SYMPOSIUM

From Habits to Self-Regulation: How Do We Change?

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The Yale Cognitive Science department hosted the conference “From Habits to Self-Regulation: How Do We Change?” on November 4 and 5, 2011, to showcase current research on self-control in cognitive science, psychology, and neuroscience. The conference included a panel discussion by four philosophers who gave context for the scope and limitations of research on self-control. The common theme concerning the best method to attain lasting change included becoming aware of what one wants to change, increasing commitment to the goal of change, and imagining all of the potential problems and solutions to those problems.

INTRODUCTION

How do we change? This is an essential question for individuals who may have gotten into bad habits such as overeating, not getting enough exercise, addiction, and depression, all of which could potentially be changed through self-control. Yale’s Tamar Gendler (Cognitive Science Chair and Philosophy) and Hedy Kober (Psychiatry) organized the conference “From Habits to Self-Regulation: How Do We Change?” at Yale University on November 4 and 5, 2011. Twenty-two professors from diverse institutions and affiliations discussed current research into why and how we control ourselves.

Self-control is defined as acting in a manner consistent with global goals and values in the face of smaller, proximal rewards when these are in conflict [1]. A dieter faced with a cupcake is one example of a good situation to exercise self-control. The conference featured research on a va-
riety of topics related to self-control, including delay discounting, psychiatric disorders, dieting, drug addiction, and schoolwork. Dialog was encouraged across disciplines, and the conference featured a panel of philosophers including Tamar Gendler, Hedy Kober and Matthew Noah Smith from Yale, Rae Langton from MIT, and J. David Velleman from New York University, who discussed the philosophical context for research on self-control. This report summarizes the opinions and findings of the following speakers: Walter Mischel from Columbia; Daeyeol Lee and Susan Nolen-Hoeksema from Yale; Richard Holton from MIT; Angela Duckworth from the University of Pennsylvania; and Kentaro Fujita from Ohio State University.

DELAY DISCOUNTING

Walter Mischel from Columbia University was the keynote speaker because his famous marshmallow experiment is the keystone of the entire field. In this experiment, 4-year-old children were given the option to eat one marshmallow right away or wait 15 minutes for two marshmallows. The children who were able to wait for the two marshmallows had significantly higher SAT scores 10 years later [2]. Mischel’s research characterized the power of the situation and the ability of an individual to change its impact on his or her behavior. Imagining a picture frame around the marshmallow enabled one child to wait for the two marshmallows, because “you can’t eat a picture!” [2]. Discovering effective cognitive strategies like this is the goal of research on self-control. How can we self-regulate to optimize life success?

This marshmallow experiment finding generalizes to other rewards, including money. Economic theory predicts rational agents who would always prefer $100 in 1 week rather than $10 right now, though experimental psychology evidence suggests that humans tend to choose concrete immediate rewards over abstract remote ones [1]. Neuroeconomics studies this type of decision by modeling delay discounting, the recalculation of value based on the expected length of delay and the expected size of reward in order to directly compare the outcomes. For example, perhaps two marshmallows in 15 minutes is subjectively equivalent to half a marshmallow right now, so the choice is made to take the immediate single marshmallow.

Neuroeconomics theorizes that there is a dual process to decision-making: model-free versus model-based learning algorithms. Model-free refers to habits, well-practiced reflexive patterns that do not require attention, like tying your shoe or driving your automatic route home. Model-based means decision-making directed at a goal that reflects on the value of action outcomes, like playing a strategy game. This terminology stems from thinking about how the brain is like a computer, where a model approximates how the world works and then is refined through comparisons to experience. Model-free decision processes involve simpler computations and are optimal under situations of certainty. Daw and colleagues in their 2005 theoretical paper [3] have postulated that these dual processes are anatomically localized in the human brain, model-free to the striatum and model-based to the prefrontal cortex, which compete for control of behavioral responses. Prefrontal cortex has largely expanded in primates and is commonly thought to be involved in executive functions like planning, verbal reasoning, and problem solving. The striatum is an evolutionarily conserved brain structure that is commonly associated with controlling complex motor patterns. Self-control aimed at changing a bad habit would utilize goal-directed or model-based learning algorithms and prefrontal cortex in this theoretical framework.

Experiments in neuroeconomics use the intertemporal choice task, where delay discounted values of options are estimated by varying the size of reward and length of the wait, and measuring brain activity related to decision-making. Daeyeol Lee of the Interdepartmental Neuroscience Program at Yale presented his research on the neural basis of delay discounting using electrophysiological recordings of individ-
ual neurons in monkeys. Electrical activity of neurons in lateral prefrontal cortex neurons and in the caudate nucleus of the striatum reflects the calculation of the difference between discounted values of outcomes [4,5]. Lee argues that since the time course of this information is the same in the striatum and the prefrontal cortex that these structures do not compete, but rather function as an iterative loop during decision-making. Further studies characterizing individual differences in the propensity to wait and what neural correlates exist for shifting between strategies in decision-making are forthcoming.

