermore, different degrees of available self-control strength did not predict performance in participants who were low in state anxiety, but did in participants who were high in state anxiety. Thus increasing self-control strength could reduce the negative anxiety effects in sports and improve athletes' performance under pressure.

Keywords: anxiety, basketball, darts, ego depletion, self-control, sports

Anxiety, Ego Depletion, and Sports Performance

Anxiety and its effects on sports performance remain one of the main research areas in sports psychology (e.g., Hanin, 2000; Woodman & Hardy, 2001). Anxiety is defined as an aversive emotional experience that can develop during potentially threatening, evaluative situations (e.g., Eysenck, Derakshan, Santos, & Calvo, 2007). Considering that athletes in competitive sports need to perform well under pressure, sporting competitions can be considered as potentially threatening evaluative situations and thus can possibly elicit heightened levels of anxiety. According to Martens and colleagues (Martens, Vealey, & Burton, 1990), anxiety is a multidimensional construct that is constituted of two main components: Cognitive anxiety (i.e., worrying thoughts about one's performance) and somatic anxiety (i.e., individual perception of one's physiological arousal, e.g., nervousness, tension, heart rate).

Anxiety can have an impact on several aspects in sports; for instance, anxiety is associated with discontinuation of sports activities (Gould, Feltz, Horn, & Weiss, 1982; T. K. Scanlan, Babkes, & Scanlan, 2005), less pleasure while participating in sports (Scanlan et al., 2005; Smith & Smoll, 1991), and impaired performance (e.g., Hanin, 2000; Woodman & Hardy, 2001). In the present paper, we focus on the effects of anxiety on sports performance. Researchers mostly have reported a negative influence of anxiety on sports performance (e.g., Kleine, 1990; Woodman & Hardy, 2003), which additionally has been shown in several different sports domains. For instance, it has been repeatedly shown that anxiety seems to be a major factor that can impair performance in soccer penalty kicks (Jordet, 2009; Jordet, Elferink-Gemser, Lemmink, & Visscher, 2006; Jordet, Hartman, Visscher, & Lemmink, 2007; Wilson, Wood, & Vine, 2009b), in rock climbing (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008; Pijpers, Oudejans, Bakker, & Beek, 2006), in golf putting (Vine, Moore, & Wilson, 2011), or in table tennis (Williams, Vickers, & Rodrigues, 2002). However, the

underlying processes for the detrimental anxiety effects on sports performance have not been sufficiently investigated as of yet (Janelle, 2002), and thus it seems highly important to identify factors that could have an influence.

In most sports, individuals need to aim precisely at specific targets to succeed (i.e., darts, soccer, basketball), which requires self-regulation of one's cognitive, emotional, and motor processes, or more concretely, effective *selective attention* (e.g., Vickers, 1996; Williams, Singer, & Frehlich, 2002). Selective attention is defined as the ability to focus on specific environmental stimuli while ignoring other stimuli in the environment that can otherwise capture attention (e.g., Schmeichel & Baumeister, 2010). Selective attention seems inevitable for superior performance in sports (Boutcher, 2002; Janelle, 2002): In order to be able to ignore irrelevant stimuli and to instead focus on the task-relevant information of the actual situation, selective attention is required (Moran, 1996, 2004). However, the success of selective attention is impaired by anxiety, as anxious individuals' attention is automatically occupied by threatening stimuli that can either be internal (i.e., worrying thoughts) or external (i.e., audience), which leaves less attention available for the actual task and can lead to performance decrements (Behan & Wilson, 2008; Vickers & Williams, 2007; Vine & Wilson, 2011; Wilson, Vine, & Wood, 2009a). This pattern of results is further highlighted by a meta-analysis conducted by Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van Ijzendoorn (2007), in which the authors report an attentional bias of anxious individuals towards threatening stimuli and an inability to disengage attention from these threatening stimuli. To conclude, anxiety seems to be detrimental to the success of selective attention.

One possible explanation for performance decrements in anxious athletes could be derived from the strength model of self-control (Baumeister, 2002; Baumeister, Vohs, & Tice, 2007; Muraven & Baumeister, 2000), as paying selective attention seems to be a self-control act (Schmeichel & Baumeister, 2010). As Baumeister and colleagues point out,

attention regulation seems to be the most important form of self-control because it influences all other forms of self-control execution (Baumeister, Heatherton, & Tice, 1994). Self-control is defined as the ability to override and alter a persons' predominant, or automatic, attentional focus or other automatic tendencies (e.g., Baumeister et al., 2007; Muraven & Baumeister, 2000; Schmeichel & Vohs, 2009). The ability to resist immediate urges or to not give in to automatic impulses in specific situations also enables one to attain preferable long-term goals instead of settling on short-term achievements (Hagger, Wood, Stiff, & Chatzisarantis, 2010a). Applying this definition to the previously mentioned attentional bias in anxious individuals (Bar-Haim et al., 2007), self-control enables one to override the automatic tendency to pay attention to threatening stimuli and instead to focus on other stimuli. Thus self-control should protect anxious individuals from performance decrements.

However, self-control does not always work: According to the strength model of self-control, successful self-control (e.g., selective attention) is dependent on a self-control resource with limited capacity. A primary self-control act temporarily depletes this strength (a state referred to as ego depletion; Baumeister, Bratslavsky, Muraven, & Tice, 1998), and therefore subsequent self-control performance is impaired (Muraven & Baumeister, 2000). This effect seems to be universal and not domain-specific (i.e., exerting self-control in one domain can have a subsequent influence on self-control in a completely different domain; e.g., Baumeister et al., 1998). Domains that have been shown to be impaired by ego depletion are, for instance, selective attention (e.g., Schmeichel & Baumeister, 2010), making choices (Baumeister & Vohs, 2007), or resisting temptations (Muraven & Baumeister, 2000). The role of self-control has also been studied in sports and exercise behavior as, for instance, lower levels of self-control strength were associated with lapses in exercise effort, planned exercise effort (Martin Ginis & Bray, 2010), and adherence to exercise plans (Hagger, Wood, Stiff, & Chatzisarantis, 2010b; Martin Ginis & Bray, 2010). Ego depletion also seems to be

associated with neuromuscular fatigue: Participants that were instructed to squeeze an isometric handgrip as long as possible before and after a task manipulating self-control strength performed worse—in terms of physical endurance—when in a state of ego depletion, and also exhibited higher EMG activation (Bray, Martin Ginis, Hicks, & Woodgate, 2008). The detrimental effects of ego depletion on subsequent self-control performance have been further confirmed in a meta-analysis by Hagger and colleagues (2010a), who analyzed a total of 83 studies on ego depletion and reported a medium-to-large effect size.

