Chapter 22
Self-Control in Sports

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Chapter Overview

Imagine yourself walking to the gym in the rain after a long hard day at work. Picture yourself lifting heavy weights, even though you would prefer sitting on the sofa watching your favorite baseball team win a playoff match. This is just one sports-related example during which self-control processes enable us to keep striving for a desirable goal and suppress potentially tempting action alternatives. In general, "self-control refers to the capacity for altering one's own responses, especially to bring them into line with standards such as ideals, values, morals, and social expectations, and to support the pursuit of long-term goals" (Baumeister et al., 2007, p. 351). However, self-control is not always applied effectively as, for instance, evidenced by the large number of gym dropouts every year (e.g., Englert & Rummel, 2016).

In this chapter, we will discuss empirical findings that highlight the importance of self-control for sports-related performance and we will introduce the theoretical accounts that try to explain why self-control sometimes appears to fail. Finally, we will discuss open research questions in order to improve our understanding of how self-control operates and why it cannot be applied at all times and at all costs.

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Self-Control and the Sensation of Effort

Research on self-control[1] has a long tradition: Narcissus Ach conducted the first studies on self-control already in the beginning of the 20th century (Ach, 1905, 1935). In general, there is a common agreement amongst researchers that exerting control over the self can be a tiring and unpleasant experience. In the mid-20th century, Hull already stated that impulses or response tendencies have a motivational strength, suggesting that in order to resist these tendencies one must invest some kind of effort or willpower (Hull, 1943). Thus, the application of self-control is intrinsically linked to the sensation of effort (e.g., Kurzban, 2016; Shenhav et al. 2017). This sensation commonly refers to “the particular feeling of that energy being exerted” and is associated with “a sensation of strain and labor, a feeling that intensifies the harder a person tries” (Preston & Wegner, 2009, p. 570). This feeling of work is associated with voluntary actions and provides crucial information for the judgement of personal actions (Preston & Wegner, 2009).

Self-Control and Sports Performance

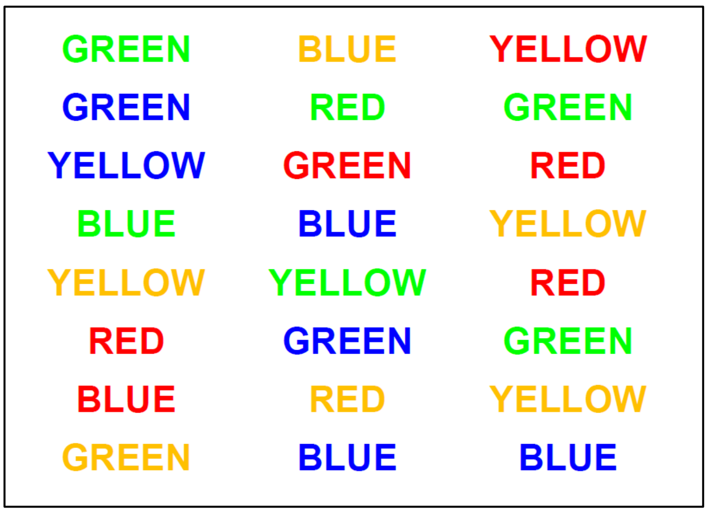
Imagine you had a long day at work, where you had to face multiple self-control demands: For example, you had to perform a very tedious task, where you had to enter an endless string of numbers into a spreadsheet. Additionally, your colleague was constantly talking loudly on the phone and you had a hard time concentrating. It is very likely that after this day you feel mentally drained and can’t (see heading *Can’t: Does the application of self-control deplete a limited resource?)* or won’t (see heading *Won’t: Does self-control reflect a reward-based choice?*) invest the mental effort that would be required to beat your personal best in a 10.000 meter run. The bulk of self-control research in sports has focused on precisely this phenomenon: the effect of prior self-control application on subsequent sports performance (for two recent meta-analyses and one book chapter, see Brown et al., 2019; Giboin & Wolff, 2019; Pageaux & Lepers, 2018).

