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Editorial

New technology and emerging theories driving progress in neuropsychiatric disorders

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As society advances, individuals face growing challenges and mental pressures, leading to a rising incidence of neuropsychiatric disorders. According to the Global Burden of Disease (GBD) report, an estimated 38% of the global population is affected by neurological disorders, with the prevalence of mental disorders reaching approximately 14% by 2021 [1]. Both conditions are characterized by complex pathogenesis and high heterogeneity, and currently, effective and universal treatments for most neuropsychiatric disorders remain scarce [2]. Fortunately, recent technological advancements, grounded in emerging scientific theories, have paved the way for novel theraputic approaches.

Genetic technologies, particularly single-cell genomics, hold promise for uncovering the regulatory mechanisms underlying brain-related traits. Techniques such as snRNA-seq and snATAC-seq, combined with machine learning, are utilized to develop predictive models for conditions like schizophrenia, autism, bipolar disorder, and Alzheimer's disease. These models provide insights into the commonalities and unique characteristics among affected individuals [3]. Furthermore, Genome-Wide Association Studies (GWAS) have significantly advanced research in neuropsychiatric disorders, revealing genetic and molecular pathophysiology shared across psychiatric and neurodegenerative diseases [4]. These developments offer new avenues for prevention and precision medicine in neuropsychiatric disorders [5].

Neurophysiological techniques, including functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and patch clamp methods, enable the measurement, recording, and analysis of neural activity at systemic, multicellular, and cellular levels [6]. These advancements have contributed to the development of brain connectivity omics, which focuses on the functional and structural connections between brain regions. This supports the "meta-networking" theory [7], which posits that complex cognition and behavior arise from the spatiotemporal integration of distributed, yet specialized, neural networks. Large-scale electrophysiology has also made significant strides. For example, Neuropixels probes, with approximately 1000 recording sites on an extremely narrow handle, enable low-noise recording from hundreds of neurons, revolutionizing the data available for analysis [8]. Brain stimulation techniques, such as repetitive transcranial magnetic stimulation (rTMS), transcranial direct current stimulation (tDCS), and deep brain stimulation (DBS) [9,10], not only serve as tools for exploring the neural circuit-level etiology of these disorders but also offer effective alternatives to psychotropic medications. While these techniques cannot fully address the complexity and variability of neuropsychiatric disorders, brain-computer interfaces (BCIs) have shown potential by recording neural activity and providing personalized stimulation strategies [11].

Technological advancements have spurred the development of new theories and refined existing hypotheses in neuroscience. Immune processes, for example, have emerged as critical factors in the central nervous system (CNS), with neuroglial cells playing an important role [12]. Chronic inflammation and latent infections can lead to disturbances in higher-order brain networks, resulting in cognitive and behavioral impairments. Beyond autoimmune brain diseases, immune dysregulation has been implicated in neuropsychiatric disorders such as schizophrenia, autism, bipolar disorder, and major depressive disorder, suggesting that immunotherapy could be a promising treatment for inflammation-related brain diseases [13]. The microbial-gut-brain axis has also garnered significant attention as a potential pathogenic mechanism in neuropsychiatric disorders, with its bidirectional communication representing a promising therapeutic target [14]. The exploration of microbiota in other organs further illuminates the complex interplay between the nervous and immune systems, opening new research avenues in neuropsychiatric diseases [15].

This special issue of *Fundamental Research* focuses on advancements in the understanding and treatment of neuropsychiatric disorders. It features three review articles, two perspectives, and two original research articles. Xu et al. [16] review the important role of peroxisomes and pexophagy in the physiological and pathological mechanisms of neurological diseases. Ye et al. [17] present recent discoveries on the role of macrophage migration inhibitory factor (MIF) in CNS diseases and discuss the development of small molecules targeting tautomers and nucleases. Yao et al. [18] revisit recent advances in calcium signaling in astrocytes, driven by progress in calcium labeling, imaging, and analysis techniques. Chu et al. [19] explore the potential of gene therapy as a novel approach for treating Scn2a mutation-induced autism spectrum disorder, discussing its pros and cons. Wang et al. [20] examine the evolution of non-small-molecule therapeutics for drug addiction, from pharmacokinetics modulation to synthetic biology. Huang et al. [21] investigate the acute anti-seizure effects of full-spectrum hemp extract, analyzing the efficacy of non-addictive cannabinoids such as cannabinol, and

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uncover the mechanisms underlying hemp extract's anti-seizure properties. Yuan et al. [22] study cortical plasticity in individuals with heroin and methamphetamine-related substance use disorders, proposing rTMS as a tool for evaluating new plasticity-based drug addiction treatments. These articles collectively address the functional development and practical applications of new technologies, propose novel mechanisms or refine existing theories, and highlight the challenges and opportunities of emerging therapies. They provide valuable guidance for future research in the field. Finally, we extend our heartfelt gratitude to all authors for their contributions to this special issue. Additionally, our sincere thanks go to the editorial department for their invaluable support and assistance.

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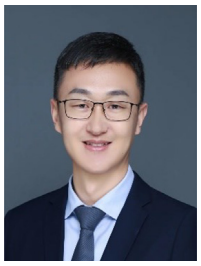

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