

# Introduction

# Chapter 1

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## Chapter 1 Introduction

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Derived from *addictionem*, meaning “an awarding, a devoting,” the term addiction evolved in the 1600s to suggest a tendency of habits and pursuits. Used in the modern sense since the 1800s with reference to tobacco, opium, and spirits, addiction now describes a symptom complex of loss of control, compulsive use, and continued use despite adverse consequence. Although “dependence” was used by DSM III to describe the physical dependence upon drugs and alcohol (as evidenced by tolerance and withdrawal) and subsequently by DSM III-R and IV to include the three Cs (Control, Compulsive use, and Consequences), there is now relatively widespread agreement that “addiction” best denotes the symptom cluster that is the focus of this volume: *Neuroimaging in Addiction* [1]. As this book goes to press, the DSM-V work group on substance-related disorders has recommended that “addiction” replace “dependence” as the diagnostic label that defines these behaviors, concerns regarding its vagueness, associated stigma, overuse, and non-scientific formulation notwithstanding [2].

“Addiction,” however, has also been usurped in the public domain to describe any behavior that is performed in excess, including Internet use, sex, chocolate, shopping, pornography, gambling, tanning, or eating. Whether or not these behaviors are truly “addictive,” and whether these behaviors are consistent with a disease process, begs the question of how to definitively identify this disorder. The diagnosis of substance use disorders (in addition to other so-called “process” or “behavioral” addictions), unfortunately, shares a dilemma encountered throughout psychiatry – the diagnosis is based solely on descriptive, symptomatic checklist criteria. The use of biological measures, such as blood tests, physiological measures (e.g., blood pressure), electrocardiograms, or x-rays, to diagnosis disease states, which are standard protocol throughout the rest of medicine, continues to elude our field. The absence of accurate (or even partially accurate) biological markers to guide the diagnosis of neuropsychiatric disorders remains a critical limiting factor in discerning a neurobiologically-based disease from a non-pathological behavioral state and may, in part, be responsible for the poor outcome prognoses for many of our patients suffering from addiction. We believe that neuroimaging techniques offer the best hope to realize this Holy Grail of psychiatry.

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*Neuroimaging in Addiction*, First Edition. Bryon Adinoff and Elliot Stein.

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When the editors began their training, brain imaging was in its early stages of development and implementation as a diagnostic tool. Researchers and clinicians were suddenly provided the opportunity to safely, and with relatively minimal patient discomfort, investigate the human brain in situ. The promises inspired by structural and functional brain imaging were profound. The 1990s were pronounced “The Decade of the Brain” and it was assumed that these tools would herald the neurobiologically based diagnosis and targeted treatment of psychiatric disorders by the turn of the twenty-first century. This, of course, did not happen. What did happen, however, were stunning technical advancements in assessing brain activity that allowed an unparalleled investigation of neural processes, exponentially increasing our understanding of how the brain perceives, integrates, and responds to sensory and affective stimuli. Steady progress has also been evident in unveiling the neurobiological differences in individuals with psychiatric disorders, albeit not (as of yet) with the diagnostic sensitivity and specificity required for clinical use. These advances, perhaps most impressive in the addictive disorders, has motivated the publication of *Neuroimaging in Addiction*.

The accomplishments in understanding the neural processes involved in addiction are due, at least in part, to superb animal models that closely mimic the repetitive and compulsive drug-taking behaviors observed in addicted humans. Neuroimaging techniques have provided the interface necessary to translate these anatomical, cellular and circuitry models into the human addicted brain. A major accomplishment of these closely aligned approaches is the elucidation of biologic processes that are shared across several substances of abuse. The growing confluence of these two approaches signaled to the editors that the timing was propitious to summarize the neuroimaging findings to-date and has guided two key concepts encapsulated in *Neuroimaging in Addiction*.

First, the chapters have been organized by key constructs shared across the various substances of abuse, starting with a description of shared disruptions in neurocircuitry and extending to experiential, cognitive and behavioral processes such as reward salience, craving, stress, and impulsivity. This approach, rather than a categorical approach based upon a specific drug of abuse, supports the common DSM-IV behavioral criteria used to describe all addictive disorders. Second, the title of the book refers to Addiction in the singular, denoting a common disease process that is differentially manifested (i.e., a shared etiology and neurocircuitry that is variably expressed with different drug choices) rather than a spectrum disorder (i.e., each substance addiction encapsulates its own etiologic and biologic profile with shared symptoms across each substance). This distinction has critical implications for our understanding, as well as treatment, of addiction.

Guided by this framework, the contributors to *Neuroimaging in Addiction* detail the state-of-the-art in their respective fields. Although the original intent of the editors was to specifically highlight the advances of neuroimaging in addiction, each chapter has also evolved into a superb overview of the construct or topic approached and thus simultaneously provides the reader with an excellent textbook on addiction neurobiology. This extensive overview emphasizes the remarkable progress that has occurred in our field over the past ten years.

Yet, as noted earlier, these great leaps forward have not been paralleled with similar progress in the diagnosis or treatment of addiction. Making accurate diagnoses on an individual subject/patient basis remains elusive, as does our ability to assess treatment efficacy. Nevertheless, dramatic advances in imaging technology, coupled with those in other fields (e.g., genomics, drug discovery), promise such breakthroughs in the not-too-distant future. New technologies have and will continue to offer new insights in

the structure and function of both the healthy brain and its pathophysiology. Justified excitement in the neuroimaging field can be seen in the recent advances in the ability to perform white matter tract tracing *in situ*, combine the excellent temporal resolution of EEG with the superb spatial resolution of fMRI in combined recording studies, and measure the important neurotransmitters glutamate and GABA via MR spectroscopy. New PET ligands are starting to emerge from the lab, promising the ability to make molecular measurements of compounds based on scientific hypotheses, not simply because a ligand was available. And new hardware continues to be developed, whether it be ever higher field MRI scanners (a human 11.7 T scanner is currently in development) or the exciting recent PET camera insert into a standard 3T MRI, allowing for the first time simultaneous measurements. Finally, especially in the field of MRI, new analysis methods are continually being developed to better extract information from the rich MRI signal. These developments include the rapidly evolving field of resting state functional connectivity, and its analysis using network and multivariate analyzes, although only the former has yet to be applied to the addiction field.

Elucidating subject-specific differences in brain functioning will enable the identification of neural correlates of behavioral complexes, unique intermediate phenotypes, and/or substance-specific disruptions as well as targeted treatment approaches and objective assessments of treatment efficacy. Clarification of the distinct and overlapping neural networks defining addictive and other psychiatric disorders, including schizophrenia, bipolar, post-traumatic stress, and antisocial social personality disorders, will allow increasingly focused treatment approaches. Finally, it is likely that identifying neural signatures of addiction will markedly diminish the stigma associated with addictive disorders. Such biological markers should lessen the fear and shame that accompanies this disease, and in turn, remove self-imposed, social, and medical obstacles in seeking and obtaining treatment. It is our hope that scientists, clinicians, and students will find the material in this volume useful as we continue our journey to understand the addicted brain with the goal of improved prevention and treatment outcomes for our patients.

## References

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