In Then Out of Control

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For all of us, self-control has its limits. However, is it possible to measure its depletion? This article reviews a study discussing how an initial task that requires controlled behavior lessens performance on a later control-related task. It also details how activity in the prefrontal cortex explains this phenomenon.

"I value self-discipline, but creating systems that make it next to impossible to misbehave is more reliable than self-control." Tim Ferriss (1872)

Self-control is a constant struggle in life. For instance, imagine walking past your neighborhood bakery. You smell the warm scent of some freshly baked treats; you would happily indulge if it were not for your diet. Even though you can't, you really want to. Will you give in to your desire for freshly baked treats? At this moment, like many moments throughout daily life, you are faced with a choice. Even though you know better, the temptation to eat the desert may become overwhelming. Mistakes are an inevitability of human nature.

Strength and consistency of our self-control separates humans from other animals. Self-control stems from the large prefrontal cortex of the human brain. Following adolescence, it makes up close to 33% of the brain. This crucial region allows restraint of impulses and inhibits inappropriate responses. Instead of acting compulsively by following our emotions, we can plan, direct attention, and evaluate situations. In most cases, we can also avoid regrettable decisions, such as consuming all of the calories contained in a donut.

Evolutionarily speaking, the prefrontal cortex is a relatively new addition to the human brain; other primates have a miniscule structure compared to humans. The prefrontal cortex is implicated in many complex behaviors, such as planning, attention, and memory; however, it is also implicated in emotions and personality. It is one of the last areas of the human brain to develop fully. At birth, the neurons in this area are uncoordinated and communication to other regions is weak. The effects of this can be seen by observing a standard tantrum in a toddler. Over time, we are able to develop, in most cases, an acceptable level of self-discipline, even though we sometimes fall short.

You have probably heard of people advising to exercise self-control. However, this creates some questions. Is self-control able to be strengthened, like other muscles in the human body? If so, is self-control able to weaken as well? In a study conducted by Inzlicht & Gutsell (2007), self-control was analyzed, specifically when it fails. Participants were asked to watch an emotionally upsetting movie for 10 minutes. Before watching the whole film, they were asked to try to either suppress or not suppress their emotions. The researchers expected that suppressing emotions would lead to depletion of self-control and participants would make more mistakes after being asked to participate in higher-order tasks.

The behavioral measure participants engaged in was a commonly used color-naming Stroop task. They were asked to read the words red and green; the font would also be either red or green. The difficulty of this task lies in the mismatch trials wherein the word does not match its font color. On mismatch trials, the participant must utilize self-control to say the correct word.

While participants performed the task, they wore an electroencephalography (EEG) headset to measure their brain activity. Specifically, they were interested in the error-processing wave emitted from the prefrontal cortex. Error detection supervises the currently engaged behavior and detects differences between intended actions and actual ones. When mistakes are made, a regulatory system is notified to ensure more mistakes are made by implementing the desired response and suppressing the incompatible one. This regulatory system is active in neuroimaging from the prefrontal cortex. From EEG, one can quantify the activity and strength of an individual's self-control used during specific events. During an event, the EEG picks up changes in the electrical activity. The changes are called event-related potentials (ERPs). When mistakes are made, there is a sharp rise in electronegativity. This type of ERP is an error related negativity (ERN). The voltage changes that are generated during an ERN expend a large amount of energy and decrease in strength over time.

After running the experiment, data revealed the participants who were asked to suppress their emotions in the first task had more errors during the color-naming Stroop task. They also had increased ERN scores. One explanation for these findings is that suppression impulses cause a metabolic strain on the brain, depleting the reserves of glucose that fuel and nourish neurons. When glucose is depleted, the likelihood of self-control failure increases. This can be seen in these participants since the people who initially exerted self-control were less responsive later to a mismatch between their actions and goals.

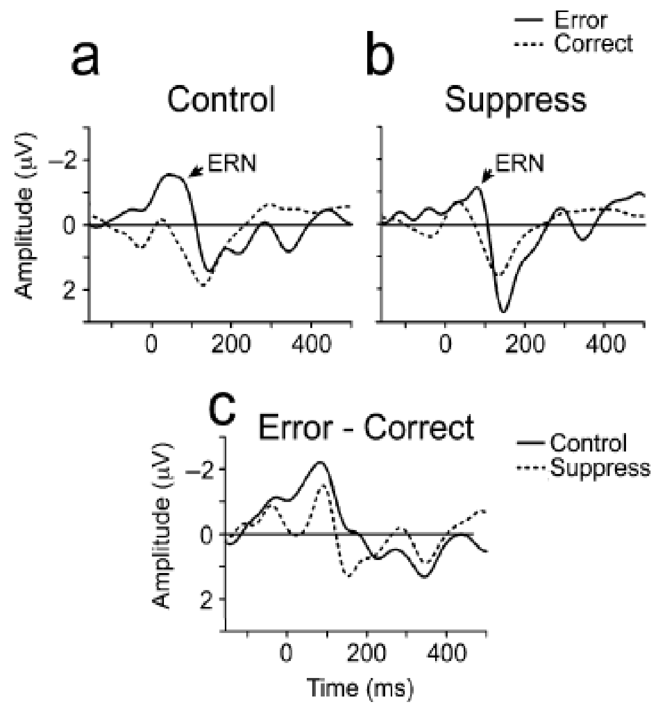
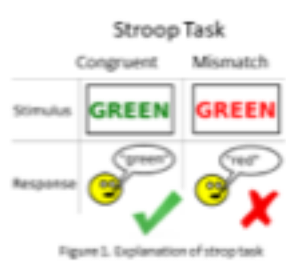


Fig. 2. Response-locked event-related potential waveforms at the Cz electrode. The upper graphs show average waveforms for correct versus error trials, separately for the (a) control and (b) emotion-suppression conditions. The error-related negativity (ERN) appears as a negative wave peaking at about 70 ms. The bottom graph (c) shows the average difference waveform (error trials minus correct trials) in each condition. Zero indicates the time of key press.



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