

Editorial

Investigating the Neuroplasticity in the Era of Artificial Intelligence

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ABSTRACT

The relationship between rehabilitation and motor recovery after stroke, as well as the impact of time on recovery, remains unclear. The widely accepted theory of “critical window for recovery” suggests that the most substantial recovery occurs within 3 to 6 months post-stroke, leading to the cessation of physical therapy during the chronic stage. However, recent studies have shown that neuroplasticity and treatment responsiveness extend beyond this critical window. Patients in chronic and late chronic stages still exhibit enhanced sensitivity to therapy. Artificial intelligence (AI) plays a significant role in predicting and understanding neuroplasticity by analyzing complex data through advanced computational methods. AI algorithms identify patterns, develop predictive models, and uncover hidden relationships, shedding light on the dynamics of neuro-plastic changes. Personalized rehabilitation approaches can be optimized through AI by tailoring treatment plans based on individual characteristics. AI’s potential in predicting and understanding neuroplasticity can advance our knowledge of brain plasticity mechanisms and improve personalized treatment strategies for stroke and related conditions.

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It is unclear how rehabilitation and the recovery of motor functions following a stroke relate to one another or how much this recovery depends on how long it has been since the stroke. The “proportional recovery rule,” a widely accepted idea in the field, contends that the most substantial recovery happens during a specified time frame, known as the “critical window for recovery,” usually between 3 and 6 months following a stroke. Based on this theory, it has been customary to stop physical therapy after this crucial window when the stroke reaches the chronic stage.

Previous research conducted on human subjects indicates the existence of a specific period, typically lasting from 3 to 6 months after a stroke, which is referred to as the “critical window” [1]. During this critical window, there is an observed increase in neuroplasticity, which refers to the brain’s ability to reorganize and adapt following injury or changes in its environment. This heightened neuroplasticity plays a crucial role in the recovery of motor functions after a stroke. The concept suggests that interventions and therapies applied during this critical window may have a greater impact on promoting neural recovery and restoring motor abilities compared to interventions applied outside of this time frame.

By analyzing the temporal pattern of recovery in individuals with hemiparesis (muscle weakness on one side of the body), researchers have discovered a specific gradient of increased responsiveness to treatment that extends beyond the traditionally defined critical window. This gradient indicates that patients at chronic and late chronic stages of stroke recovery still exhibit enhanced sensitivity to therapeutic interventions. These findings emphasize the importance of offering rehabilitation therapy to individuals even after the critical window has passed, as there is evidence that significant improvements can still be achieved during the chronic and late stages of stroke.

Artificial intelligence (AI) can help predict and explain neuroplasticity by using cutting-edge computing methods and machine learning approaches to analyze convoluted information about brain structure, function, and behavioral effects [2]. Large data sets can be processed by AI algorithms, which can also spot patterns that might not be clear using more conventional techniques.

AI can be useful for predicting the likelihood of brain recovery and comprehending the underlying mechanisms of neuroplasticity [2]. AI algorithms can create prediction models to calculate the likelihood and magnitude of neuroplastic changes occurring after an acci-

dent or neurological condition by examining multiple parameters such as demographic data, medical history, imaging data, and treatment interventions. Furthermore, by combining multiple data sources and locating hidden correlations between variables, AI approaches can aid in revealing the complex dynamics of neuroplasticity. A fuller understanding of the mechanisms underlying neuroplastic alterations, such as synapse rewiring, cortical reorganization, and functional recovery, may result from this [3].

By customizing treatment plans based on individual features, including genetic variables, biomarkers, and response patterns, AI can support personalized rehabilitation approaches. Clinicians and academics can improve treatment plans and interventions using AI to support neuroplasticity and improve recovery results [3]. Overall, using AI to anticipate and comprehend neuroplasticity has enormous potential for extending our understanding of the mechanisms behind brain plasticity, enhancing prognostic capacities, and directing personalized treatment plans for people with neurological diseases.

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