Feedback legend:
pink- structural feedback,
yellow- grammatical feedback
blue- general comments

This paper explores the concept of brain criticality and its potential implications on cognition and mental illnesses. Brain criticality refers to the state of the brain where it operates at the boundary between order and randomness, displaying complex and information-processing capabilities. This concept is based on the idea of criticality in complex systems, which are often positioned at the brink of a phase transition. When applied to the brain, the criticality theory suggests that the global neuronal dynamics of healthy brains operate at the brink of a critical phase transition between order and disorder. This means that the large-scale behavior of the brain, composed of billions of interacting elements (neurons), undergoes a qualitative change when a certain global parameter, such as excitation/inhibition balance or neuromodulator concentration, passes a critical point. At this critical point, the brain exhibits long memory, which refers to the persistence of neuronal activity patterns over time. This long memory allows the brain to retain information for short periods, acting as a form of short-term memory. The persistence of neuronal activity patterns at the critical point enables the brain to process and integrate information over time, contributing to cognitive processes. Thus, the computational features of brain criticality could provide a theoretical framework for understanding brain function and dysfunction.

Criticality in brain dynamics is associated with remarkable information-processing capabilities and is believed to contribute to the brain's computational efficiency. The brain's proximity to the critical point allows for the emergence of complex and flexible patterns of activity, enabling the integration and processing of information. The critical point also plays a role in the brain's ability to transition between different cognitive states and adapt to changing environmental demands. Understanding the dynamics and behavior of the brain at the critical point is essential in studying its efficiency in both biological and artificial neural networks.

Criticality theory suggests that deviations from the critical point, where the brain operates at the boundary between order and disorder, may be associated with mental illness. By exploring the distance to criticality as a metric, criticality theory provides a parameter for characterizing cognitive differences and mental illness, further enhancing our understanding of emergent function in the brain. Researchers can gain insights into the dynamical operating point of mental illness, such as autism, schizophrenia, and depression.

Although research in depression has made significant progress over the past decade, there continue to be obstacles that hinder further advancements in the field. For example, the lack of biomarkers continue to be an issue both in the diagnosis and research of depression. In the clinical context, due to how heterogeneous the nature of the illness is, it is challenging to identify consistent biomarkers or treatment strategies that are effective for all individuals. With the lack of biomarkers, diagnosing and assessing depression often rely on subjective reports, which can be influenced by personal biases and individual differences. Having objective measures like reliable biomarkers are crucial for more accurate diagnosis and treatment monitoring. The brain criticality theory suggests that specific patterns of neural activity may serve as biomarkers for mental health conditions. Researchers can explore whether certain features of neural network dynamics, such as critical brain states, can be identified as reliable biomarkers for depression. This could contribute to more accurate and objective diagnostic criteria for depression. By incorporating neural network dynamics into diagnostic assessments, researchers may improve the precision of identifying individuals with depression and differentiating subtypes of the disorder. Furthermore, examining individual differences in neural network criticality may provide insights into the heterogeneity of depression and anxiety. Not all individuals experience depression in the same way, and understanding how individual variations in critical brain states relate to symptom profiles and treatment responses can inform personalized approaches to intervention.

Another obstacle in the research of depression is treatment resistance. A significant portion of individuals do not respond adequately to existing treatment. The reasons for treatment resistance is still unclear, and novel therapeutic approaches have yet to be developed. Examining critical brain states in individuals with treatment-resistant depression may help identify specific mechanisms contributing to resistance. This knowledge can guide the development of targeted interventions for individuals who do not respond to conventional treatments.

Additionally, the neurobiological mechanisms underlying depression remain incompletely understood. There is a need for more precise knowledge of the neural circuits, neurotransmitter systems, and genetic factors involved. Integrating brain criticality research with genetic and molecular studies can provide a more comprehensive understanding of the neurobiological basis of depression and anxiety. Examining how genetic factors influence critical brain states and molecular processes associated with neural network dynamics may uncover novel targets for intervention.

In conclusion, this article covers the concept of criticality in complex systems and how it can be applied to the study of the brain and mental illnesses. Criticality theory provides a framework for understanding the dynamics of the brain in mental illness, by examining the distance to criticality as a metric for characterizing cognitive differences and mental illness. By studying the proximity to the critical point, researchers can investigate how deviations from criticality may be associated with conditions such as depression. Integrating conventional neurobiological research with brain criticality allows for a more holistic view of the disease and could lead to the possible identification of consistent biomarkers, aiding in both the diagnosis and advent of new therapeutic approaches.

Some general comments/feedback:
1. I don't know if you used any outside sources because the works cited wasn't included
but if you did, you should include in-text citations (you should probably also include them for what was referenced from the original article).
2. While the paper is super informative, is doesn't really make any connections to the course content or "Deep Simplicity" which I believe is one of the key parts of the assignment, so it might be a good idea to add a paragraph on that.
3. I think the tone is perfect- it is objective and informal as needed.
4. I like the flow of the paper. The connections to the course content (if added) could flow nicely within paragraphs 5 and 6