In this line of research, scientists primarily adopt a *two-task-paradigm*: A primary task which either does or does not require the exertion of self-control or intense mental effort and a subsequent secondary task which requires self-control from all participants (e.g., Muraven et al., 1998). One of the most frequently administered self-control tasks is the *Stroop* task during which participants work on a series of color words which are either written in the same font color as the color word (e.g., “red” written in red font color; congruent trial) or in a different font color (e.g., “red” written in yellow font color; incongruent trial; Stroop, 1935; see Figure 22.1). To correctly identify the incongruent trials, one must override the dominant tendency to read the color word and instead name the font color. It has frequently been shown, that participants who have worked on a series of incongruent Stroop trials tend to perform worse in secondary self-control tasks than participants who have previously answered the congruent version of the Stroop task (e.g., Bray et al., 2011; Englert & Wolff, 2015). To assess the effects of prior mental exertion on sports performance, performance in specific sporting tasks is used as a secondary self-control task in sport psychology research. For example, Boat and Taylor (2017) asked their participants to perform a wall-sit-task for as long as possible after having worked on a primary task, which either did or did not require self-control. The results revealed that the wall-sit durations were significantly shorter in participants who had to control their impulses in the previous task. Thus, the primary self-control task had reduced the capability or willingness to apply the self-control that would be required to do well in the wall-sit task (also see Zering et al., 2017). Englert and Wolff (2015) tested the effects of prior mental exertion on endurance performance in an indoor cycling task. In their study, participants performed the indoor cycling task at two times of measurement. The experimental setup was almost identical with the only difference being that at one time of measurement participants

[1] According to Duckworth and Kern (2011), the terms self-regulation, willpower, or inhibitory control are synonyms for self-control and supposedly capture the same psychological phenomenon.

worked on a self-control demanding primary task (i.e., incongruent Stroop task), while at the other time of measurement they completed a less self-control demanding primary task (i.e., congruent Stroop task). Again, participants performed worse after they had worked on the self-control demanding primary task, compared to when they worked on the less demanding primary task. Apparently, the same participants were less capable or less willing to push themselves to their limits during the cycling task if they had to control their impulses in the previous task (see also, Martin Ginis & Bray; 2010; Wagstaff, 2014). In line with these studies, meta-analytic evidence supports the notion that prior mental exertion is a detriment to subsequent sports performance (Brown et al., 2019; Giboin & Wolff; 2019).

Figure 22.1
Illustration of the Stroop task



Note. Categorizing the words' font color is easier and faster when font color and meaning match ("congruent") compared to when they differ ("incongruent").

Research has also shown that prior mental exertion impairs sports-related performance under pressure (for an overview, see Englert, 2015; Englert & Bertrams, 2015). In general, anxiety negatively affects efficient attention regulation as anxious individuals are more likely to be distracted by irrelevant stimuli (e.g., the crowd or worrying thoughts; e.g., Wilson et al., 2009). In order to shift the focus away from the irrelevant stimuli onto the actual task at hand, self-control is highly important (Schmeichel & Baumeister, 2010). However, if prior mental exertion affects the capability or willingness to effectively apply self-control, it should be more difficult to flexibly shift attention away from these stimuli, potentially affecting performance. Empirical evidence has reliably supported this assumption. For instance, Englert and Bertrams (2012) instructed basketball players to perform a series of free-throws under high and low anxiety conditions after having worked on a self-control demanding or a non-demanding primary task. In the high anxiety condition, participants scored a significantly lower number of successful free-throws when they had worked on the self-control demanding primary task, compared to those who had worked on the non-demanding task (see also, Englert & Bertrams, 2015; Englert, Zwemmer, Bertrams, & Oudejans, 2015; Shin et al., 2019; Yang et al., 2019).

Prior Mental Exertion Does Not Impact All Types of Physical Performances

Since the study of Marcora et al. (2009), the effects of prior mental exertion on subsequent physical performance has also been a growing topic of interest for exercise (neuro)physiologists. While these researchers mainly refer to mental fatigue induced by prolonged engagement in cognitively demanding tasks, they are using similar experimental setups involving the sequential task paradigm (for reviews, see Brown et al. 2019; Pageaux & Lepers 2018). In these studies, the classical Stroop paradigm is used, as well as other tasks such as the AX Continuous Performance test known to involve sustained attention, working memory, and response inhibition processes. The principal difference between the two approaches is that exercise neurophysiologists traditionally use longer primary tasks compared to the psychological self-control researchers (50±27 vs 5±3 minutes; Giboin & Wolff, 2019).