In order to assess the influence of ego depletion on subsequent self-control, the application of a two-task paradigm has been established (e.g., Baumeister et al., 1998). The first task within this paradigm serves as the independent variable in which self-control strength is experimentally manipulated. Individuals are either assigned to a depletion condition or a nondepletion condition, and both groups work on a similar task (e.g., watch a video with a young woman being interviewed while words pop up on the screen; Schmeichel, Vohs, & Baumeister, 2003). However, in the depletion condition, for a successful mastery of the task, self-control is needed (e.g., participants are instructed to pay no attention to the words), while successful performance for participants from the nondepletion condition is not dependent on self-control (e.g., participants just watch the video without any further instructions). Therefore, in the depletion condition, participants' self-control strength should be depleted after this primary task, while in the nondepletion condition, participants' self-control strength should be intact. Depending on the momentary availability of self-control strength, self-control in the second task—which is identical for both conditions—should differ between the two conditions because depleted participants should perform worse than the nondepleted participants here, as they do not have the same amount of self-control strength to invest in the second task (e.g., Baumeister et al., 1998; Baumeister et al., 2007; Muraven, Tice, & Baumeister, 1998).

Performing a successful free-throw in basketball, or hitting a specific target while playing darts, can be viewed as tasks that are highly dependent on selective attention since the athlete needs to concentrate on the relevant information (i.e., the basket, the dartboard) while ignoring other information (e.g., worries; Oudejans, van de Langenberg, & Hutter, 2002; Ripoll, Bard, & Paillard, 1986; Vickers, Rodrigues, & Edworthy, 2000). In line with these assumptions, Wilson, Vine, and Wood (2009a) found that increased levels of state anxiety were associated with impaired selective attention and a lower free-throw success rate in basketball. Based on the strength model of self-control (Baumeister, 2002; Baumeister et al., 2007; Muraven & Baumeister, 2000), we assume that anxious individuals in a state of ego depletion are less adept in selectively controlling their attention than participants whose resource is fully available. This is because they cannot invest additional self-control strength in order to override their automatic tendency to focus on anxiety-related, task-irrelevant stimuli. This diversion of attention should be associated with impaired performance in sports tasks that require selective attention (i.e., far-aiming tasks; e.g., basketball free-throws, darts, rifle-shooting). Anxious participants with fully available self-control strength, however, should be able to selectively control their attention. Therefore, we assume that the momentary availability of self-control strength serves as a moderator for the often reported negative relation between anxiety and sports performance.

Likewise, the relation between the availability of self-control strength and sports performance should depend on anxiety levels. The momentary availability of self-control strength determines the degree to which people can pay selective attention—a self-control act—at a given moment (Schmeichel & Baumeister, 2010). However, low self-control strength should affect motor performance only if something that can distract attention is momentarily present and, thus, imposes the requirement for selective attention. One major source of distraction during evaluative situations may be anxiety-related worries: Worries

have been considered as threatening stimuli, to which anxious individuals' attention automatically shifts (Eysenck et al., 2007). So anxiety makes individuals prone to get distracted by threatening stimuli, and is also associated with the presence of such distracting threatening stimuli (i.e. worries; Eysenck et al., 2007). Thus, at least if no other intense distractions are additionally present, levels of state anxiety should moderate the adverse effect of ego depletion on sports performance. The momentary availability of self-control strength should not predict sports performance—despite its general impact on attention regulation—if there are no distracting stimuli (e.g., anxiety-related worries) at hand.

Subsequently, we tested our assumption that self-control strength and state anxiety interact in predicting sports performance in two studies. In Study 1, our sports performance measure was basketball free-throws, while in Study 2, we chose darts: Both of these two sports are far-aiming tasks that are dependent on selective attention (Oudejans et al., 2002; Ripoll et al., 1986; Vickers et al., 2000). We proposed that there was a stronger negative relation between state anxiety and performance for individuals in a state of ego depletion compared to participants whose self-control strength was intact. In addition, we expected the effect of ego depletion on sports performance to be less debilitating for individuals who were low compared to high in state anxiety.

Study 1: Anxiety, Ego Depletion, and Free-Throw Performance in Basketball

Method

Participants. A total of $N = 64$ amateur male basketball players ($M_{age} = 22.92$, $SD = 6.11$) from six German basketball teams of the 4th highest German league (German: Oberliga) participated in the present study. On average, the players had been playing competitive basketball on a team for 9.16 years ($SD = 5.06$). The athletes participating in our study had a free-throw success rate of 63.2% ($SD = 14.46$) in their last season of play and therefore can be defined as members of the "near elite" group, since their free-throw success rate was

below the 75% threshold for elite basketball athletes recommended by Harle and Vickers (2001). In exchange for their support, the teams received a box of energy drinks. Before starting the experimental procedure, the experimenter obtained informed consent from each participant.

Materials and Procedure. The study was conducted during regular training sessions of the respective clubs. Participants worked on a set of paper and pencil questionnaires in a separate area of the training facility.