Lee has found that choice behavior in delay discounting is best modeled by a hyperbolic function [4]. An individual with strong self-control would prefer the delayed larger reward across more situations, and their discounting function would consequently approach a flat line. Individuals with addiction, bipolar disorder, schizophrenia, or attention deficit hyperactivity disorder all share steeper discounting functions, shifted the opposite direction toward preferring the immediate smaller reward [6,7]. Delay discounting is one experimental technique used to discover rational therapies for these disorders.

A variation of the standard intertemporal choice paradigm introduces risk into the decision by adding uncertainty as to whether the delayed large reward would be awarded. Adding risk to the delayed reward increases the use of model-free learning algorithms and consequently pushes the discounting function toward preferring the smaller immediate certain reward over the larger later uncertain reward [4]. This technique was used to show the efficacy of guanfacine (trade name Intuniv), a drug used to treat attention deficit hyperactivity disorder [8]. Guanfacine is an agonist of the alpha-2A subtype of the norepinephrine receptor, a rational treatment based on current theory of the molecular basis of working memory [9]. Acute treatment with guanfacine shifts delay discounting function toward preference for the larger later reward in the standard procedure, but does not change preference for risk in the uncertain version of the task [8]. Therapeutic guanfacine use can thus be expected to increase patience without increasing impulsive risk taking.

PSYCHIATRIC DISORDERS

Many psychiatric disorders also result from aberrant self-regulation, and rational therapies can harness self-control mechanisms. Susan Nolen-Hoekesema, Chair of Yale’s Psychology Department, presented her research on rumination, the cognitive basis for depression and anxiety. Depression and anxiety disorders are accompanied and perpetuated by rumination, the passive focus on one’s symptoms of distress, and possible causes and consequences of these symptoms [10]. In this case, thinking about the abstract long-term future is harmful, and finding new strategies to engage problem solving may be therapeutic. Therapy often points out the habitual pattern of negative thoughts that have become ingrained worries. Strategies to enhance awareness of rumination have been shown to improve mood, particularly mindfulness meditation [11]. Mindfulness meditation is a practice of making non-judgmental observation of present moment experiences, including sensations, feelings, and thoughts. This practice is thought to work by making an individual aware of when he or she is engaging in rumination and then can use various strategies like journaling or jogging to process emotion or distract from the problematic habitual thought patterns. Mindfulness meditation has diverse implications for medicine, ranging from treatment of chronic pain to recovering from obesity to improving doctor-patient dialogue [12]. Mindfulness is one practice to enhance awareness that can improve self-control.

DIETING

Dieting is one example of self-control, where one must behave in accordance with the abstract long-term goal of losing weight over the immediate reward of a chocolate cupcake. Interestingly, meta-analysis of data
collected using self-report measures of self-control shows only small effect sizes for self-control leading to diet success [13]. This meta-analysis also shows that trait self-control has a greater influence on automatic rather than controlled behaviors, suggesting that self-control helps form good habits [13]. Successful weight loss is expected when an individual fosters long-term changes of eating habits.

Cognitive neuroscientists use functional magnetic resonance imaging to measure changes in blood flow, or the blood oxygenation level dependent (BOLD†) contrast, as a proxy for neural activity, based on the assumption that increased activity in a region’s neurons related to a given task will require more oxygen. Cognitive regulation of craving high calorie foods is associated with decreases in striatum and increases in prefrontal cortex BOLD signal [14]. Reduced craving is achieved by focusing on the long-term deleterious effects of consuming the cupcake, which brings conscious awareness to the importance of the long-term goal of dieting [14]. Focusing awareness on what one wants to change and on how to solve problems is a helpful strategy to encourage development of good habits.

**DRUG ADDICTION**

Drug addiction is viewed as self-control failure by the economics model of the individual making decisions based on reason. Richard Holton, a philosopher from MIT, discussed the role of self-control in addiction in relation to the law. Rational individuals ought to be held responsible for their actions under just laws. Punitive laws for use of illegal drugs should follow if a user willfully engages in drug taking. If, however, drug taking has become a compulsive habit that an addict has lost the ability to control using reason, how responsible for drug use can law hold the addict? Illegal drugs are sampled by many in the population by their mid 30s, but most people stop use when incentives shift to maintain employment or a relationship with a spouse, implying a rational decision strategy [15]. Addiction in a rational individual would result from withdrawal, the negative reinforcement of consequences of stopping, which continues the drug use. However, the chance of relapse after withdrawal is very high, so the high cost of withdrawal cannot be reinforcing drug use [16]. It is not rational to immediately return to drug use when one has just felt the worst of the negative consequences of that behavior.