During sporting events, athletes' performance is linked to their ability to accurately and efficiently produce different types of physical performance. As an example, during a game, basketball players are confronted with physical efforts that drastically differ in nature. They have to sprint as fast as possible in a fast break situation to take advantage of the defense, throw the ball as accurately as possible to score points, decide when to pass the ball to their teammate in the most accurate timing, or have to repeat a vast number of efforts over the course of the game. These examples in the context of basketball illustrate that athletes' performance can be subdivided into their ability to a) produce a given speed, power or force as fast as possible (i.e., maximal force production, sprinting), b) efficiently perform goal-directed movements (i.e., motor skills performance, shooting), c) make accurate decisions based on the information provided by the environment (i.e., decision-making performance, passing), and d) repeat their effort for a prolonged duration (i.e., endurance performance). Therefore, athletes and coaches would greatly benefit from research that specifically assesses the effects of prior mental exertion on each subgroup of physical performance that is required in sports.

Interestingly, a recent meta-analysis questioned the magnitude of the detrimental effect of prior mental exertion, also referred to as mental fatigue, on subsequent physical performance (Holgado et al., 2020). However, it is important to note that this effect size is likely to hinge on the specific nature of the subsequent physical performance. It is plausible that due to differences in physiological and psychological demands of different sports-related performances, prior mental exertion could differentially impact these various performances. This possibility has not been accounted for in this recent meta-analysis. Building on this rationale proposed by Pageaux and Lepers (2018), Brown et al. (2019) confirmed in their meta-analysis a performance dependant effect of prior mental exertion. It appears that contrary to endurance performance, motor skills performance and decision-making performance, maximal force production is not impaired by prior mental exertion. In other words, when an athlete is mentally fatigued, their sprinting or jumping performance is unlikely to be affected, whereas their endurance performance, movement precision or decision making are all likely to suffer.

While further research is needed to better understand why prior mental exertion specifically impacts some types of physical performances, it is worth noting that the only subgroup of physical performance not impacted by mental fatigue, maximal force production, is the only kind of performance where self-control might not be critically present. Indeed, in this kind of performance, the athlete has to produce an all-out-effort that does not require taking any specific decisions and/or choosing between different conflicting action alternatives (e.g., endurance: deciding to quit / slow-down or not; motor skills: choosing and executing the appropriate movement; decision-making: choosing an action between different action alternatives). This observation reinforces the link between the self-control and mental fatigue literature, and highlights the need of multidisciplinary research breaking the traditional barriers between sport psychology and exercise (neuro)physiology to better understand how sports-related performance is regulated.

Self-Control Failures: Can't or Won't?

As we have seen so far in this chapter, a large body of empirical evidence attests to the importance of self-control for sports performance (for a review, please see Englert 2017, 2019). Particularly, the detrimental effects of prior mental exertion on subsequent physical performance has been well supported (Brown et al., 2019; Giboin & Wolff, 2019; see also Pageaux & Lepers 2018). This begs an important question: Why does prior mental exertion have these detrimental effects? Or more generally, what are the operating principles that underlie the application of self-control, and why does it sometimes appear to fail?

To answer these questions, a plethora of theoretical models have been developed in recent years (Baumeister, 2003; Kool & Botvinick, 2014; Kurzban et al., 2013; Shenhav et al., 2013; Shenhav et al., 2016; Wolff & Martarelli, 2020). While most researchers seem to agree on the observation that applying self-control is perceived as effortful and produces some form of cost, there is less agreement on the nature of this cost (Shenhav et al., 2017). Broadly, one theoretical branch proposes that the exertion of self-control reduces the *capacity* to further apply self-control (Baumeister, 2003), while the other branch proposes that it reduces the *willingness* to apply self-control (Inzlicht & Schmeichel, 2012).

Photo by Karolina Grabowska from Pexels

Can't: Does the Application of Self-Control Deplete a Limited Resource?