After reporting demographic data (age, sex, mother tongue, years of membership in a basketball club, and the free-throw success rate of their last season of play), the participants completed a series of ten free-throws from the regular basketball free-throw line (i.e., distance 4.60m) to a hoop at regular height (i.e., height from the ground 3.04m) as a measure of their current free-throw competence in a neutral scenario. We then calculated each individual's free-throw success rate (number of successful free-throws x 100/total number of throws).

In a next step, we assessed participants' dispositional sports anxiety by applying the Sport-Anxiety-Scale-2 (SAS-2; Smith, Smoll, Cumming, & Grossbard, 2006), which consists of 15 items that are answered on 4-point Likert-type scales ranging from 1 (*not at all*) to 4 (*very much*) in regard to how they generally feel before or during a sports competition. Five items each can be assigned to one of the following subscales: Worry (e.g., "I worry that I will not play well"; $\alpha = .89$), somatic (e.g., "My body feels tense"; $\alpha = .76$), or concentration (e.g., "It is hard to concentrate"; $\alpha = .74$). For the SAS-2 subscales as well as for the other self-report measures included in this study, we computed overall scores by averaging each participant's answers on the specific measure so that higher scores on the respective measure always indicated higher values of the respective variable.

Then we experimentally manipulated participants' self-control strength by randomly

assigning them to either the depletion condition (n = 32) or the nondepletion condition (n = 32). Participants transcribed a neutral text onto a separate sheet of paper for 6 minutes. However, participants in the depletion condition were asked to always omit the letters "e" and "n" while transcribing the text; participants in the nondepletion condition did not receive any specific instructions on how to transcribe the text (cf., Schmeichel, 2007). One needs to exert self-control strength to overcome one's usual writing habits, and the success of this manipulation of self-control strength has been shown in previous studies (e.g., Bertrams, Englert, & Dickhäuser, 2010). By previously measuring participants' current free-throw competence and their dispositional sports anxiety, we wanted to make sure that there would not be differences in these respective measures between the two experimental conditions.

To assess the success of the experimental manipulation of self-control strength, participants answered a three-item manipulation check (e.g., "How difficult did you find the transcription task?", "How effortful did you find the task?", and "How depleted do you feel at the moment?"; α = .79) on 4-point Likert-type scales from 1 (*not at all*) to 4 (*very much*) that we adopted from Bertrams and colleagues (2010). To rule out the possibility that the different instructions in the transcription task had an impact on self-efficacy, we included an additional item ("How successful do you think you performed in the transcription task?") that was also answered on a 4-point Likert-type scale (1 = *not at all* to 4 = *very much*).

Next, participants were informed that they again would have to perform ten free-throws. As anxiety can arise in potentially threatening, evaluative situations (e.g., Eysenck et al., 2007), we increased the evaluative character of the situation by inducing a potentially threatening situation which adapted an instruction that, in other sports domains, had previously been successfully applied to induce anxiety (Behan & Wilson, 2008; Murray & Janelle, 2003; Wilson et al., 2009a): Participants were informed that it would be extremely important to shoot as accurately as possible because their performance would be compared to

the performance of their teammates, and that the average shooting performance of their club would be compared to the average performance of other clubs. They were further told that they would receive face-to-face feedback about their shooting efficiency.

Before actually performing the free-throws, we measured participants' actual level of state anxiety by applying the German short version of the state scale of the State-Trait Anxiety Inventory (STAI-SKD; Englert, Bertrams, & Dickhäuser, 2011; α = .86). The STAI-SKD consists of five items (e.g., nervous): Individuals rate the items in regard to how they feel at that specific moment on 4-point Likert-type scales (1 = *not at all* to 4 = *very*). Englert and colleagues have delivered evidence for the reliability and validity of the STAI-SKD.

Next, the participants completed a series of ten free-throws. We again calculated each individual's free-throw success rate.

Finally, participants were thanked and rewarded for their participation. Additionally, in order to make sure no participant left the training facility feeling distressed, we informed them about the real content of the study and debriefed them.

Results

Preliminary analysis. The experimental manipulation of self-control strength was successful in the present study, as there were significant mean differences in the three-item manipulation check between the depletion condition (M = 1.91, SD = 0.67) and the nondepletion condition (M = 1.56, SD = 0.48), $t(62) = 2.35$, $p = .02$, $d = 0.29$.

There were no statistically significant mean differences in participants' baseline free-throw performance between the depletion condition (M = 67.19%, SD = 18.33) and the nondepletion condition (M = 71.56%, SD = 17.06), $t(62) = -0.95$, $p = .34$, $d = -0.12$.

There were also no statistically significant mean differences in the three subscales of the SAS-2 between the depletion condition and the nondepletion condition [worry: M = 1.80, SD = 0.71 vs. M = 1.79, SD = 0.59, $t(62) = 0.10$, $p = .92$, $d = 0.01$; somatic: M = 1.59, SD =

0.51 vs. $M = 1.53$, $SD = 0.43$, $t(62) = 0.53$, $p = .60$, $d = 0.06$; concentration: $M = 1.32$, SD = 0.36 vs. $M = 1.40$, $SD = 0.47$, $t(62) = -0.77$, $p = .44$, $d = -0.10$].

Further, there were no statistically significant group differences in how the participants rated their performance in the transcription task, indicating that it was not likely that the transcription task led to differences in perceived self-efficacy between the depletion condition ($M = 2.21$, $SD = 0.90$) and the nondepletion condition ($M = 2.50$, $SD = 0.91$), $t(62) = -1.20$, $p = .24$, $d = -0.16$.

Main analysis. To test the assumption that self-control strength and state anxiety interacted in predicting free-throw success rate at Time 2, we applied hierarchical multiple regression analysis since state anxiety was measured on a continuous scale. Before the analysis, we centered the state anxiety scores. In a first block, we included the experimental condition (i.e., depletion vs. nondepletion) and state anxiety (centered scores) as predictors for the free-throw success rate at Time 2, and in a second block we included the interaction of both as an additional predictor. As expected, the experimental condition and state anxiety statistically significantly interacted in predicting the free-throw success rate at Time 2, $B = 24.78$, $SE\ B = 11.16$, $\beta = .79$, $p = .03$.

