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Energy and Psychology

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ABSTRACT

The current work is a review of recent findings on energy. Ego depletion, or decreases in self-control caused by prior use, has been found in the areas of sex, aggression, helping, death thought, social norms, crime, emotion regulation, self-views, and passivity. Hunger impaired self-control, and eating restored it. Self-control uses large amounts of bloodstream glucose and brain glycogen and is impaired when these metabolites are low. Minor reductions in oxygen use reduced the number of conscious thoughts that people had. Energy is limited, and energy use by one process can divert it from others.

KEYWORDS : energy, self-control, self-regulation, ego depletion, hunger, food, glucose, glycogen, oxygen

Theories of energy have fallen out of favor in recent Psychology. Not since the 1920's has energy held much prominence (Freud, 1923/1961; Lotka, 1922). The past ten years of my social psychological work, in contrast, has brought back 'energy' as a core construct. The material that follows is a brief overview of a research program on energy that summarizes 31 papers published by Gailliot and colleagues that explain psychology in terms of energy.

Energy may be the basis of the next big question in Psychology. It is a basic construct that cuts across and unites fields, including Social Psychology, Cognitive Psychology, Evolutionary Psychology, Abnormal Psychology, Biological Psychology, Physiological Psychology, Neuroscience, Neurobiology, Neuroendocrinology, Endocrinology, Pharmacology, Physiology, Anatomy, Biology, and Evolution. This review reintroduces a construct that has not led the field for nearly 100 years.

People are metabolic entities. Life is concomitant with energy use and management. Simply put, we consume energy (eat) and use that energy for thought and behavior. This basic idea makes for a powerful view that has generated effects replicated consistently in my laboratory and theoretical work.

Self-Control and Energy

Freud theorized that the self consists of three components – the id, the superego, and the ego (Freud, 1923/1961). These components capture the essence of what can be construed of as self-control conflict. The id is pleasure seeking and drives us to indulge our impulses. It is the component that overlaps with low self-controlled thought and behavior. The superego pushes us toward our ideal self that is in line with societal standards. It can be thought of as overlapping with good or high self-control. The ego is the component that resolves conflict between the id and superego. Its operation can be viewed as self-control exertion.

Evidence from my work and others' indicates that the ego relies on a limited energy source that can become depleted with use. In other words, when people use self-control, it reduces the ability to use additional self-control. A variety of findings from my work demonstrate this idea.

From the start of graduate school, I was fascinated by the idea of mental fatigue. The phenomenon seemed to occur mostly for acts of self-control – having used self-control impaired later self-control. Could this be true? My skeptical mind led me to test whether having used self-control would increase sexual behaviors typically restrained (Gailliot & Baumeister, 2007a), increase provoked yet controllable aggression (DeWall, Baumeister, Stillman, & Gailliot, 2007), decrease effortful and controlled helping (DeWall, Baumeister, Gailliot, & Maner, 2008), and decrease the controlled suppression of death related thought (Gailliot, Schmeichel, & Baumeister, 2006; Gailliot, Schmeichel, & Maner, 2007). It did. The most plausible model for these findings was that using self-control depleted some sort of energy needed for later self-control. The power of the ego is limited.

Later findings confirmed the model and extended it in new directions. One set of studies demonstrated that low trait and state self-control each increased social norm violations, including taking ethical risks, using curse words, and violating rules set by the experimenter (Gailliot, Baker, Gitter, & Baumeister, 2012). Likewise, ego depletion was found to increase the self-reported likelihood of engaging in criminal acts (Gailliot, 2014a). Other work showed that emotion regulation relies on interchangeably used self-control energy (Gailliot, Zell, & Baumeister, 2014).

In other studies, we examined the relationship between self-control and self-views. We found that self-control is required to maintain moderate self-views, such that prior self-control use increases biases related to self-esteem (Gailliot & Zell, 2014). Participants interacted with another person and completed various measures. Higher self-esteem predicted a greater bias in overestimating the extent to which the other person viewed oneself positively, but this relationship was strongest among participants who had completed a self-control task prior to the interaction.

Energy for self-control appears to be widely used, even more so than for only ego related acts. Specifically, the energy is used for action generally. After people use self-control, they are more passive (Vohs & Gailliot, 2007). Participants become, for example, less talkative and more shy (Gailliot, 2015a).

