**SELF-REGULATION**

Participation in sport and exercise requires self-regulation. Examples of self-regulation include an individual fighting the urge to stop during an intense exercise class; a golfer trying to ignore feelings of excitement and focus on a simple putt to win a tournament; and a soccer player resisting the desire to strike an opponent who has repeatedly fouled him. The process by which individuals consciously attempt to constrain unwanted thoughts, feelings and behaviours and bring these in line with ideals or goals is termed self-regulation, or self-control. The ability to self-regulate has been shown to contribute positively to performance and behaviour in a number of domains, including sport and exercise.

 Athletes and exercisers use numerous self-regulation strategies. For example, in an attempt to control anxiety before an important game, a hockey player may engage in the regulation of his thoughts by using self-talk to re-appraise the importance of the game, imagine performing well, and distract himself by listening to music. An exerciser fighting the impulse to stay in and watch television instead of working out may do so by using motivational self-statements (e.g., “Get off the couch - I will feel so much better after exercising”) and images of achieving her fitness goals, or seeking the support of a fellow exerciser. The aim in using these strategies is to make achieving an important goal (e.g., play well in the hockey match or maintain fitness) more likely by regulating thoughts, feelings and behaviours, that can detract from the goal (e.g., worrying about the outcome, watching the TV). Overriding the impulses that negate our goals is not easy, and to understand why, the core aspects of self-regulation are first outlined here. Following this, a discussion is provided about when self-regulation may be impaired. The entry concludes with a discussion about how self-regulation can be developed.

**Core Aspects of Self-Regulation**

 Self-regulation comprises four core aspects; *standards, monitoring, strength,* and *motivation*. Regulation means a change to bring into line with some *standard*, which is not possible without keeping track or *monitoring* current states, and so the first two aspects are inextricably linked. For example, if a tennis player is to reduce her angry outbursts on the court in line with the umpire’s standards, she must monitor her thoughts, feelings, and behaviours to curb displays of frustration following unfavourable line calls. This ‘curbing’ is difficult and much like any effortful task requires energy. Therefore, self-regulatory *strength* will determine whether the tennis player is capable of avoiding displays of frustration. *Motivation* to change is also necessary; in this example, if the outbursts are leading to point penalties, this may increase the tennis player’s *motivation* to change her responses. The core aspect of self-regulation that has generated most research is the notion that self-regulation requires energy, and as such can be depleted. This proposition is central to the strength model of self-regulation, which is now discussed.

**The Strength Model**

The strength model was proposed by Roy Baumeister and colleagues in the early nineties and its central premise is that self-regulation deteriorates over time from repeated exertions, as if reliant on a finite energy source. A consistent body of research has supported this view. This research has typically used a dual-task paradigm in which one group of participants completes a task requiring self-regulation and one group completes a task that does not. Both groups then complete a second task that does require self-regulation. The key finding is that participants are more likely to perform worse at later tasks requiring self-regulation if they have already done a task requiring self-regulation. To illustrate, participants in one study who first completed a thought suppression task (try not to think of a white bear) were less able to resist the temptation of a beer before completing a driving simulator task compared with participants who had first completed a five minute mental arithmetic task. Further, the energy source required for self-regulation is depleted regardless of the type of self-regulation. Of particular interest to sport and exercise participants is that physical performance can be affected by the regulation of thoughts or emotions. To illustrate, self-regulation on a cognitive task (e.g., stoop test) has been shown to deplete performance on muscular endurance tasks (e.g., handgrip test), with participants having to work harder to achieve the same level of physical performance. The findings suggest that self-regulatory depletion may cause central fatigue, which can be thought of as the failure of the central nervous system to drive the muscles. Thus, athletes and exercisers striving to control their thoughts and emotions in competition may be more prone to suffer disruptions in endurance performance.

In sum, research consistently shows that after an initial bout of self-regulation, subsequent self-regulation is disrupted, regardless of the sphere. In other words, it matters little whether the initial bout of self-regulation task involves the control of thoughts, feelings, or behaviours; subsequent self-regulation in the same, or different, sphere is disrupted. This clearly has implications for sport and exercise participants. It could explain why after a difficult day at work in which self-regulatory resources are depleted an individual is less able to resist the lure of a TV dinner on the couch and misses his exercise class, while a netball player who depletes her self-regulatory resources in regulating anxiety before a crucial game is less able to resist feelings of tiredness then normal and get up and down the court as efficiently as usual. However, to date we do not have any research specifically in sport and exercise settings exploring of self-regulation may affect behaviour and performance.

**The Importance of Glucose for Self-Regulation**

To this point, self-regulation has been described as a limited resource, with no explanation provided for *what* is depleted. Most researchers agree that glucose is the crucial energy source for self-regulation, and, specifically, that lower levels and the inability to transport glucose effectively to the brain is associated with impaired self-regulation. This does not mean that the more glucose one has the better one can self-regulate. It simply means that self-regulation consumes glucose, and if enough glucose is replaced, self-regulation will be maintained, but if glucose is not replaced subsequent self-regulation efforts are more likely to fail.