In order to interpret the interaction, we conducted simple slope analysis (Aiken & West, 1991). Considering that our predictor experimental condition was a dichotomous variable, we applied the recoding procedure (J. Cohen, Cohen, West, & Aiken, 2003) and conducted a multiple regression analysis for each of the two experimental conditions, each involving the same data. By doing so, we were able to assess the specific relations between state anxiety and free-throw success rate at Time 2 in the two experimental conditions separately by only changing the coding of the two conditions (the B, $SE\ B$, β, and p values of state anxiety—which predict the free-throw success rate at Time 2—apply to the condition coded as 0). In a first multiple regression analysis applied to the depletion condition (ego

depletion coded as 0; nondepletion coded as 1), the results were in line with our assumptions: State anxiety did statistically significantly predict the free-throw success rate at Time 2, B = -22.85, $SE\ B$ = 6.30, β = -.52, $p < .001$. This means that the free throw performance of participants in a state of ego depletion was lower as their anxiety increased, as indicated by the negative β value. However, in a second multiple regression analysis applied to the nondepletion condition (ego depletion coded as 1; nondepletion coded as 0), state anxiety did not statistically significantly predict the free-throw success rate at Time 2, B = 1.92, $SE\ B$ = 9.22, β = .04, p = .84.

Additional simple-slope-analyses (Aiken & West, 1991) revealed that participants low in anxiety (1 *SD* below *M*) in the depletion condition (M = 76.90%) did not differ from participants low in anxiety in the nondepletion condition (M = 68.90%) in terms of their free-throw performance, B = -0.80, $SE\ B$ = 0.66, β = -.20, p = .23. For highly anxious participants (1 *SD* above *M*), however, we did find a statistically significant difference in free-throw performance between the depletion condition (M = 56.30%) and the nondepletion condition (M = 70.70%), B = 1.43, $SE\ B$ = 0.71, β = .37, p = .05. The results are illustrated in Figure 1a.

There was no main effect of experimental condition on free-throw success rate at Time 2, B = 2.49, $SE\ B$ = 4.77, β = 0.06, p = .60. Thus the depletion condition (M = 65.01%, SD = 21.99) and the nondepletion condition (M = 70.00%, SD = 16.85) did not statistically significantly differ in free-throw success rate at Time 2.

Discussion

The results of Study 1 were in line with our expectations: There was a statistically significant relation between state anxiety and free-throw performance only for basketball players in a state of ego depletion, meaning that depleted participants performed worse as their anxiety increased; for basketball players whose self-control strength was not experimentally depleted, this relation was not statistically significant. Moreover, as assumed,

the availability of self-control strength affected free-throw performance, depending on anxiety levels: The adverse effect of ego depletion on sports performance would become stronger as state anxiety increased. Without considering anxiety, ego depletion did not affect performance. These results convey initial evidence that self-control strength and state anxiety interact in predicting sports performance.

Additionally, we did not find any differences between the two experimental conditions in how the participants rated their performance in the transcription task, indicating that the experimental manipulation of self-control strength did not yield differences in perceived self-efficacy. These results are compatible with previous findings that also excluded self-efficacy as an alternative explanation for ego depletion effects (Gailliot & Baumeister, 2007; Wallace & Baumeister, 2002).

There are some limitations in the current study. First of all, our sample consisted exclusively of athletes who were practicing their sports-domain specific skills on a regular basis. Therefore, we cannot generalize our findings to recreational athletes who do not regularly work out in the specific sports domain.

The sample also consisted exclusively of male basketball players. As Elliott (1992) pointed out, the techniques in taking basketball shots differ between male and female players, which is why future studies should replicate the current findings with female basketball players as well.

Further, the varied instructions in the transcription task could have had an influence on mood, since participants in the depletion condition could have been in a worse mood than participants from the nondepletion condition. However, in the majority of studies on self-control strength, this potential effect has been controlled for and, thus far, there have not been differential effects of self-control manipulation on mood (e.g., Baumeister et al., 1998;

Muraven et al., 1998; Schmeichel et al., 2003). Nonetheless, mood differences should also be considered as a potential explanation for the results presented in this study.

Finally, we cannot draw conclusions about the causal role of state anxiety as we did not experimentally manipulate different levels of state anxiety. Furthermore, it may be possible that the test announcement had unintended effects on factors other than state anxiety (e.g., global affect).

Study 2: Anxiety, Ego Depletion, and Dart Performance

Study 2 served as a replication of the previous findings of Study 1 in a different sport domain, while also addressing the limitations of Study 1. We chose dart as our sports task because darts can also be considered as a far-aiming task that is dependent on selective attention, as one needs to focus on the specific field of interest while ignoring potential distractors (e.g., worries; Vickers et al., 2000). As previously mentioned, increased levels of anxiety can impair one's ability to solely pay attention to the relevant stimuli, potentially leading to impaired performance (Behan & Wilson, 2008; Vickers & Williams, 2007; Vine & Wilson, 2011; Wilson et al., 2009a). However, as in Study 1, we assumed state anxiety to affect sports performance (i.e., dart performance) in interaction with momentarily available self-control strength: We expected a more pronounced negative relation between state anxiety and dart performance for participants in a state of ego depletion compared to participants whose self-control strength was fully available. In addition, we assumed the degree of available self-control strength to affect performance, depending on state anxiety: Depletion of self-control strength should cause stronger performance decrements for participants in an anxiety condition compared to participants in a no-anxiety condition.

In this study, apart from manipulating self-control strength, we additionally experimentally manipulated state anxiety, leading to a 2×2 design. By manipulating state

anxiety, we wanted to make sure that our anxiety instruction actually had an influence on state anxiety and did not have any unintended effects on other factors (e.g., global affect).

Finally, to increase the generalizability of our findings on recreational athletes, our sample consisted of university students who were not performing the specific sports task (i.e., darts) on a regular basis. This was different from Study 1, where amateur athletes participated that were already adept at the specific sports task.

