FINGERPRINTING THE BRAIN: THE DEVELOPMENT OF PSYCHIATRIC DISORDERS IN ADOLESCENTS

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NEURAL ACTIVITY AND ITS CORRELATION TO THE DEVELOPMENT OF PSYCHIATRIC DISORDERS

In the past year, neuroscience has made tremendous breakthroughs in research surrounding the development of psychiatric disorders in adolescents. Whereas past approaches to understanding the cause of a particular behavior relied on studying specific regions of the brain, modern techniques have shifted focus to the networks of neurons that transmit nerve impulses throughout the brain.[1] According to some studies performed, the process of normal brain maturation involves the consolidation of the brain connectome, a whole-brain map of the neural circuits throughout the brain; many psychiatric disorders may originate from abnormalities in this comprehensive network.[8]

The brain consists of millions of neurons, which function by receiving information from other parts of the body, integrating incoming signals, determining which information is more important to send to the rest of the brain, and communicating with other neurons, muscles, and glands.[11] The new methods of mapping these neural connections in the brain originate from a groundbreaking neuroscience research initiative known as the The Human Connectome Project. Prior to this project, uncovering psychiatric disorders in the brain relied on specialization, the idea that certain areas of the brain are more involved in certain behaviors and skills than others.[1] Speaking about the importance of The Human Connectome Project, Deanna Barch, Professor of Psychological and Brain Sciences at The University of Washington in St. Louis explains, "These advances have provided the basis for recent efforts to develop a more complex understanding of the function of brain circuits in health and of their relationship to behavior—providing, in turn, a foundation for our understanding of how disruptions in such circuits contribute to the development of psychiatric disorders."[7] Researchers across the world have used the data from the Human Connectome Project to study its relationship to brain maturation and mental health disorders, and how they develop in adolescents.

From prior research, it has become clear that a rapid developmental stage in the brain progresses starting in early adolescence. In order to distinguish between a "normal" brain and one that is showing signs of developing a psychiatric disorder, researchers have found that brains with a higher frequency of psychiatric symptoms had "less distinctive and individually varying" connectomes.[1] Specifically, the connectomes in the brains of individuals with psychiatric disorders showed a delayed rate of maturation in the development of the distinctions in their individual neural networks.

In order to study the development of this less distinctive connectome and how it is attributed to brain maturation, a group of researchers at The University of Oslo measured how the distinctive networking of the brain connectome is most visible and obvious in adolescents during puberty, with a focus on young males. The researchers used four groups of interest to study the correlation between brain connectome distinctiveness and the development of

psychiatric disorders. The brain activity of the participants in this study were examined using Functional Magnetic Resonance Imaging (fMRI), a tool that detects changes in blood flow in the brain relative to its concentration of oxygen. Based on clinical symptom scores, these four groups included a healthy control group, a group exhibiting symptoms of attention deficit disorder, a group showing initial symptoms of schizophrenia, and a group showing initial symptoms of depression. Their findings showed that the groups with clinical symptoms of initial signs of schizophrenia and depression had a delayed rate of maturation in the brain. As these psychiatric disorders progressed, the data showed that connectome differences did not appear during the ages of 8-14, showing that these distinctions develop during puberty.[2] Tobias Kaufmann, one of the lead researchers on the team, concluded from their data that the brains of adolescents with psychiatric symptoms contained a delay in the individualization of their brain connectome. In other words, the presence of less distinct neural circuits in the brain was correlated with a higher probability of the existence of symptoms of mental illness.[3]

In order to explain how these psychiatric disorders develop in adolescents, it is necessary to understand the concept of neuroplasticity, the brain's ability to reorganize itself by strengthening or weakening neural connections in response to development and methods of use. Another group of researchers reached this conclusion by focusing on symptoms of depression in adolescents, and how it can preface depression in adulthood. They created four subgroups out of 243 adolescents, including a control group with low levels of depression, two groups with a decrease in symptoms, and one with an increase in symptoms. They tested the four depression trajectory groups on both whole brain and regional levels, finding that the groups varied in mean differences in nodal efficiency, a measure of how efficiently the network of neurons exchanges information in regards to the level of individual connections between regions in the brain. The groups with symptoms of depression showed a deviation in the normal development of network consolidation in the brain, suggesting that this might be an indicator of an individual's predisposition to depression in the future.[9]