Hunger, Food, Glucose, Glycogen, Oxygen, and Limited Energy

Initial work on ego depletion failed to pinpoint what sort of energy actually becomes depleted. Later work, however, provided some clues. Specifically, it appeared that the energy source had something to do with food. Consuming a milkshake beverage, as well as a neutral tasting dairy drink, were found to replenish self-control (Gailliot, 2009a). Of note, neither the taste or the pleasureableness of the beverage seemed to have an influence. Other work showed that ego depletion increased attentional adhesion to food (i.e., participants are slower to disengage their visual attention from food items), further underscoring a link between depletion and food (Gailliot, 2014b).

If food replenishes self-control, then participants should perform worse on self-control tasks when they are hungry. This is precisely what I found across ten studies (Gailliot, 2013a). Higher levels of hunger—as assessed by self-report, time since last eating, or physiology—predicted reduced self-control, as indicated by increased racial prejudice, hypothetical sexual infidelity, passivity, accessibility of death thoughts and perceptions of task difficulty, as well as impaired Stroop performance and decreased self-monitoring. Increased rates of hunger across 200 countries predicted increased war killings, suggestive of reduced aggressive restraint. In a final experiment, self-reported hunger mediated the effect of hungry (versus fed) participants performing worse on the Stroop task, suggesting a causal relationship of hunger reducing self-control.

Determined to discover what the energy might be, I was ecstatic

when I came across initial evidence that self-control performance fluctuates with levels of glucose in the bloodstream. Glucose is a primary energy for both the body and brain, and it is depletable. A review of the literature revealed several links between self-control and glucose, including findings on attention control, emotion control, smoking cessation, coping, impulsivity, crime, aggression, alcohol, Diabetes, and daily changes in glucose tolerance (Gailliot & Baumeister, 2007b). Indeed, a set of experiments demonstrated that a) using self-control reduced blood glucose, b) lower blood glucose after an initial self-control task predicted poorer performance on a subsequent self-control task, and c) initial acts of self-control impaired performance on subsequent self-control tasks but consuming a glucose drink eliminated these impairments (Gailliot, Baumeister, DeWall, Maner, Plant, Tice, et al., 2007). Aside from extending theory on self-control, these findings help clarify the dynamic interplay between mind and body.

Later findings provided additional support for the link between blood glucose and self-control. One set of studies connected glucose to aggression (DeWall, Deckman, Gailliot, & Bushman, 2011). Participants who consumed a glucose drink, versus a placebo, behaved less aggressively. Diabetes and glucose-6-phosphate dehydrogenase deficiency were related to increased violence. Other work connected glucose to prejudice. Consuming a glucose drink reduced stereotype use and prejudice (Gailliot, Peruche, Plant, & Baumeister, 2009). Drops in glucose mediated the effect of an interracial interaction impairing subsequent Stroop performance (Gailliot, 2009b). Another finding was that a glucose drink reduced worldview defense caused by mortality salience (Gailliot, 2012a). It is plausible that the glucose drink aided the suppression of death related thought, thereby decreasing worldview defense.

One study included a test of learning self-control (Gailliot, 2012b). Participants completed the Stroop task twice, spaced weeks apart. A measure of learning was computed as the difference in performance between the first and second sessions. Making fewer errors and going faster during the second session indicated improved learning. Larger drops in glucose while performing the Stroop task during the first session predicted improved learning. This suggests that glucose depletion make occur as a result of one's learning how to exert self-control in specific domains.

I have also linked glucose to processes other than self-control. Three studies supported the hypothesis that low glucose increases reliance on heuristic thought (Gailliot, 2015b). In Study 1, lower levels of glucose in the bloodstream predicted a larger correspondence bias, or the tendency to attribute the cause of a woman's behavior to her personality rather than the environment. In Study 2, participants who completed a task found to deplete glucose showed increased primacy in impression formation, compared to participants who completed a nondepleting task. In Study 3, consuming a glucose drink, versus a placebo, reduced the tendency to ignore base rate information when estimating probability and assume probability based on the ease with which relevant examples come to mind.

Metabolic energy appears to be used interchangeably throughout the body. If one process uses energy, then it diverts this energy from other processes (Gailliot, Hildebrandt, Eckel, & Baumeister, 2010). This general theory suggests that premenstrual syndrome may be associated with reduced self-control. Premenstrual syndrome occurs when increased metabolic activity in the ovaries may divert energy from processes that benefit self-control. Extant findings provided broad, consistent support for this idea. Evidence linked premenstrual syndrome to increased difficulty controlling emotions, attention, and fine motor movements, increased intake of alcohol, drugs, nicotine, caffeine, and food, impaired work performance, and increased stress, aggression, criminal behavior, interpersonal conflicts, and passivity.