Method

Participants. The sample consisted of $N = 79$ German university students (67 women; six left-handed; $M_{age} = 22.27$, $SD = 3.39$) that voluntarily participated in our study. The participants were randomly assigned to one of the four experimental conditions (depletion - anxiety: $n = 21$; depletion – no-anxiety: $n = 21$; nondepletion – anxiety: $n = 18$; nondepletion – no-anxiety: $n = 19$). The participants received 4 Euros as a reward for their participation (approximately US$6 at the time). Sixty-five participants had dart experience, but none had ever been an active member of a dart club. Participants' pre-experimental mean rating of their dart throwing accuracy on a scale from 0-100 was at 45.73% ($SD = 20.89\%$). Informed consent was obtained before the study began.

Materials and Procedure. We conducted the study in single sessions of approximately 25 minutes each in our laboratory. In one part of the room, the participant performed the dart throws and in another part of the room, the participant worked on a set of paper-pencil questionnaires.

First, participants gave demographic information (age, sex, mother tongue, throwing hand, dart experience, membership in a dart club, and a rating of their dart throwing accuracy).

Then, as a baseline measure for each participant's dart proficiency level, they were asked to throw darts on a regular dartboard (diameter 0.43m), which was set up in a standard

position (i.e., 2.37m distance from the throwing line; centre of the board was at 1.73m height off the ground), with regulation steel-tip darts (weight 22g). We arranged the dartboard as described in a study by Oudejans and Pijpers (2009): There were 10 concentric circles of equal radial width (alternating black and white color) on the face of the board. We allocated points for every circle, starting with 10 for the bull's-eye down to 0 when the board was not hit at all. As opposed to regular dart practice, participants were instructed to hit the center of the target (bull's-eye). Participants threw three sets of three darts each, resulting in 9 throws in total. After each set, the experimenter removed the darts from the dartboard, registered the score for each throw (i.e., according to the value allocated to the specific circle on the face of the dartboard), and handed the darts back to the participant. We calculated each participant's average score per throw.

Next, to assess participants' level of dispositional sport anxiety, they worked on the SAS-2 (Smith et al., 2006). The internal consistencies for the three subscales of the SAS-2 were all satisfactory (worry: $\alpha = .75$; somatic: $\alpha = .80$; concentration: $\alpha = .58$).

In a next step, same as in Study 1, we applied the transcription task to manipulate self-control strength (cf. Schmeichel, 2007). The two depletion conditions consisted of $n = 42$ participants while the two nondepletion conditions consisted of $n = 37$ participants.

The transcription task was followed by a manipulation check ($\alpha = .63$) containing the same three items as in Study 1 (Bertrams et al., 2010), and we again asked participants how they rated their performance in the transcription task by using the same item as in Study 1 as an indicator for perceived self-efficacy.

Next, to make sure that the differential instructions for the transcription task did not lead to differences in mood, we applied the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; German: Krohne, Egloff, Kohlmann, & Tausch, 1996). In the PANAS, one subscale measures positive affect (ten items; $\alpha = .85$) and one subscale

measures negative affect (α = .77) in the given situation. Participants answered each item (e.g., "active" or "worried") on 5-point Likert-type scales from 1 (*not at all*) to 5 (*extremely*).

Then participants were told that they would have to perform another series of dart throws; however, as opposed to the previous study, we manipulated state anxiety with two differential instructions. In the two anxiety conditions (n = 39) we again referred to previous anxiety instructions (Behan & Wilson, 2008; Murray & Janelle, 2003; Wilson et al., 2009a): Participants were informed that it was extremely important to perform as well as possible, and were told that it should not be a problem for a normally gifted human being to perform at a high level. Further, we told them that their performance would be compared with other participants' performances and that they would receive a personal face-to-face feedback from the experimenter. In the two no-anxiety conditions (n = 40), participants were simply told to hit the bull's-eye as often as possible without receiving any further instructions.

To assess the success of the experimental manipulation of anxiety, participants then indicated their actual level of state anxiety on an anxiety thermometer (Houtman & Bakker, 1989). The participants rated their state anxiety level by placing a vertical line on a 10 cm continuous scale, where 0 was at the bottom of the thermometer (indicating not anxious at all) while 10 was on the top of the thermometer (indicating extremely anxious). To calculate each participant's state anxiety score, we measured the distance (cm) from the bottom of the thermometer to the vertical line. The anxiety thermometer has been successfully applied in previous studies (e.g., Oudejans & Pijpers, 2009) and allows for a quick and reliable assessment of state anxiety. However, to rule out the possibility that the anxiety manipulation had any unintended effects on other mood facets, we administered additional thermometers. These additional thermometers measured mood facets that were derived from the Expanded Form of the Positive and Negative Affect Schedule (PANAS-X; Watson & Clark, 1992) and

included four positive emotions (joviality, self-assurance, attentiveness, and serenity) and three negative emotions (sadness, hostility, and guilt).

Participants then were instructed to again throw three sets of three darts each aiming for the bull's-eye. The experimenter handed the darts back to the participant after each set and kept score for each throw. We calculated each participant's average score per throw.

At last, the experimenter thanked the participants and handed them the reward for their participation. The participants were told about the deception and the true aim of the study, and were finally debriefed by the experimenter.

Results

Preliminary analysis. As expected, there were statistically significant group differences in the manipulation check following the transcription task, indicating that the experimental manipulation of self-control strength was successful [depletion: $M = 2.05$, $SD = 0.43$ vs. nondepletion: $M = 1.59$, $SD = 0.39$, $t(77) = 4.84$, $p < .001$, $d = 1.20$].

