

To Do or Not To Do? The Complexities of Addiction, Motivation, Self-Control, and Impulsivity

Addictions exact tremendous individual and familial suffering, costing U.S. society over \$500 billion annually (1). An improved understanding of the neurobiological correlates of addictions should substantially inform the development of improved prevention and treatment strategies for these disorders that often respond suboptimally to currently available interventions. The study of cocaine-abusing and nonaddicted subjects by Goldstein and colleagues makes important contributions to the understanding of addictions. The study examines the relationship between motivation and self-control and brain activations during the processing of monetary rewards. Self-reported task engagement and reward-related performance were correlated in nonad-

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dicted subjects but not among cocaine-abusing ones. Nonaddicted subjects showed correlated activation of prefrontal and orbitofrontal cortical circuitry during reward processing that was disrupted among cocaine-abusing people. In contrast, among cocaine-abusing subjects but not comparison ones, trait measures of motivation and self-control were associated with lateral prefrontal cortical activation. Thus, this study provides empirical support for disrupted neural processing of nondrug rewards in cocaine abuse.

Addictions involve continued behavioral engagement despite adverse consequences and have been conceptualized as disorders of misdirected motivation and impaired self-control (2–4). Addicted individuals tend to select preferentially small immediate rewards over larger delayed ones, a process termed delay discounting (4). This tendency has important clinical implications because risky, disadvantageous, or impulsive decision-making has been correlated with adverse measures of real-life functioning in addicted groups and those at risk for addiction, such as adolescents (5, 6). Moreover, treatments that provide small immediate rewards for abstinence, such as contingency management, have demonstrated efficacy in the short-term treatment of addiction (7). As such, the identification of differences in the neural correlates of monetary reward processing and their relationships to measures of self-control and motivation in cocaine-abusing versus nonaddicted groups lays important groundwork for the development of improved prevention and treatment strategies. Future important steps in this process involve parsing reward processing into its core components in addicted individuals (8); examining specific elements of motivation and self-control in relationship to addictions; evaluating the generalizability to other addictions; and studying the relationships between motivation, self-control, and reward processing in individuals at various stages of the addiction process. In particular, the extent to which reward processing differences related to motivation and self-control are evident in at-risk individuals and may be “normalized” in addicted people with behavioral and/or pharmacological interventions warrants additional investigation.

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The article by Goldstein et al. has important psychiatric implications extending beyond addictions. Impulsivity represents a quantifiable phenotype early in the path leading to addictions and other psychiatric conditions (8). Impulsivity is relevant to many psychiatric disorders and has been defined as “a predisposition toward rapid, unplanned reactions to internal or external stimuli [with diminished] regard to the negative consequences of these reactions to the impulsive individual or others” (9). This definition not only overlaps with ones for addiction (4) but also indicates that impulsivity is complex and multifaceted. Hence, understanding how specific elements contributing to impulsivity (e.g., response inhibition, reward saliency, punishment sensitivity) relate to specific psychiatric disorders should help optimize prevention and treatment strategies for not only addictions but also other mental health disorders. The articles authored by Hong et al., Leibenluft et al., and Pat-Horenczyk et al. highlight the complexity of impulse regulation and its relevance across diagnostic boundaries. Hong and colleagues report that two measures of sensory gating in schizophrenia are inversely or largely unrelated, suggesting that there exist multiple independent components of inhibitory function in schizophrenia. These findings echo those in the article by Goldstein and colleagues, in which one measure related to impulsivity (reaction time) was inversely correlated with another (subject-reported self-control) in cocaine-abusing subjects but not nonaddicted ones. Leibenluft and colleagues report neural correlates of unsuccessful motor inhibition in children with bipolar disorder in medicated and unmedicated states and with and without attention deficit hyperactivity disorder. Because these two disorders are each characterized by impaired impulse control and treated with medications that diminish impulsive behaviors, dissecting the relative contributions of co-occurrence and pharmacotherapy is not only important in understanding the neuroimaging findings but also clinically relevant. Pat-Horenczyk and colleagues examine the relationship between terrorism exposure and risk-taking behaviors. These findings highlight the impact of exposure to potentially stressful or traumatic events on risk-taking during adolescence. The importance of considering sex differences in understanding the relationship between environmental risk factors and engagement in behaviors characterized by impaired impulse control is highlighted as boys showed a stronger correlation than girls between posttraumatic symptoms and risk-taking. Together, these four studies reinforce the notion that impulsivity and related constructs are not only relevant to multiple psychiatric disorders but are also complex phenomena influenced by multiple environmental and biological factors. A society devoted to the study of impulsivity and impulse control disorders (the International Society for Research on Impulsivity; <http://www.impulsivity.org>) was recently created to advance scientific work in this area. It is anticipated that such work will better define the biology of impulsivity and its relationship to psychiatric health and illness and that this understanding will help generate improved prevention and treatment strategies for addictions and other disorders characterized by impaired impulse control.

References

1. Uhl GR, Grow RW: The burden of complex genetics in brain disorders. *Arch Gen Psychiatry* 2004; 61:223–229
2. Goldstein RZ, Volkow ND: Drug addiction and its underlying neurobiological basis: neuroimaging evidence for the involvement of the frontal cortex. *Am J Psychiatry* 2002; 159:1642–1652
3. Chambers RA, Taylor JR, Potenza MN: Developmental neurocircuitry of motivation in adolescence: a critical period of addiction vulnerability. *Am J Psychiatry* 2003; 160:1041–1052
4. Potenza MN: Should addictive disorders include non-substance-related conditions? *Addiction* 2006; 101(suppl 1):142–151
5. Bechara A: Risky business: emotion, decision-making, and addiction. *J Gambling Stud* 2003; 19:23–51
6. Lejuez C, Aklin WM, Zvolensky MJ, Pedulla CM: Evaluation of the balloon analogue risk task (BART) as a predictor of adolescent real-world risk-taking behavior. *J Adolesc* 2003; 26:475–479
7. Carroll KM, Onken LS: Behavioral therapies for drug abuse. *Am J Psychiatry* 2005; 162:1452–1460
8. Kreek MJ, Nielsen DA, Butelman ER, LaForge KS: Genetic influences on impulsivity, risk-taking, stress responsivity and vulnerability to drug abuse and addiction. *Nat Neurosci* 2005; 8:1450–1457

9. Moeller FG, Barratt ES, Dougherty DM, Schmitz JM, Swann AC: Psychiatric aspects of impulsivity. *Am J Psychiatry* 2001; 158:1783–1793

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