Psychoradiology is an emerging discipline at the intersection between radiology and psychiatry. It holds promise for playing a role in clinical diagnosis, evaluation of treatment response and prognosis, and illness risk prediction for patients with psychiatric disorders. Addressing complex issues, such as the biological heterogeneity of psychiatric syndromes and unclear neurobiological mechanisms underpinning radiological abnormalities, is a challenge that needs to be resolved. With the advance of multimodal imaging and more efforts in standardization of image acquisition and analysis, psychoradiology is becoming a promising tool for the future of clinical care for patients with psychiatric disorders.

Resting-state functional connectivity (RSFC) has been widely studied in functional magnetic resonance imaging (fMRI) and is observed by a significant temporal correlation of spontaneous low-frequency signal fluctuations (SLFs) both within and across hemispheres during rest. Different hypotheses of RSFC include the biophysical origin hypothesis and cognitive origin hypothesis, which show that the role of SLFs and RSFC is still not completely understood. Furthermore, RSFC and age studies have shown an “age-related compensation” phenomenon. RSFC data analysis methods include time domain analysis, seed-based correlation, regional homogeneity, and principal and independent component analyses. Despite advances in RSFC, the authors also discuss challenges and limitations, ranging from head motion to methodological limitations.

Psychiatric disorders are common and can be severe. There is a need to identify biomarkers of psychiatric disorders to better diagnose and treat patients with psychiatric symptoms. Magnetic resonance spectroscopy (MRS) is a tool used to measure the levels of various metabolites in the human brain, and MRS studies of psychiatric disorders have identified potentially useful biomarkers of psychiatric illness. There have been significant advances in the way that psychiatric disorders are understood, classified, and researched as well as improvements in magnetic resonance imaging/MRS technology. MRS as a tool has not yet proved helpful to individual patients with psychiatric symptoms.
Imaging-Based Subtyping for Psychiatric Syndromes
Elena I. Ivleva, Halide B. Turkozer, and John A. Sweeney

Despite considerable research evidence demonstrating significant neurobiological alterations in psychiatric disorders, incorporating neuroimaging approaches into clinical practice remains challenging. There is an urgent need for biologically validated psychiatric disease constructs that can inform diagnostic algorithms and targeted treatment development. In this article, the authors present a conceptual review of the most robust and impactful findings from studies that use neuroimaging methods in efforts to define distinct disease subtypes, while emphasizing cross-diagnostic and dimensional approaches. In addition, they discuss current challenges in psychoradiology and outline potential future strategies for clinically applicable translation.

Individual-Specific Analysis for Psychoradiology
Hesheng Liu, William J. Liu, Danhong Wang, and Louisa Dahmani

In neuroimaging research, averaging data at the level of the group results in blurring of potentially meaningful individual differences. A more widespread use of an individual-specific approach is advocated for, which involves a more thorough investigation of each individual in a group, and characterization of idiosyncrasies at the level of behavior, cognition, and symptoms, as well as at the level of brain organization. It is hoped that such an approach, focused on individuals, will provide convergent findings that will help identify the underlying pathologic condition in various psychiatric disorders and help in the development of treatments individualized for each patient.

Psychoradiological Biomarkers for Psychopharmaceutical Effects
Anouk Schrantee, Henricus Gerardus Ruhé, and Liesbeth Reneman

The application of personalized medicine to psychiatry is challenging. Psychoradiology could provide biomarkers based on objective tests in support of the diagnostic classifications and treatment planning. The authors review potential psychoradiological biomarkers for psychopharmaceutical effects. Although none of the biomarkers reviewed are yet of sufficient clinical utility to inform the selection of a specific pharmacologic compound for an individual patient, there is strong consensus that advanced multimodal approaches will contribute to discovery of novel treatment predictors in psychiatric disorders. Progress has been sufficient to warrant enthusiasm, in which application of neuroimaging-based biomarkers would represent a paradigm shift and modernization of psychiatric practice.

Implementing MR Imaging into Clinical Routine Screening in Patients with Psychosis?
André Schmidt and Stefan Borgwardt

MR imaging is a suitable instrument for the detection of incidental radiological findings in patients with early psychosis and guidance of subsequent treatment adjustments. The authors outline evidence showing the clinical utility of MR imaging to guide treatment selection by identifying radiological abnormalities and predicting clinical outcomes in early-stage psychosis. They argue that MR imaging is an indispensable screening tool to detect gross radiological abnormalities in early psychosis and implementation in routine clinical assessments is warranted. The authors highlight future key challenges and make pragmatic suggestions to exploit the potential of MR imaging to construct robust prognostic models for personalized early interventions.
Neuroimaging in Schizophrenia 73
Matcheri S. Keshavan, Guusje Collin, Synthia Guimond, Sinead Kelly, Konasale M. Prasad, and Paulo Lizano

Schizophrenia is a chronic psychotic disorder with a lifetime prevalence of about 1%. Onset is typically in adolescence or early adulthood; characteristic symptoms include positive symptoms, negative symptoms, and impairments in cognition. Neuroimaging studies have shown substantive evidence of brain structural, functional, and neurochemical alterations that are more pronounced in the association cortex and subcortical regions. These abnormalities are not sufficiently specific to be of diagnostic value, but there may be a role for imaging techniques to provide predictions of outcome. Incorporating multimodal imaging datasets using machine learning approaches may offer better diagnostic and predictive value in schizophrenia.

Widespread Morphometric Abnormalities in Major Depression: Neuroplasticity and Potential for Biomarker Development 85
Cynthia H.Y. Fu, Yong Fan, and Christos Davatzikos

Major depression is common and debilitating. Identifying neurobiological subtypes that comprise the disorder and predict clinical outcome are key challenges. Genetic and environmental factors leading to major depression are expressed in neural structure and function. Volumetric decreases in gray matter have been demonstrated in corticolimbic circuits involved in emotion regulation. MR imaging observable abnormalities reflect cytoarchitectonic alterations within a local neuroendocrine milieu with systemic effects. Multivariate pattern analysis offers the potential to identify the neurobiological subtypes and predictors of clinical outcome. It is essential to characterize disease heterogeneity by incorporating data-driven inductive and symptom-based deductive approaches in an iterative process.

The Neurodevelopment of Autism from Infancy Through Toddlerhood 97
Jessica B. Girault and Joseph Piven

Autism spectrum disorder (ASD) emerges during early childhood and is marked by a relatively narrow window in which infants transition from exhibiting normative behavioral profiles to displaying the defining features of the ASD phenotype in toddlerhood. Prospective brain imaging studies in infants at high familial risk for autism have revealed important insights into the neurobiology and developmental unfolding of ASD. In this article, the authors review neuroimaging studies of brain development in ASD from birth through toddlerhood, relate these findings to candidate neurobiological mechanisms, and discuss implications for future research and translation to clinical practice.

Imaging of Posttraumatic Stress Disorder 115
Kouhei Kamiya and Osamu Abe

This review summarizes current knowledge obtained from psychoradiological studies of posttraumatic stress disorder (PTSD). The authors first focus on 3 key anatomic structures (hippocampus, amygdala, and medial prefrontal cortex) and the functional circuits to which they contribute. In addition, they discuss the triple-network model, a widely accepted neurobiological model of PTSD that explains the vast majority of neuroimaging findings, as well as their interactions and relationships to functional disruptions in PTSD.