One of the most prominent theoretical explanations for the observation that we do not apply self-control consistently conceives self-control as a limited resource (Muraven et al., 1998). Such resource-based accounts assume that individuals are less adept at controlling themselves after having previously engaged in another self-control demanding task (e.g., Audiffren & André, 2015; Englert, 2017, 2019). The resource-based account that has shaped the last 20 years of psychological self-control research is the strength model of self-control (e.g., Baumeister et al., 2007). The strength model postulates that there is only a limited amount of self-control strength available at a given point of time (e.g., Baumeister et al., 2007). Supposedly, all actions which require self-control draw upon this finite resource, meaning it is not domain-specific. Importantly, according to the strength model, the resource can become temporarily depleted after a primary self-control act and is not immediately replenished, which is a state labelled as *ego depletion* (e.g., Muraven et al., 1998). The strength model of self-control has been frequently adopted to explain sports-related performance in several domains (e.g., endurance performance, impulse regulation, performance under pressure; for an overview, Englert, 2017, 2019; see also Ntoumanis, 2014). Thus, according to the strength model of self-control, the detrimental effect of prior mental exertion on subsequent sports performance is due to ego depletion: The self-control demanding task depletes the participants' self-control strength, thereby leaving them unable to perform the sporting task as efficiently as their non-depleted peers, who had performed a less self-control demanding primary task.

Despite their popularity and intuitive appeal, resource-based accounts have recently been questioned on empirical (e.g., Wolff, Baumann, & Englert, 2018; Wolff, Sieber, et al., 2019) and on theoretical grounds (e.g., Inzlicht & Berkman, 2015; Inzlicht & Schmeichel, 2012; Kurzban et al., 2013). In 2016, the results of a preregistered replication report did not find any significant empirical evidence for the ego depletion effect (Hagger et al., 2016) and also other replication attempts often failed to support the assumptions of the strength model (e.g., Blázquez et al., 2017; Vohs et al., 2021; Witte & Zenker, 2017), raising questions regarding its validity. In addition, the robustness of the ego depletion effect has further been questioned by research pointing towards evidence for publication bias and to a large body of grey literature in ego depletion research (Wolff, Baumann et al., 2018). It is important to note that most of the published replication failures have been outside the sports context and two recent sports-related meta-analyses of the published literature revealed that prior mental exertion was related to lower endurance, motor skills and sports-related decision-making performances (Brown et al., 2019; Giboin & Wolff; 2019). In addition, if prior mental exertion depletes a resource, then the performance impairment on the secondary task should scale as a function of the primary tasks' duration (Hagger et al., 2010). While some researchers have found such a relationship (Boat et al., 2020; Brown & Bray, 2017), other large scale studies have failed to do so (Wolff, Sieber, et al., 2019), and the two meta-analyses by Giboin and Wolff (2019) and Brown et al. (2019) revealed that task duration was unrelated to the subsequent drop in endurance performance. In light of these findings, researchers have increasingly turned to explain the application of self-control as a reward-based choice, thereby circumventing the notion of a limited (but not yet identified) self-control resource (Kurzban et al., 2013).

Won't: Does Self-Control Reflect a Reward-Based Choice?

Emerging evidence on the effect prior mental exertion has on subsequent performance is not fully in alignment with the notion of limited resources. In addition, it has been argued that without specifying and identifying *which* physiological resource becomes depleted when self-control is applied, then the notion of resources represents an unnecessary assumption (Inzlicht & Schmeichel, 2012). To illustrate, if you do not perform well on a secondary task after having applied self-control in a primary task, then this drop in performance must not necessarily mean you *can't* perform well. It might simply mean you *won't* be willing to perform another effortful self-control task. Indeed, research shows that the effects of prior mental exertion can be readily offset; for example, by incentivizing the secondary task with money (Muraven & Slessareva, 2003), thereby indicating that subsequent performance impairments might rather be a motivational phenomenon. This finding is hard to reconcile with the notion of limited resources. However, it also shows that applying self-control is indeed costly and people are only willing to incur these costs if the prospective outcome is worth the effort. In line with this reasoning, recent theoretical and empirical work has focused on explaining the costs of self-control beyond limited resources, as well as on the decision processes that govern the application of self-control (e.g., Kurzban et al., 2013; Shenhav et al., 2013; Wolff & Martarelli, 2020).