Glucose is considered as the finite energy source because the availability and effective use of glucose is paramount for effective brain function, and if the flow of glucose to the brain is inadequate, cerebral functioning is impaired. So it is not surprising that some research has found that self-regulation is associated with changes in glucose levels. For example, controlling attention, regulating emotions, and coping with stress have been associated with a reduction in blood glucose levels compared to tasks that require no self-regulation. However, the data on which these conclusions are based have been questioned. Furthermore, the amount of additional glucose consumed by the brain during the self-regulation tasks employed in these studies, which typically last a few minutes, has been proposed to be minimal at 0.2 calories. So, at the present time, there is uncertainty as to the effect of self-regulation tasks on glucose levels.

There is, however, other research that points to the role of glucose. Low glucose, and inefficient glucose use, has also been shown to be associated with poor self-regulation. For example, low glucose is linked to less vigilance, more aggression, greater distractibility, higher incidence of emotional disorders, increased emotional outbursts, and impaired performance under stress, while inefficient glucose use is linked to impaired attentional control, poor emotion regulation, and greater impulsivity. The administration of glucose has been shown to counteract the effects of prior exertions of self-regulation. That is, performance on a second task requiring self-regulation is not impaired even after completing a prior task requiring self-regulation provided glucose levels are replenished. In sum, although there is debate about some of the currently available evidence, proponents of the strength model propose that self-regulation appears to be susceptible to changes in glucose levels, and self-regulation failure is more likely when glucose levels are low or when glucose is metabolised inefficiently.

To complement the research supporting the central role of glucose in self-regulation, and the conflicting research suggesting it has a much more limited role, a recent proposal outlines a third way in which glucose plays a role in self-regulation. This proposal is that the distribution of glucose, rather than glucose level, determines effective self-regulation. To explain, with ample blood glucose available and motivation maintained to persist in a task, self-regulation is likely to be successful. In the event of low blood glucose availability, as long as motivation to persist is maintained and the task is deemed important for the individual, self-regulation can still be successful, because glucose is redirected to the areas of the brain needed for self-regulation. This could explain why even after a difficult day at work in which self-regulatory resources are depleted individuals sufficiently motivated to exercise will be able to resist the lure of a TV dinner, and a netball player who depletes her self-regulatory resources in regulating anxiety before a crucial game, but is highly motivated to win, is still able to work as hard as normal on the court. Again, however, we do not have any research specifically in sport and exercise settings exploring the interaction between motivation and levels of glucose depletion.

**Improving self-regulation**

 Apart from supplementing glucose, there are four other proposals for strengthening self-regulation; *conservation hypothesis, motivation, recovery hypothesis,* and *self-regulation exercises.* The *conservation hypothesis* holds that an individual can reserve some self-regulatory energy if they are made aware of a subsequent self-regulation task. For example, in one study, after an initial task requiring self-regulation, participants performed a second task with half informed that there would be a third task. The depletion effects in the second task were most pronounced among participants who expected a third task. People do seem able to conserve self-regulation resources for an expected task.

The power of *motivation* to overcome depletion also suggests that self-regulation is never completely exhausted, but temporarily depleted until sufficient motivation is generated to encourage the expenditure of further resources. Laboratory studies indicate that participants can self-regulate successfully if they are offered incentives to do so, even after first being depleted of self-regulation resources. This shows how self-regulation can be maintained in an important competition or meaningful exercise activity.

 Sleep also has an important part to play in self-regulation. Insufficient sleep is linked to poorer self-regulatory capacity and sleep replenishes self-regulatory resources. This idea is similar to the conservation hypothesis, but is more akin to a *recovery hypothesis*. Studies have shown that a rest period between self-regulation tasks results in replenishment of resources, and that rest and relaxation allays depletion effects.

 Repeated *self-regulation exercises* can also enhance self-regulatory capacity, much like building a muscle through physical training. Studies have shown that, when compared to a control group, participants who practise self-regulation, such as by avoiding sweet foods for two weeks improve performance on other self-regulation tasks,. In other words, in the short term self-regulation depletes resources, but in the long term, repeated self-regulation makes a person’s ability to self-regulate stronger.

**Concluding Remarks**

 Given that sport and exercise environments frequently give rise to intense emotions, and can test a person’s ability to regulate behaviour (e.g., effort, decision-making) it is not surprising that self-regulation should be a crucial aspect of participation in sport and exercise. Failures to self-regulate may be reflected in emotional outbursts, poor decisions and a reduction in physical performance. While the ability to self-regulate may be depleted, under what circumstances this happens, and the interaction between motivation and levels of glucose, is still to be determined by researchers. Further exploration of how self-regulation can be developed over time is also warranted given its clear applications to sport and exercise settings.

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**Cross-References**

Emotional Responses; Aggression; Imagery; Self-Talk; Psychological Skills; Relaxation; Effort

**Further Readings**

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