As I read more about metabolism, I noticed a pattern involving another metabolite – brain glycogen, which is glucose stored in the brain. Specifically, self-control and executive functioning use a relatively large amount of glycogen and are impaired when glycogen is low (Gailliot, 2008). Findings on stress, physical persistence, glucose tolerance, Diabetes, sleep, heat, and other topics provided general support for this view.

Some findings on glycogen suggest that repeatedly depleting glycogen stores might increase those stores in the long run. Consistent with this hypothesis, participants who had completed two weeks of self-control exercise (e.g., avoiding the use of curse words, quitting smoking) performed better on self-control tasks after having suppressed stereotypes, compared to participants who did not complete the exercises (Gailliot, Plant, Butz, & Baumeister, 2007). It is possible that the self-control exercise temporarily depleted, but eventually increased, glycogen stores.

Applying these ideas to drinking alcohol, I recently found that drinking more during a nighttime social event predicted increased effortful psychological stamina the next morning (Gailliot, 2015c). Drinking alcohol may deplete metabolites, thereby causing subsequent increases in stored metabolites that benefit effortful stamina.

Glucose is one primary energy for the brain, the other is oxygen. Evidence indicates that conscious processes are sensitive to minor fluctuations in oxygen availability. If so, then people should have fewer conscious thoughts when oxygen is reduced. This is precisely what I found across five studies (Gailliot, 2013b). Participants reported having fewer thoughts while having breathed through a bag without, rather than with, a hole at its end (Study 1). Participants who held their breath for 10 seconds reported having had fewer conscious thoughts than did participants who breathed normally (Study 2). Consistent with economic theories of resource scarcity increasing value, reduced thought increased the importance of thought. Ratings of importance for a potpourri of items increased among participants who held their breath while rating those items, relative to ratings made by participants who breathed normally (Study 3), an effect that is mediated partly by effort expenditure, as suggested by self-reports of hiccup riddance (Study 4). Self-reported hunger correlated positively with ratings of importance of thought content (Study 5), raising plausibility of metabolite resource availability as an explanatory mechanism.

I wrote an extensive review article showing that both heat and cold reduce self-control (Gailliot, 2014c). The article included evidence that these effects may be due to heat and cold increasing the use of glucose and oxygen, thereby causing their depletion. First, evidence indicates that glucose and oxygen use increase. In heat and/or cold, metabolic rate, brain activity, and oxygen uptake and use all increased. Second, evidence indicates that glucose and oxygen availability is then reduced. Heat and/or cold is associated with reduced plasma volume of metabolic substrate, blood and oxygen flow to the brain, and cerebral blood flow and velocity. Reduced oxygen content in the prefrontal cortex and neurotransmitter and glycogen depletion have also been found. Ingesting glucose attenuated the effects of heat.

Other Findings on Energy

Energy applies to evolution. People have evolved to attain more energy and to use it efficiently. For one, we strive to have surplus energy and we strive to be happy. Happiness is therefore posited as a state of having surplus metabolic energy (Gailliot, 2012c). Happiness is associated with good metabolism and glucose levels, fewer demands (from parenting, work, difficult social relationships, or personal threats), and goal achievement, as well as increased ease of processing, mental resources, social support, and monetary wealth. Each of these either provide or help conserve energy.

One example of a drive to use energy more efficiently is observational learning (Gailliot, 2014d). Observational learning may have evolved on the basis of its being energy efficient. People more readily mimic energy efficient than inefficient models. When ascending a hallway, people were more likely to use the energy-efficient incline than the staircase when research assistants modeled (used) both the incline and staircase than when they did not. Observational learning thus demonstrated a bias toward energy efficiency.

Another finding on energy pertains to the mental cost of processing information. Does simple understanding take much energy? The results of one study suggest that it might (Gailliot, 2009c). Participants estimated the distance between them and one of two signs. One sign was blank, it served as a control. Another sign had a word printed on it. Participants estimated the sign with a word as being father away than the blank sign. Distances that involve effort are perceived of as

being farther than distances that do not, therefore the sign with a word on it may have involved effort. Could this effort be the cost of simple understanding?

Future Directions

This line of research raises many questions and opens up avenues for many new lines of exploration. I am excited to pursue further this line of work by extending it in novel and stimulating directions.

One hypothesis pertains to bloodstream glucose and brain activity. There have been very few investigations into the relationship between blood glucose levels and brain activity. It is possible that the relationship may be strongest for activity in the prefrontal cortex, because they may be metabolically expensive tissue. Low (high) glucose decreases (increases) glucose availability in the prefrontal cortex, thereby decreasing neuronal activity.