Beyond Limited Resources: Why is Self-Control Costly?

If self-control indeed does not rely on a global depletable resource but is nevertheless costly to apply, what is it that makes self-control costly? Various explanations have been put forward to explain the costs of self-control and these must not be mutually exclusive (Shenhav et al., 2017).

One explanation that has been supported by recent computational work is that applying self-control produces the sensation of effort due to functional processing constraints in the brain (Feng et al., 2014). According to this view, the brain has developed a preference for sharing neural representations (i.e., a preference for multiplexing) between various mental operations because this facilitates learning (Musslick et al., 2016). The reliance on shared representations for different operations severely limits our capacity for multitasking (i.e., for doing multiple tasks simultaneously), and tasks that tap into the same neural representation require self-control to avoid the detrimental impact of "cross-talk" that occurs when two tasks compete for the same local processing resource (Cohen et al., 1990). To illustrate, during an incongruent Stroop trial, the automatic response would be to categorize the word according to its meaning and this interferes with the task demand of categorizing it according to its font color. The perceived effort that co-occurs with applying self-control then indexes the costs that arise when tasks compete for the same neural representation and require self-control to prevent cross-talk (Shenhav et al., 2017). This explanation can account for replication failures in ego depletion research, where, instead of performing worse, participants sometimes even improved on a self-control demanding secondary task over time (Wolff, Sieber, et al., 2019): Longer exposure to an initially self-control demanding task is expected to make this task less reliant on shared representations and allow for a more automatic task execution (Cohen et al., 1990). This might be one reason for the heterogeneous findings in regard to the effect of primary task duration on subsequent performance in the ego depletion and mental fatigue literature.

Beyond costs that are intrinsic to the application of self-control, it has been proposed that self-control produces opportunity costs (Kurzban et al., 2013). According to this view, applying self-control towards one goal implies that one has to forego behavioral alternatives that might be pursued instead. Thus, while one is responding to an incongruent Stroop trial, one cannot use valuable processing capabilities for a task that might be more rewarding. The perceived effort that arises when self-control is applied is then thought to signal the incurred opportunity costs. This explanation can, for example, explain replication failures in ego depletion research, where participants perceived to be depleted (i.e., they perceived the task to be very costly) and the amount of perceived depletion scaled as a function of task duration (i.e., the longer the task, the costlier it felt), but did not show signs of impaired performance (Wolff, Sieber, et al., 2019). Thus, although a task produced very high opportunity costs, this did not impair performance because presumably no resource had been depleted. Likewise, an opportunity cost account on self-control can explain why monetary incentives offset ego depletion effects: If applying self-control yields a sufficient reward then it should make the costs worthwhile.

Taken together, functional processing constraints and opportunity costs provide compelling alternative explanations as for why the application of self-control is costly. An opportunity costs account also points to the conditions under which people are willing to incur these costs: the rewards need to outweigh the costs of self-control.

Self-Control as a Reward-based Choice: The Expected Value of Control (EVC)