To test whether there were differences between the groups in baseline dart performance, we conducted a 2 (depletion: yes vs. no) × 2 (state anxiety: yes vs. no) analysis of variance (ANOVA). The interaction term was not statistically significant, $F(1, 74) = 0.63$, $p = .43$, $\eta_p^2 = .01$. Additionally, there were no significant main effects, neither for depletion $F(1, 74) = 0.71$, $p = .40$, $\eta_p^2 = .01$ nor for state anxiety, $F(1, 74) = 1.86$, $p = .18$, $\eta_p^2 = .03$, indicating that the groups did not differ in terms of their baseline dart performance.

We conducted a 2 (depletion: yes vs. no) × 2 (state anxiety: yes vs. no) ANOVA to test for group differences in dispositional sports anxiety in the three subscales of the SAS-2 (Smith et al., 2006). There were no statistically significant differences between the groups in any of the three subscales, as indicated by nonsignificant interactions [worry: $F(1, 75) = 1.62$, $p = .21$, $\eta_p^2 = .02$; somatic: $F(1, 75) = 0.13$, $p = .91$, $\eta_p^2 = .00$; concentration: $F(1, 75) = 0.73$, $p = .40$, $\eta_p^2 = .01$], and by nonsignificant main effects of depletion [worry: $F(1, 75) = 0.05$, p

= .83, η_p^2 = .01; somatic: $F(1, 75) = 0.04$, $p = .85$, $\eta_p^2 = .01$; concentration: $F(1, 75) = 0.39$, $p = .53$, $\eta_p^2 = .01$], and state anxiety [worry: $F(1, 75) = 1.67$, $p = .20$, $\eta_p^2 = .02$; somatic: $F(1, 75) = 0.60$, $p = .44$, $\eta_p^2 = .01$; concentration: $F(1, 75) = 0.01$, $p = .93$, $\eta_p^2 = .00$].

Additionally there were no group differences in how participants rated their performance in the transcription task [depletion: $M = 2.26$, $SD = 0.67$ vs. nondepletion: $M = 2.41$, $SD = 0.76$, $t(77) = -0.89$, $p = .37$, $d = -0.2$].

Further, the PANAS revealed that there were no group differences in mood following the transcription task. Neither for positive affect [depletion: $M = 2.88$, $SD = 0.64$ vs. nondepletion: $M = 2.77$, $SD = 0.62$, $t(77) = 0.74$, $p = .46$, $d = 0.17$] nor for negative affect [depletion: $M = 1.22$, $SD = 0.24$ vs. nondepletion: $M = 1.26$, $SD = 0.40$, $t(77) = -0.62$, $p = .54$, $d = -0.12$].

Finally, the experimental manipulation of state anxiety was successful, as indicated by statistically significant group differences in the scores on the anxiety thermometer [anxiety: $M = 2.52$, $SD = 1.98$ vs. no-anxiety: $M = 1.41$, SD 1.64, $t(77) = 2.71$, $p = .01$, $d = 0.61$]. There were no statistically significant group differences on the other mood thermometers, (ts < 1).

Main analysis. In order to test our main assumption that state anxiety and momentarily available self-control strength interact when predicting dart performance at Time 2, we entered participants' dart performance at Time 2 into a 2 (depletion: yes vs. no) × 2 (state anxiety: yes vs. no) ANOVA. The analysis revealed the expected statistically significant Depletion × State Anxiety interaction, $F(1, 75) = 3.94$, $p = .05$, $\eta_p^2 = .05$. The effect of state anxiety on dart performance was clearly different, depending on whether participants' self-control strength had been previously depleted. Depleted participants' dart performance was significantly lower in the anxiety condition ($M = 4.16$, $SD = 0.89$) than in the no-anxiety condition ($M = 5.06$, $SD = 1.40$), $F(1, 75) = 6.46$, $p < .01$, $\eta_p^2 = .08$. For nondepleted participants, there was no difference in dart performance between the anxiety

condition (M = 4.96, SD = 1.12) and the no-anxiety condition (M = 4.83, SD = 1.08), $F(1, 75) = 0.11$, $p = .74$, $\eta_p^2 = .00$. Additionally, the depleted and nondepleted participants differed significantly in the anxiety condition, $F(1, 75) = 4.69$, $p = .03$, $\eta_p^2 = .06$, but not so in the no-anxiety condition, $F(1, 75) = 0.40$, $p = .53$, $\eta_p^2 = .01$. Figure 1b depicts the main results. As in Study 1, there was no main effect of the experimental condition on performance, $F(1, 75) = 1.21$, $p = .28$, $\eta_p^2 = .02$. Thus there was no statistically significant difference in dart performance between the depletion condition (M = 4.61, SD = 1.25) and the nondepletion condition (M = 4.89, SD = 1.09).

Discussion

We were able to replicate the findings of Study 1 in another sports game that is also dependent on selective attention (i.e., darts) while additionally manipulating state anxiety. Via the manipulation of state anxiety, we were able to draw causal conclusions about the role of state anxiety. We also controlled for the possibility that the anxiety instruction led to differences in other facets of mood. As expected, momentarily available self-control strength moderated the relation between state anxiety and dart performance. There was a significant relation between state anxiety and dart performance only for participants in a state of ego depletion. If the participants had sufficient self-control strength, state anxiety was not associated with impaired performance. Furthermore, in accordance with the results of Study 1, ego depletion led to performance decrements only in an anxiety condition, but not so in a no-anxiety condition. Without taking anxiety into account, self-control strength did not predict dart performance.

The fact that we were able to replicate our findings with a sample that consisted of university students that had never played darts on a regular basis further speaks for the quality of our results. We were also able to demonstrate that the differential instructions for the experimental manipulation of self-control strength did not lead to group differences in

mood or how participants rated their performance, excluding potential alternative explanations for our results.

One could argue the fact that our sample—consisting mostly of female participants—reduces the generalizability of our findings on both sexes. There are studies reporting gender differences in several different motor skills (e.g., catching, jumping, throwing; Thomas & French, 1985, 1987), which is also the case in dart throwing for both novice players (Thomas & French, 1985) as well as for professional players (Duffy, 2002). Therefore, future studies should also test our assumptions on male participants. However, considering that the results in both studies were similar, despite the fact that the sample of Study 1 consisted exclusively of male athletes and the sample of Study 2 almost exclusively of female participants, also speaks for the generalizability of our findings.