Self-control may relate to glycogen in the liver. Self-control may be impaired when glycogen is low. Feedback from the liver to the brain may be nearly instantaneous, occurring over the afferent vagus nerve, beginning near the hepatic plexus in the liver and ending around the median eminence in the brain.

A mechanism underlying the effects of low or depleted bloodstream glucose may be the sodium-potassium pump of the neuron. Glucose and/or oxygen undergo the processes of glycolysis, the Krebs cycle, and the electron transport chain so as to produce adenosine triphosphate that is used to power the sodium-potassium pump. When glucose is low or depleted, insufficient energy is available for the pump to return the neuron to homeostasis after firing, thereby likely reducing the capacity for neuronal firing.

Glucose may be used to explain the afterimage fatigue effect. After staring at the color red, white, or blue, the opposite color (green, black, or yellow, respectively) may be seen when looking at a white sheet of paper. This effect may occur because glucose is depleted in localized areas of the visual cortex. Specific neurons lack sufficient energy to continually fire, and so the competing color is seen.

A basic principle is that brain glucose use is a pattern of activation in one brain area that increases glucose use and a roughly simultaneous corresponding deactivation in another brain area that decreases glucose use. In this fashion, the brain remains at a homeostatic level of activation and glucose use. It is important to determine which areas and processes are coupled together in their activation and deactivation patterns, such that activation (deactivation) of one area or process causes deactivation (activation) in a different area or process.

Doubt is one area of study that can benefit from the application of findings on energy. Doubt is marked by a pattern of disengagement and reengagement of goals. This may correspond to decreases and then increases in glucose availability, which marks the metabolic pattern of glucose.

Metabolically expensive traits signal that a male carries good genes for the immune system. According to this good genes hypothesis, men possessing these traits should be selected as fathers of potential offspring. Given that self-control is metabolically expensive, men with good self-control should be selected as fathers of potential offspring.

One theory is that the production of progesterone, during the menstrual cycle, reduces self-control by diverting metabolic resources (Gailliot et al., 2010). Ovulation occurs at a time when progesterone production is high and increasing. It may therefore be associated with impaired self-control. Indeed, some of the effects of ovulation (e.g., increases in some forms of sexuality) may be attributable to lowered self-control.

One hypothesis concerns dispositional emotion and efficiency. The idea is that dispositional emotions are energetically efficient, which is why we tend to experience them. Humans tend toward that which is efficient. Other work involves the waist-hip ratio in women. The hypothesis is that, given that a low waist-hip ratio makes it less efficient to walk, women with a low waist-hip ratio will prefer men with nice cars. The car provides compensation for the higher cost of walking.