In light of the well-established costs of applying self-control, researchers have become increasingly interested in explaining the conditions under which people are willing to incur these costs. Similar to opportunity cost accounts of self-control, most recent theoretical accounts conceptualize self-control as a reward-based choice, in which the benefits of an ongoing activity are pitted against the costs of the self-control that is required to continue with this activity (Kool & Botvinick, 2014; Shenhav et al., 2013, 2016). For example, while one might see substantial prospective benefits in running (e.g., getting in better shape), this benefit needs to outweigh the self-control costs one incurs when running despite being tired. One recent theory that has gained a considerable amount of traction is the Expected Value of Control (EVC) theory (Shenhav et al., 2013, 2016). EVC theory integrates assumptions from other reward-based theories and provides a mathematically explicit and mechanistically coherent framework for explaining self-control. In a nutshell, EVC theory proposes that people try to maximize the EVC. This is achieved by comparing the perceived prospective rewards that can be attained by a self-control demanding action (e.g., getting in better shape by running) with the costs of applying a given amount of self-control (e.g., sustaining the fatigue due to running and the opportunity costs of not being able to do something else while running) and by taking into account the temporal delay with which these rewards will be obtained (e.g., getting in better shape with running will take a couple of weeks and this delay in rewards affects the EVC of applying control towards getting fitter). Recent simulation studies have provided support for this proposed computational basis of self-control (Lieder et al., 2018; Musslick et al., 2015). In regard to its mechanistic basis, the EVC theory proposes that the dorsal Anterior Cingulate Cortex (dACC) computes the EVC and specifies the control signal where the EVC is maximized. The specified self-control command (e.g., resist the impulse to slow down during the run) is then executed by structures in the lateral Prefrontal Cortex (lPFC). These proposed mechanistic underpinnings are well supported by neuroscientific evidence (Shenhav et al., 2013). Importantly, emerging evidence in the sports context has provided ample support for the proposed role of lPFC during self-controlled sports performance (for an overview, see Wolff, Hirsch, et al., 2021). For example, a systematic review showed that lPFC activity covaried with the difficulty of an endurance task (Rooks et al., 2010). Thus, when the sporting task was more self-control demanding, because it required more effort, then activity in a key area for applying self-control increased. Linking this pattern more directly to self-control, one study investigated the effects of forming implementation intentions on lPFC activation during a strenuous static muscular endurance task (Wolff, Bieleke et al., 2018). Compared with a control group, participants who had formed an implementation intention exhibited a less pronounced increase in lPFC activation during the strenuous task. This finding is in line with research outside the sports setting showing that implementation intentions make goal-pursuit less self-control demanding (Bayer et al., 2009). Further support for the lPFC's role in dealing with the self-control demands of sports comes from research showing that individuals who score high on a self-report measure of self-control display a less steep increase in lPFC activation and mental exertion during an isometric handgrip task (Wolff, Schüler, et al., 2019). Thus, high self-control might allow people to process self-control demands more efficiently (as indicated by less pronounced increase in lPFC activation) and thereby reducing the perceptual costs of performing a physically demanding task (as indicated by a less pronounced increase in mental exertion).

Conclusion

In the previous sections we have explicated different theoretical explanations for the costliness of applying self-control and have discussed how sports-related performance is likely to hinge on effective allocation of self-control. We have also briefly presented the negative impact of prior mental exertion on subsequent sports-related performances. With the importance of self-control in sports being widely acknowledged and the rapid theoretical progress that has been made in recent years, several fascinating research questions remain. To conclude this chapter, we would like to discuss a set of research questions that we deem to be particularly interesting for further advancing our understanding of self-control in sports.

