Introduction

Neuroimaging of Emotions in Psychiatry

By Israel Liberzon, MD

The development of functional neuroimaging techniques, such as single photon emission tomography, positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), revolutionized the field of cognitive neuroscience. Investigators are now able to identify the neurocircuitry associated with specific cognitive functions in vivo without complex invasive procedures. In the past decade, these methodologies have been increasingly applied to the study of emotion (eg, of affective neuroscience). Emotions are central to human motivation, behavior, and social interactions and, thus, understanding these emotions is fundamental to a full understanding of the human brain. Abnormal or altered emotional responses are the hallmark of all major psychiatric disorders, so understanding psychiatric disorders will necessarily require better understanding of both normal and abnormal emotional function. The emergence of novel imaging tools and their application to the study of emotions have been critical to the substantial progress that has been made in this regard. This work carries a great promise to facilitate our efforts to advance understanding of abnormal emotional functioning in psychiatric illness.

Functional neuroimaging of emotions can aid the study of the human brain in health and disease in many ways. Novel imaging methodologies allow us to trace the circuitry and connectivity underlying emotional processing and also permits examination of processing at cellular and molecular levels. Four of the articles in this issue describe studies that assess neuronal activity in specific brain regions by measuring regional cerebral blood flow with PET, or blood-oxygen level-dependent effects with fMRI, while the fifth reports on PET radiotracer binding studies which examine indices of various neurotransmitters in specific brain regions. These articles demonstrate a variety of potential applications of functional neuroimaging to the field of psychiatry and psychopathology.

The summary of two meta-analytic studies, reported by K. Luan Phan, MD, and colleagues, demonstrates how accumulating evidence from multiple neuroimaging studies provides a better understanding of the specific roles that brain structures like the amygdala, insula, medial prefrontal cortex, and anterior cingulate play in the processing of emotions. This approach also allows us to examine empirically prevailing but difficult to test beliefs or hypotheses, such as the predominance of right hemisphere in processing emotions.

Christian G. Kohler, MD, and colleagues focus on recognition of facial emotions, examine the neural circuitry that subserves this function, and compares activation of the identified circuits in different psychiatric conditions (eg, schizophrenia, affective disorders, brain lesions, neurodevelopmental and neurodegenerative disorders) relating the findings to interpersonal communication difficulties observed in these disorders.

The investigational approach demonstrated by Mary L. Phillips, MD, PhD, and colleagues uses functional neuroimaging as a tool to try to further refine diagnostic categories. It aims to establish a better link between neuroimaging findings and symptom-specific dimensions in a clinically heterogeneous disorder like obsessive-compulsive disorder. It tests whether a particular symptom, such as contamination/washing, is associated with neuroimaging findings and with abnormalities in disgust perception in a subgroup of individuals with obsessive-compulsive disorder.

Carl E. Schwartz, MD, and colleagues show how sophisticated neuroimaging approaches can be used in longitudinal prospective studies by developing specific probes that are sensitive to stable trait-like phenomena. The amygdala probe developed by their group might be of use in defining a stable endophenotype for inhibited temperament. This, in turn, might provide a critical step future differentiation of genetic versus environmental factors in a number of anxiety and mood disorders.

In their focused review of the neuroimaging research on neurotransmitter systems in depression, Susan E. Kennedy, BS, and Jon-Kar Zubieta, MD, PhD, provide a window into in vivo neurotransmitter physiology and pathophysiology. They demonstrate how major hypotheses, such as the involvement of serotoninergic systems in affective disorders, can be critically examined in vivo, and how new hypothesis regarding the involvement of opioidergic systems, can be derived from neuroimaging findings. The utilization of radiolabeled ligands and appropriate kinetic quantification models permits the study of neuroreceptors and of neurotransmitter and neuronal circuitry and connectivity underlying emotional processing.

As evident in this collection of papers in CNS Spectrums, the psychiatric application of functional neuroimaging is still at an early stage of development. In order to address a specific question, investigators often must develop new and better stimuli, new probes and paradigms, new radiotracers or new analytic approaches. Additional novel and exciting methodologies, such as magnetoencephalography and magnetic resonance spectroscopy, are under rapid development and are gathering momentum, but their description is beyond the scope of this particular issue. The full scope of potential applications is also well beyond the scope of any single journal issue, but this volume provides a sampler that will hopefully stimulate our readers' curiosity, and trigger an eagerness to learn more and to apply these findings and techniques to their own clinical and scientific questions.