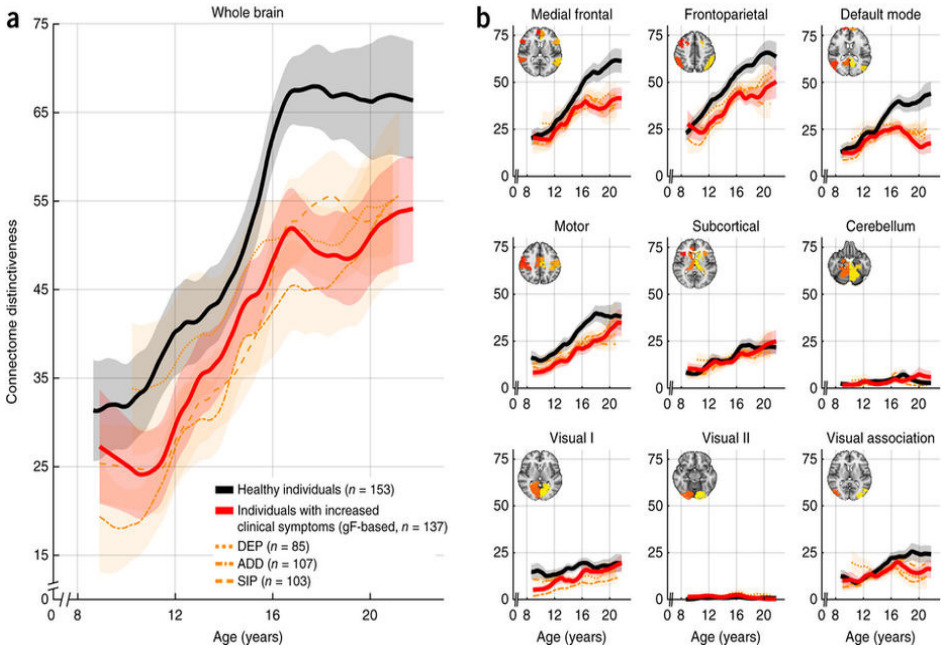

Figure 1: These graphs represent (a) analysis of whole-brain connectivity and (b) analysis of nine sub-networks of the brain (medial frontal, frontoparietal, default mode, motor, subcortical, cerebellum, visual I, visual II, and visual association). Individuals with a higher clinical symptoms score showed a lack of brain maturation in terms of brain connectome distinctiveness.[13]

Since just the beginning of this year, neuroscientists have already made great strides in understanding the maturation of our individual neural networking in the brain and its subsequent correlation in the development of psychiatric disorders.[1] Advancements in the understanding the individuality of our distinct connectomes and the delayed rate of maturation in the brain contributes to the viability of recognition and treatment of these abnormalities, propelling this branch of neuroscience research into the future.

"Connectomes resemble a fingerprint; they are distinct from person to person and evolve during adolescence."

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"The presence of less distinct neural circuits in the brain was correlated with a higher appearance of symptoms of mental illness."

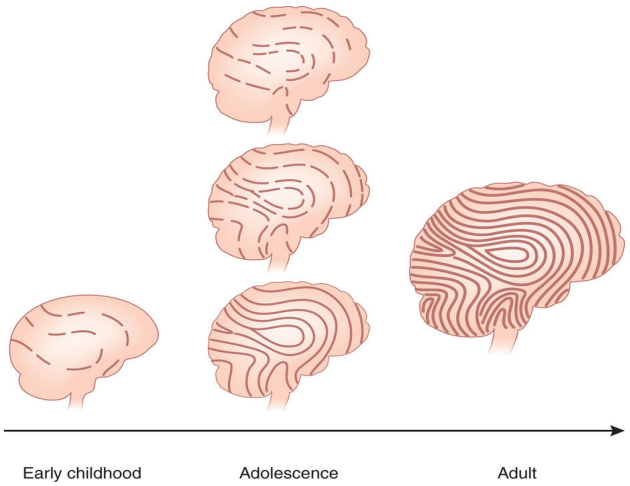

Figure 2: The brain connectome 'fingerprint' transforms into a distinct and individualized network of neural connections during early adolescence. In this study, people with higher levels of clinical symptoms of psychiatric disorders had visibly less distinct connectomes, as seen in the top figure of the brain during adolescence. People whose neural networks revealed greater complexion and individualization had, on average, a lower

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