The Relevance of Sport-Specific Expertise for Self-Control Performance

It is reasonable to assume that athletes who are used to controlling their impulses during a sporting competition are more adept at doing so, meaning their self-control performance should not be as strongly affected by previous self-control demands as in beginners. To the best of our knowledge, there are only very few studies which have focused on this issue in sports-related settings (e.g., Martin et al., 2016). A notable exception is a recent study by Englert and colleagues (2020), in which they asked elite and amateur rifle shooters to perform two 1-hour shooting rounds consisting of 50 shots each. The shooters also reported their perceived level of self-control strength at the beginning of each shooting round and after 10 shots each. The results revealed that in amateurs, the level of perceived self-control strength decreased significantly over the course of each shooting round, while their shooting accuracy also decreased over time. Interestingly, there was neither a decrease in perceived self-control strength nor a significant drop-off in shooting accuracy in elite performers. These results illustrate how expert performers might be less likely to suffer from multiple self-control demands during a sporting competition and how this helps them to keep performing at a high level (see also Englert et al., under review). In a similar fashion, Martin et al. (2016) asked eleven professional and nine recreational road cyclists to complete a 20-min cycling time trial following a 30 min Stroop task (mental exertion condition) or a 10 min control task (control condition; order counterbalanced). The results revealed no significant differences in time trial performance between the two conditions for the professional cyclists, while recreational cyclists performed worse in the mental exertion condition. The question is though, why is that the case? One possible explanation might be that in order to achieve an elite status, athletes must generally be especially adept at controlling their impulses across several domains (e.g., forcing yourself to go to practice every day, to not eat too much candy, to not go out before a game day). According to De Ridder and colleagues (2012), some individuals are generally better at controlling themselves than others, as for some it might be a constant struggle to resist the last piece of cake, while for others it is rather easy. The general ability to control your impulses is referred to as trait self-control (Tangney et al., 2004). In line with this assumption, Wolff, Bertrams, and Schüler (2019) found out that youth soccer players with higher levels of trait self-control were more likely to be selected for a talent development program than players with lower levels of trait self-control. In the same vein, in a study by Toering and Jordet (2015), Division One soccer players in Norway were generally more adept at controlling their impulses than amateur players. If high levels of trait self-control are indeed required to achieve elite status in a specific sport, this would have an important impact on player drafting strategies: Tryouts should not only focus on sport-specific skills and the well-known psychological skills, but also assess each athletes' self-control skills. A second explanation might be that repeatedly being confronted with the multiple self-control demands of a sporting competition makes the demands less demanding. For instance, for an elite rifle shooter it should be less difficult to ignore distracting stimuli than for an amateur, simply because he or she is used to it. If this is actually the case, even players with lower levels of trait self-control can achieve elite status. Given the fact that not all professional athletes seem to be capable of always regulating their impulses, this second explanation seems more likely. Future research is therefore highly necessary, to dig deeper into the relationship between sport-specific expertise and (self-control) performance.

Boredom as an Overlooked Self-Control Demand

Throughout this chapter, we have implicitly linked self-control with the completion of challenging and difficult tasks like completing an incongruent Stroop task or running a marathon. This is in line with the bulk of self-control research in the sports setting and beyond. However, recently it has been proposed that boredom, a sensation that occurs when tasks are over- or underchallenging and/or feel meaningless (Westgate & Wilson, 2018), might pose a substantial self-control demand (Wolff & Martarelli, 2020; Martarelli & Wolff, 2020). More specifically, boredom is thought to act as a signal that one's resources should be deployed elsewhere (Bieleke & Wolff, in press), thereby making it harder to continue with an ongoing course of action (Bench & Lench, 2019; Danckert & Eastwood, 2020; Westgate & Wilson, 2018; Wolff & Martarelli, 2020). Supporting the link between boredom and self-control, preliminary evidence outside the sporting context shows that boredom makes it more difficult to adhere to a goal and self-control moderates how well people deal with these difficulties (Danckert et al., 2020; Bieleke et al., 2010; Wolff et al., 2020). Surprisingly, although the relevance of boredom in the context of repetitive athletic training has been emphasized already in the early parts of the 20th century (Davies, 1926), research on boredom and self-control in sports is scarce (Wolff, Bieleke, Martarelli, & Danckert, 2021). We know of only one study that has assessed the link between both concepts in the sporting context: Wolff and colleagues showed that boredom and self-control combine into distinct latent personality profiles that are linked to the weekly amount of exercise (Wolff, Bieleke, Stähler, & Schüler, 2021): One profile was characterized by a combination of low boredom and high self-control and this was linked with more exercise. The other profile displayed the reverse pattern and was linked with relatively lower levels of exercise. Taken together, conceptual work, empirical evidence from outside the sporting context and first evidence from the sporting context all point towards a close link between boredom and self-control. Investigating how boredom modulates the self-control demands of sports and how boredom might be alleviated will be important and fascinating questions for future research.

Can Effort Be Valuable?