General Discussion

In this paper, we demonstrated that the momentary availability of self-control strength moderated the relation between state anxiety and performance in two different sports tasks; in a basketball free-throw task, and in a dart throwing task. Stated another way, in both studies there were significant negative relations between state anxiety and performance for participants in a state of ego depletion, while there were no substantial relations between state anxiety and performance for participants whose self-control strength was fully available. Furthermore, the effect of self-control strength on sports performance depended on the anxiety level: Ego depletion was more likely to impair performance when anxiety was high compared to low. For both sport tasks, we did not find a general effect of self-control strength on sports performance. This finding is line with our assumption that self-control strength should not predict sports performance if there are no distracting stimuli—such as anxiety-related worries—at hand. Additionally, we were able to rule out the possibility that group differences in self-efficacy or in mood were responsible for the results.

We chose a basketball free-throw task and a dart throwing task because, for both of them, selective attention is an important component necessary for successful performance (Oudejans et al., 2002; Ripoll et al., 1986). Selective attention is highly dependent on the momentary availability of self-control strength (Schmeichel & Baumeister, 2010). In our studies, anxious participants in a state of ego depletion may have been impaired in selectively controlling their attention. Thus depleted anxious individuals may not have been able to override their automatic tendency to pay attention to task-irrelevant, attention-grabbing stimuli (e.g., anxiety-related worries) and instead focus on the task-relevant stimuli (i.e., the basket, or the dartboard), which led to poorer performance.

The current results are in line with the assumptions of the attentional control theory (ACT; Eysenck et al., 2007), which is based on processing efficiency theory (PET; Eysenck & Calvo, 1992). The basic principle of ACT and PET is that anxious individuals need to invest more effort than nonanxious individuals to perform at a comparable level. In this case, more effort means paying selective attention; namely, inhibiting the automatic tendency to focus on distracting stimuli (e.g., worries) and to shift the focus on the relevant stimuli instead (i.e., the basket, the dartboard). According to Schmeichel and Baumeister (2010), paying selective attention is a self-control act that is dependent on the momentary availability of self-control strength. Therefore a combination of ACT and PET with the strength model of self-control may be a fruitful approach to explain performance impairments under anxiety: Depleted anxious individuals do not have the necessary self-control strength to invest more effort and to selectively control their attention. If anxious participants, however, have sufficient self-control strength, they can counteract the detrimental anxiety effects and shift their attention to the relevant stimuli. This assumption receives further support from the fact that there are also studies that did not report a negative relation between anxiety and performance (e.g., Gould, Petlichkoff, Simons, & Vevera, 1987; Hammermeister & Burton,

1995; Woodman & Hardy, 2003): In these studies, anxious individuals may have had the self-control strength to selectively control their attention.

There are some further issues in the current paper that need to be addressed. First of all, the tasks we applied to deplete participants' self-control strength were not specifically related to sports. However, we felt the need to apply an established task to manipulate self-control strength in these pilot studies in order to gain initial empirical feedback on our research rationale. Nonetheless, during sporting competitions there are several potential situations that can lead to a depletion of ones' self-control strength. For instance, obeying specific rules of a sport may require a great deal of self-control, as it would be easier to win a competition by cheating; also resisting the temptation to commit a foul on an aggressive opponent can be considered as a self-control act. A challenge for future studies is to find innovative approaches to manipulate self-control strength in a more realistic sports-related manner.

Furthermore, in our study we assumed that anxious individuals in a state of ego depletion are less able to direct their attention away from distracting, irrelevant stimuli and to the task-relevant stimuli instead. Future studies should test this assumption more specifically, for instance, by assessing participants' gaze behavior, or more precisely, the *quiet eye* (i.e., the final fixation before completing the aiming task in sports), which is widely used as an indicator for efficient attention control (e.g., Behan & Wilson, 2008; Vickers, 1996; Vickers & Williams, 2007). Anxious athletes' gaze behavior has been found to be different compared to nonanxious ones', as they have shorter quiet eye periods and are less adapt at suppressing their tendency to look at other, irrelevant stimuli (Behan & Wilson, 2008; Janelle, Singer, & Williams, 1999; Mann, Williams, Ward, & Janelle, 2007; Vickers, 1996; Vickers & Williams, 2007). For instance, anxious participants performing a soccer penalty kick, compared to nonanxious participants, had significantly more and longer fixations on the

goalkeeper (i.e., the threatening external stimulus) than on one of the corners of the goal, which led to more centralized and thus unsuccessful penalty kicks (Wilson et al., 2009b). One can explain the results of this study by Wilson and colleagues by referring to the assumptions of ACT (Eysenck et al., 2007): The anxious participants were not able to selectively control their attention, and thus were unable to inhibit their automatic tendency to pay attention to distracting stimuli (i.e., the goalkeeper) and to shift their attention to the relevant stimuli instead (i.e., the corners of the goal). We assume, however, that anxious individuals whose self-control strength is intact should be able to counteract this increased distractibility and to focus on the relevant stimuli by selectively controlling their attention. By analyzing the gaze behavior of anxious athletes performing a sports task while depending on their momentarily available self-control strength, it would be possible to gain further support for our assumption about the role of self-control strength on attention regulation under anxiety in sports tasks.

The present results have some practical implications for counteracting the negative anxiety effects on sports performance. According to the strength model of self-control, the self-control resource is comparable to a muscle which can be strengthened through specific strategies (for an overview, see Baumeister, Gailliot, DeWall, & Oaten, 2006). For instance, regular self-control exertion can improve self-control strength (e.g., restraining from cursing; Gailliot, Plant, Butz, & Baumeister, 2004). Furthermore, relaxation can help to revitalize a depleted self-control resource (Tyler & Burns, 2008), and additionally, self-affirmation has been shown to be a successful strategy for overriding the depleting effects of self-control demands (Schmeichel & Vohs, 2009). Applying specific self-control improving strategies could benefit anxious athletes in sports competitions by enabling them to focus on the actual situational demands instead of on task-irrelevant stimuli.

