Current Topics in Behavioral Neurosciences

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About this series

*Current Topics in Behavioral Neurosciences* provides critical and comprehensive discussions of the most significant areas of behavioral neuroscience research, written by leading international authorities. Each volume offers an informative and contemporary account of its subject, making it an unrivalled reference source. Titles in this series are available in both print and electronic formats.

With the development of new methodologies for brain imaging, genetic and genomic analyses, molecular engineering of mutant animals, novel routes for drug delivery, and sophisticated cross-species behavioral assessments, it is now possible to study behavior relevant to psychiatric and neurological diseases and disorders on the physiological level. The *Behavioral Neurosciences* series focuses on “translational medicine” and cutting-edge technologies. Preclinical and clinical trials for the development of new diagnostics and therapeutics as well as prevention efforts are covered whenever possible.
Behavioral Neuroscience of Drug Addiction
Drug addiction is a chronically relapsing mental illness involving severe motivational disturbances and loss of behavioral control leading to personal devastation. The disorder afflicts millions of people, often co-occurring with other mental illnesses with enormous social and economic costs to society. Several decades of research have established that drugs of abuse hijack the brain’s natural reward substrates, and that chronic drug use causes aberrant alterations in these reward-processing systems. Such aberrations may be demonstrated at the cellular, neurotransmitter, and regional levels of information processing using either animal models or neuroimaging in humans following chronic drug exposure. Behaviorally, these neural aberrations manifest as exaggerated, altered or dysfunctional expression of learned behavioral responses related to the pursuit of drug rewards, or to environmental factors that precipitate craving and relapse during periods of drug withdrawal. Current research efforts are aimed at understanding the associative and causal relationships between these neurobiological and behavioral events, such that treatment options will ultimately employ therapeutic amelioration of neural deficits and restoration of normal brain processing to promote efforts to abstain from further drug use.

The Behavioral Neuroscience of Drug Addiction, part of the Springer series on Current Topics in Behavioral Neurosciences, contains scholarly reviews by noted experts on multiple topics from both basic and clinical neuroscience fields. In the first two chapters, recent technological advances in the ability to monitor synaptic neuroplasticity and transient dopamine release events are discussed in relation to drug and alcohol addiction models. These studies have greatly advanced our understanding of how chronic drug exposure changes the responsiveness of primary reward substrates for drugs of abuse. Subsequent chapters illustrate how these events translate into addictive behavior and recruit additional brain regions involved in reward-related learning and behavioral disinhibition. Other chapters delve into the relationship between heightened drug responsivity and the propensity for relapse, and the neurobiology of anhedonia after chronic drug use is discontinued. Together, these chapters provide a focused and critical review of current animal models and methods along with functional relationships between
neurobiological and behavioral change. Many of the neurobiological and behavioral changes produced by chronic drug exposure in animals are reflected in human studies using modern neuroimaging and neurocognitive analyses, while others differ. The second part of the volume is dedicated to studies in human drug abusers, beginning with two chapters on alterations in drug and neurotransmitter receptor levels, dopamine release, and their relationship to drug taking and craving. In addition, the association of genomic markers with vulnerability to drug and alcohol addiction is reviewed in relation to genes known to be involved in transmitting drug signals and drug metabolism, and other approaches to identify novel genes associated with addicted phenotypes that could ultimately serve as targets for treatment. Three chapters discuss the various cognitive abnormalities that accompany drug addiction, including deficits in attention, memory, and executive control, susceptibility of the adolescent brain, and the impact of such changes on the inability to make appropriate and beneficial life choices in the context of a behavioral economic model of addiction. These latter chapters illustrate the global impact of drug-induced alterations discussed in earlier chapters on complex neurocircuitry involved in the intricate interplay between cognitive processing and decision-making. Finally, while several non-pharmacological treatments for addiction have been explored, an explosion in potential pharmacological targets has lead to several novel treatments based on known and unknown mechanisms of action, and the latest findings are compared with more traditional approaches.

The findings reviewed in this volume suggest that an emerging consensus exists for the underlying pathology of drug addiction. Basic neuroscience research conducted in animal models suggests that neuroadaptations in limbic brain regions promote drug-taking behavior by enhancing the neural substrates of primary drug reward, while weakening neural mechanisms of inhibitory control. The latter is paralleled in humans by deficits in neocortical function and executive/cognitive information processing. However, human neuroimaging studies also suggest that drug addiction is associated with deficits in dopaminergic neurotransmission, the major neural substrate for primary drug reward. These and other discrepancies indicate that more work is needed to reconcile the findings from animal models and human drug addiction. Furthermore, there are numerous other drug-induced changes that encompass regulation of gene expression, intracellular signaling molecules, and several other neurotransmitter, metabolic and morphological changes that have been identified, but their relevance to human behavioral change is unknown. Ultimately, it is important for animal models to better emulate human cognitive abnormalities so that critical cause-effect relationships between neurobiological and behavioral change may be determined. We hope the breadth of behavioral neuroscience endeavor contained in this volume will assist in directing future research aimed at integrating human and animal work towards a cohesive body of research with substantial implications for treatment.
Dedication

Dr. Julie Staley passed away on July 25, 2009 shortly after completing her work as co-editor for this book. Her struggle with a long-term illness never once diminished her devotion and vigor for scientific endeavor, and her profound dedication to this project. This book is dedicated to Julie, and the tireless enthusiasm she displayed in life remains an inspiration for all of us.

Dr. Julie Staley

David Self

Kelly Cosgrove
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