In this chapter, we have emphasized the intrinsic relationship between effort and self-control and have reiterated that the sensation of effort feels costly and that people, in general, try to avoid it. However, at times sport seems to be somewhat at odds with these premises. To illustrate, hobby runners who sign up for a marathon voluntarily pay entry fees for an event they have no hope of winning and apply considerable amounts of self-control to complete the race (Maxcy et al., 2019). Indeed, it has been argued that people do this not despite the associated effort but rather because it requires effort (Loewenstein, 1999). In this case, instead of reducing an activity's value, effort appears to add value. This effort paradox has only recently been recognized by self-control researchers (Inzlicht et al., 2018) and sport seems to be ideally suited to further investigate this phenomenon (Wolff, Hirsch, et al., 2021). EVC theory indicates two ways how effort might indeed add value. First, the amount of effort that has gone into an achievement might affect its perceived value. For example, having mustered the self-control to go out for a run after a hard day at work might feel particularly rewarding. Second, applying self-control might become a secondary reinforcer in its own right. For example, an athlete who repeatedly learns to associate effort with value (e.g., "hard training makes me stronger!") might start to seek out effortful activities irrespective of the outcome they yield. It is important to note that while ECV theory provides testable ways how effort might add value, this has so far been a theoretical blind spot that requires more research (Inzlicht et al., 2018). Therefore, investigating this effort paradox, particularly in the sports setting, appears to be a particularly promising question for future research.

Better Understanding Perception of Effort to Improve Our Knowledge on Self-Control

As previously described in this chapter, self-control is associated with the sensation of strain and labor. This sensation is traditionally defined in the exercise science literature as the perception of effort or the sense of effort (Marcora, 2010; Pageaux, 2016). Interestingly, as self-control is known to interact with mental fatigue, perception of effort has been identified as the key variable explaining the observed decreased performance in its presence (Marcora et al., 2009). Perception of effort is also, to the best of our knowledge, the only variable systematically altered by both physical and mental exertion inducing fatigue (Le Mansec et al., 2018; Pageaux & Lepers, 2016). The sensation of effort is also present in the physical and mental domain (Preston & Wegner, 2009). Indeed, effort is perceived when engaging in various tasks such as jogging, walking up the stairs, completing Sudoku, or revising for an exam. Therefore, it seems tempting to propose that investigating the perception of effort could be an ideal way of improving our knowledge of self-control. Other evidence of the potential interest of better understanding perception of effort to better understand self-control, is the close link between self-control and performance in the physical and mental domains (e.g., Englert, 2017, 2019). As self-control, effort and its perception are widely recognized in the psychophysiology literature to be a key determinant of performance (see the motivational intensity theory: e.g., Brehm & Self, 1989; Richter et al., 2016; and the psychobiological model of endurance performance: e.g., Marcora, 2019; Pageaux, 2014). Self-control is also interacting with pain (Silvestrini & Rainville, 2013; Silvestrini et al., 2020), another perception that is known to be inherently costly and to interact with performance (Torta et al., 2017). While this accumulation of evidence reinforces the rationale of better understanding perception of effort to improve our knowledge of self-control, it has to be acknowledged that so far, most of the research on self-control and perception of effort is performed in "silos". Merging the literature from psychology, psychophysiology, neuroscience and exercise neurophysiology could be of great interest to better understand the overlap between self-control and perception of effort. Such multidisciplinary research would allow us to gain unique integrative knowledge of the underlying neurophysiological mechanisms of self-control and perception of effort. This will most likely lead to the opportunity of creating, tailoring, and implementing unique interventions aiming at improving performance, such as brain endurance training (Dallaway et al., 2021; Marcora et al., 2015), mindfulness (Bernier et al., 2009; Stocker et al., 2019), or hypnosis (Barker et al., 2013; Pates et al., 2001). The rationale for researchers from the aforementioned disciplines to team together and unify their strength is strong as it cannot be ignored that our mind, and therefore our brain, interacts with our body to ensure optimal performance. Such a step forward approach would first require some clarification and consensus on the different definitions and constructs used in the exercise science literature to investigate the perception of effort (for more information, see Halperin & Emanuel, 2020; Pageaux, 2016).

Learning Exercises

1. How can you define self-control?
2. Why is self-control important in sport and exercise settings?
3. What exactly is the "two-task paradigm"?
4. What does "ego depletion" mean and how does it affect sports-related performance?
5. How is the research on ego-depletion and mental fatigue closely related in the context of sports-related performance?
6. How can self-control application be understood as a reward-based choice?
7. What is the "Expected Value of Control"?
8. Which brain areas are primarily involved in self-control processes?
9. Why is self-control costly? Can effort be valuable?

Further Reading

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