To conclude, taking the strength model of self-control (Baumeister, 2002; Baumeister et al., 2007; Muraven & Baumeister, 2000) into account as a moderator for the negative

influence of anxiety on sports performance could lead to the development of valuable training approaches to help athletes perform to their best capabilities, even under potentially threatening circumstances.

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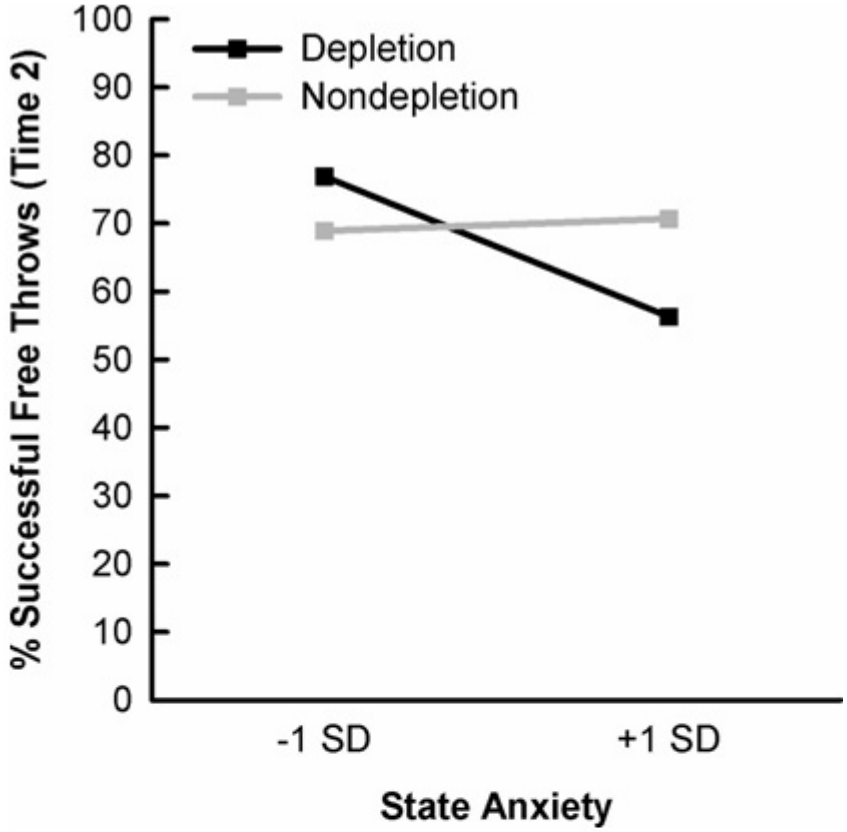
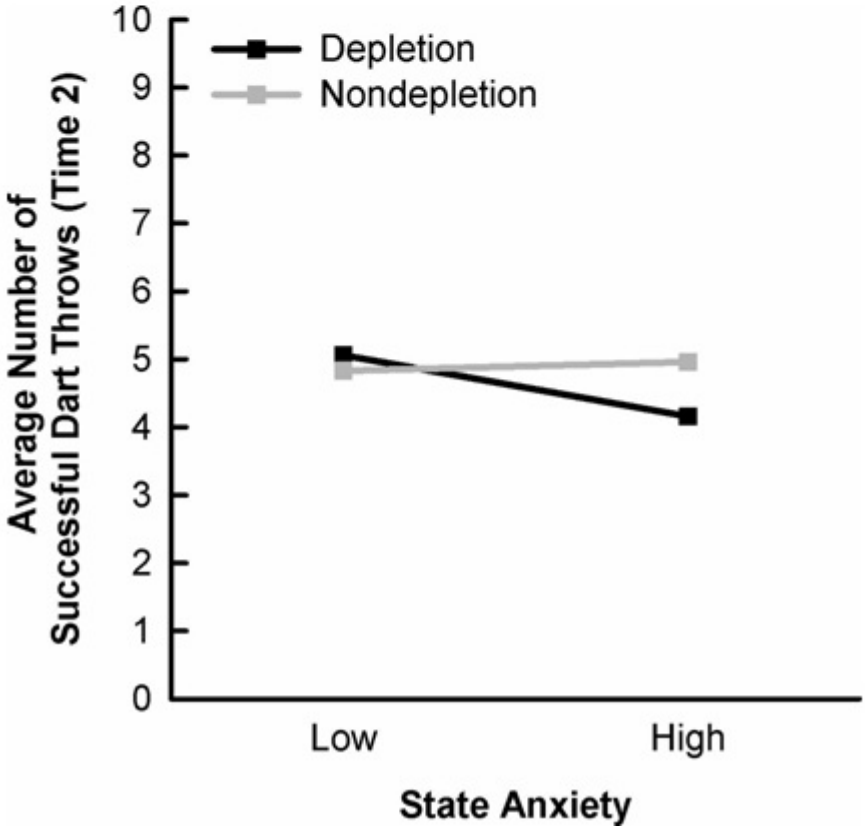
Figure Caption

Figure 1. (a) Basketball free-throw performance (Time 2) in Study 1 and (b) average number of successful dart throws (Time 2) in Study 2 depending on state anxiety and self-control strength (depletion vs. nondepletion of self-control s trength). Black line = depletion condition, grey line = nondepletion condition.

(a)


100
90
80
70
60
50
40
30
20
10
0
% Successful Free Throws (Time 2)
Depletion
Nondepletion
-1 SD
+1 SD
State Anxiety

(b)


10
9
8
7
6
5
4
3
2
1
0
Average Number of Successful Dart Throws (Time 2)
Depletion
Nondepletion
Low
High
State Anxiety