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PROSPECTIVE

A New Era of Human Brain Research

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Human brain research is essential to neuroscience, and several generations of brain scientists have contributed to this field. In 1861, French surgeon *Pierre Paul Broca* described two patients unable to speak after injury to the posterior inferior frontal gyrus of the brain through autopsy. This work lays the foundation for modern neuropsychology and cognitive neuroscience (Dronkers et al., 2007). Furthermore, the deficit in language production was known as *Broca's aphasia*, and the approximate region involved in the brain was named *Broca's area*. In 1907, a German neuropathologist *Alois Alzheimer* described the presence of extraneuronal senile plaques and intraneuronal neurofibrillary tangles in the case of brain autopsy from a patient who had progressive presenile dementia with general cortical atrophy (Trejo-Lopez et al., 2022). The neurodegenerative disorder was later named *Alzheimer's disease* (AD). Several approaches have emerged in the past century regarding the diagnostic technologies and underlying mechanisms of AD to diagnose AD. However, the two original biomarkers (i.e. senile plaques and neurofibrillary tangles) discovered by Dr Alzheimer are still considered the "golden criteria" for the neuropathological diagnosis of the disease.

With the rapid progress of modern neurology and neurosurgery, several novel techniques have been invented to obtain detailed information from the human brain and/or obtain human brain tissue samples with various physiological and pathological conditions. These techniques mainly include neuroimaging (such as computed tomography, magnetic resonance imaging, positron emission tomography, magnetoencephalography, and electroencephalography), neuro-intervention, and microneurosurgery. On the other hand, further progress of radiosurgery, psychosurgery, robotization, biotechnology, and nanotechnology may also facilitate human brain research (Nikova & Birbilis, 2017). The developments in all these technologies have paved the way for a new era of brain research.

The *Brain Research through Advancing Innovative Neurotechnologies* (*BRAIN*) *Initiative* was announced in 2013 by the US government, focusing on innovative technologies for a better understanding of the human brain and further diagnosis, prevention, and treatment of brain disorders (Insel, 2013). The same year, the *Human Brain Project*, a *European Commission Future and Emerging Technologies Flagship*, was also started. However, it remained controversial due to the decreased emphasis on experimental neuroscience and the brain itself (Frégnac & Laurent, 2014). The *China Brain Project* was first proposed in 2016 with a framework of "one body, two wings",

in which the basic research on the neural circuit mechanisms underlying cognition offers inputs and receives feedback in the brain-inspired intelligence technologies and early diagnosis/intervention of brain disorders (Poo et al., 2016). This project was formally launched in 2021, entitled as the *Brain Science and Brain-Inspired Intelligence Technology Major Project*. All these projects focus on understanding the brain, protecting the brain, and developing the brain, where understanding the brain is the foundation of further explorations. The core objectives of the research are looking for better inventions for brain disorders and developing the potential of the human brain. However, our current understanding of human brain is still preliminary, and there are different challenges that need to be addressed. Compared with the research initiatives for animal models, the funding for direct study of human brain, including its structure, function, and related diseases, is relatively insufficient. The importance of brain research based on human brains should be emphasized, and the research challenges can possibly be addressed by the cooperation of policy makers, neuroscientists, and clinicians in related fields.

With the rapid progress of new energy technology, information technology, biotechnology and medicine, human development has reached a new era. I encourage basic and clinical researchers to collaborate in depth and break the barriers between the bench and bedside. Researchers may integrate resources, including human brain banks and other resource platforms (Tang, 2020), to conquer the diseases that seriously threaten human health, such as AD, cerebrovascular diseases, and brain tumors, and eventually benefit human beings through human brain research. This is also the expectation of the *Human Brain*. I sincerely wish this new journal could become a leading, clinical neurology neuroscience and clinical neurology.

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