The incentive salience model of drug addiction posits that there are independent representations of liking and wanting in the brain, and that addiction is wanting without liking [16]. When one becomes addicted, the drug increases in saliency as a reward, which drives drug seeking beyond the hedonic value enjoyed. A rational individual would make choices based on liking something, seeking drugs based on their hedonic properties alone. Drug seeking persists in spite of the absence of enjoyment, like when the drug is not given and also persists in the face of losing jobs, family, and friends, despite admittance that the pleasure is not worth those costs [16]. Drug abuse affects the neurotransmitter dopamine, a component signal of reward, which hastens the development of habits, or model-free representations [17,18]. Regulation of drug craving involves engaging higher activation in the dorsolateral prefrontal cortex and lower activation in the ventral striatum by thinking of long-term consequences [14]. Effective therapies for rehabilitating drug addicts should focus on reducing the cue-sensitized reward seeking and modulating the incentive salience of the drug so that normal incentives like avoiding jail time or earning income by maintaining a job can be motivating.

**SELF-CONTROL AND SCHOOL**

Angela Duckworth worked as a teacher before becoming a Psychology professor at the University of Pennsylvania, researching why self-control is necessary for schoolwork or “how can we make algebra homework into Angry Birds?” a popular smartphone game. Schoolwork is deemed equally important to
future goals and requires just as much concentration for C average and A average students [19]. Unfortunately for Duckworth, this data set also showed that A students do not rate homework as fun any more than C students do, which means they are not turning homework into Angry Birds. Self-discipline is a better predictor of grade point average than intelligence, demonstrating that the ability to commit to long-term goals is instrumental to scholastic success [20]. It is important to start learning self-control early, since the ability to delay gratification as a child predicts adaptive long-term developmental outcomes, including better physical health and personal finances and lower incidence of substance dependence and criminal records [21]. Mental contrasting is one method used to heighten commitment to long-term goals. This technique involves imagining the desired future and then contrasting it with the present reality and picturing all that stands in the way of reaching that future. Thinking about obstacles that could hamper reaching a goal has been shown to increase achievement when compared to just thinking positively about the desired future [22]. Self-control is enhanced through mental contrasting and forming implementation intention plans to surmount obstacles on the way to goal attainment.

WHAT ARE THE ETHICS OF SELF-CONTROL RESEARCH?

Matthew Noah Smith contended that self-regulation research is inherently based on normative values. What is normal? How ought we to live? The Yale Philosophy professor cautioned that we not over-regulate ourselves. He gave complementary examples where one would not want to suppress expression of emotion, including when a friend is sick or when one scores a goal while playing a sport. The definition of self-control used by the conference — acting in a manner consistent with global goals and values in the face of smaller, more concrete proximal rewards when these are in conflict — would undermine these objections, because in these situations, there is no conflict between feeling one’s emotions and achieving one’s long-term goals. Cheering after scoring a goal need not be regulated, because that proximal reward does not conflict with the long-term goal of winning the game. Feeling sadness and sympathy for a sick friend is an expectable response to a particular event. These feelings are not in line with either proximal or distal rewards, so self-control is irrelevant to this situation.

The Diagnostic and Statistical Manual of Mental Disorders does imply normative judgments. The definition of a disorder is any mental condition that causes significant distress or disability. A diagnosis of disorder signifies suffering and impairment. This is only useful when the difference from a norm used to define the disorder is associated with suffering. The mental conditions used to diagnose a disorder must also not be an expectable response to a particular event. Empirical study of prevalence, progression, and prognosis of disorders aids in the development of interventions statistically shown to improve quality of life.

Tamar Gendler, Chair of the Yale Philosophy department, pointed out that goal-directed behaviors are not always better than habitual behaviors. Skills that we cultivate to levels of expertise come with the automaticity of habits. Self-control is often instrumental to developing skills through practice. Understanding which behaviors should be under conscious control and which should be well practiced is key to optimal decision-making.

The philosophy panel also warned neuroscientists to avoid getting caught up in mind-body duality, that the soul will not be localized to a particular brain structure. Though many models presented in the self-control symposia contained duality — the “hot/cool” model by Mischel [23], model-free versus model-based decision-making process [3], the dual-motive conflict [1] — this is not a mind-body duality. Kentaro Fujita, recently tenured Psychology faculty at Ohio State University, used Congress as an elegant metaphor for how the mind works, where every motivation is represented as a Senator, who each gets a turn to speak on the
floor of the Congress, but eventually, a vote will decide what the Congress’s action will be. The goal of self-control is to express each motivation at the right time and place. Philosophers voiced that the materialistic explanation is just one way of knowing.

CONCLUSION

Self-control can be used to change bad habits by becoming aware of the habitual behavior, increasing commitment to long-term goals, and imagining solutions to problems before they occur. Neuroscience studies the physiology of delayed gratification and finds that the prefrontal cortex and striatum are involved. Theories of how these brain regions work in self-control are currently being researched and refined. Good self-control predicts many adaptive long-term outcomes, including physical fitness, mental health, and scholastic achievement. Strategies like mental contrasting and mindfulness meditation that enhance self-control are useful. Mindfulness meditation practice can enhance awareness of thought patterns that are counterproductive to achievement of goals. Mental contrasting implementation intention can increase self-control, because one forms a plan about the future, increasing commitment to distal rather than proximal goals. Understanding who is capable of controlling themselves has broader implications for many psychiatric disorders, obesity, and the law.

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