REFERENCES

DeWall, C. N., Baumeister, R. F., Gailliot, M. T., & Maner, J. K. (2008). Depletion makes the heart grow less helpful: Helping as a function of self-regulatory energy and genetic relatedness. Personality and Social Psychology Bulletin, 34, 1653-1662. | DeWall, C. N., Baumeister, R. F., Stillman, T., & Gailliot, M. T. (2007). Violence restrained: Effects of self-regulation and its depletion on aggression. Journal of Experimental Social Psychology, 43, 62-76. | DeWall, C. N., Deckman, T., Gailliot, M. T., & Bushman, B. J. (2011). Sweetened blood cools hot tempers: Physiological self-control and aggression. Aggressive Behavior, 37, 1, 73-80. | Freud, S. (1961). The ego and the id. In J. Strachey (Ed. and Trans.), The standard edition of the complete psychological works of Sigmund Freud (Vol. 19, pp. 12–66). London: Hogarth Press. (Original work published 1923). | Gailliot, M. T. (2008). Unlocking the energy dynamics of executive functioning: Linking executive functioning to brain glycogen. Perspectives on Psychological Science, 3, 245-263. | Gailliot, M. T. (2009a). The effects of glucose drinks on self-control are not due to the taste of the drink: Glucose drinks replenish self-control. Unpublished manuscript. | Gailliot, M.T. (2009b). Effortful outgroup interactions impair self-control via the depletion of glucose: The control of stereotypical thought and prejudice as metabolically expensive. Unpublished manuscript. | Gailliot, M. T. (2009c). Does simple understanding take much energy?: Biases in distance perception suggest the effort of meaning. Unpublished analyses. | Gailliot, M. T. (2012a). Mortality salience and metabolism: Glucose drinks reduce worldview defense caused by mortality salience. Psychology, 12, 991-996. | Gailliot, M. T. (2012b). Improved self-control associated with using relatively large amounts of glucose: Learning self-control is metabolically expensive. Psychology, 12, 987-990. | Gailliot, M. T. (2012c). Happiness as surplus or freely available energy. Psychology, 3, 702-712. | Gailliot, M. T. (2013a). Hunger and reduced self-control in the laboratory and across the world: Reducing hunger as a self-control panacea. Psychology, 4, 59-66. | Gailliot, M. T. (2013b). Air metabolite preclusion reduces conscious thought. Research in Endocrinology, 2013, 1-6. | Gailliot, M. T. (2014a). Having used self-control increases criminality. Advances in Social Sciences Research Journal, 1, 29-33. | Gailliot, M. T. (2014b). Having used self-control increases attention to food: A functional bias in the management of metabolic energy and a bias toward indulgence. US Open Psychology Journal, 1, 1-12. | Gailliot, M. T. (2014c). An assessment of the relationship between self-control and ambient temperature: A reasonable conclusion is that both heat and cold reduce self-control. International Review of Social Sciences and Humanities, 8, 149-193. | Gailliot, M. T. (2014d). Increased mimicry of energy efficient than inefficient models: Observational learning as an evolved tendency. US Open Psychology Journal, 1, 1-6. | Gailliot, M. T. (2015a). Action and passivity as proportional to available self-control (metabolic) energy: Self-control use, diabetes, and action. Journal of Advances in Humanities, 3, 292-299. | Gailliot, M. T. (2015b). Heuristic thought fluctuates with blood-glucose levels – Lower metabolic energy predisposes to simplistic thought. Global Journal for Research Analysis, 4, 227. | Gailliot, M. T. (2015c). Alcohol consumption reduces effortful fatigue after sleep: Testing a theory of metabolite depletion and subsequent supercompensation. Journal of Advances in Humanities, 3, 271-276. | Gailliot, M. T., Baker, M. D., Gitter, S. A., & Baumeister, R. F. (2012). Breaking the rules: Low trait or state self-control increases social norm violations. Psychology, 12, 1074-1083. | Gailliot, M. T., & Baumeister, R. F. (2007a). Self-regulation and sexual restraint: Dispositionally and temporarily poor self-regulatory abilities contribute to failures at restraining sexual behavior. Personality and Social Psychology Bulletin, 33, 173-186. | Gailliot, M. T., & Baumeister, R. F. (2007b). The physiology of willpower: Linking blood glucose to self-control. Personality and Social Psychology Review, 11, 303-327. | Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., Brewer, L. E., & Schmeichel, B. J. (2007). Self-Control relies on glucose as a limited energy source: Willpower is more than a metaphor. Journal of Personality and Social Psychology, 92, 325-336. | Gailliot, M. T., Hildebrandt, B., Eckel, L. A., & Baumeister, R. F. (2010). A theory of limited metabolic energy and premenstrual syndrome (PMS) symptoms – Increased metabolic demands during the luteal phase divert metabolic resources from and impair self-control. Review of General Psychology, 14, 269-282. | Gailliot, M. T., Peruche, B. M., Plant., E. A., & Baumeister, R. F. (2009). Stereotypes and prejudice in the blood: Sucrose drinks reduce prejudice and stereotyping. Journal of Experimental Social Psychology, 45, 288-290. | Gailliot, M. T., Plant, E. A., Butz, D. A., & Baumeister, R. F. (2007). Increasing self-regulatory strength can reduce the depleting effect of suppressing stereotypes. Personality and Social Psychology Bulletin, 33, 281-294. | Gailliot, M. T., Schmeichel, B. J., & Baumeister, R. F. (2006). Self-regulatory processes defend against the threat of death: Effects of self-control depletion and trait self-control on thoughts and fears of dying. Journal of Personality and Social Psychology, 91, 49-62. | Gailliot, M. T., Schmeichel, B. J., & Maner, J. K. (2007). Differentiating the effects of self-control and self-esteem on reactions to mortality salience. Journal of Experimental and Social Psychology, 43, 894-901. | Gailliot, M. T., & Zell, A. L. (2014). Self-regulation to maintain moderate self views: Prior self-regulation increases biases related to self-esteem. Open Access Library Journal, 1, 1-6. | Gailliot, M. T., Zell, A. L., & Baumeister, R. F. (2014). Having used self-control reduces emotion regulation – Emotion regulation as relying on interchangeably used 'Self-Control Energy'. Open Access Library Journal, 1, 1-13. | Lotka, A. J. (1922). Contribution to the energetics of evolution. Proceedings of the National Academy of Science, 8, 147-151. | Vohs, K. D., & Gailliot, M. T. (2007). A loss of self-regulatory resources makes people more passive. Advances in Consumer Research, 34, 485.