Title: The cerebro-cerebellar system: Integrative roles in motor control, cognition, and neuropsychiatric disorders

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Abastact: The cerebro-cerebellar system, a network of bidirectional loops between the cerebellum and cerebral cortex, is crucial for coordinating motor control, cognition, and emotion. Moving beyond its traditional role in motor coordination, contemporary research underscores the cerebellum's significant involvement in higher-order functions, including executive control, language, and social cognition. This review synthesizes current anatomical, functional, and clinical evidence to delineate the cerebellum's role in neuropsychiatric and neurodegenerative disorders such as schizophrenia, autism spectrum disorder (ASD), and ataxia. Unlike previous broad reviews, this article provides a structured framework that links cerebellar functional topography with disease-specific pathophysiological mechanisms. We particularly highlight the cellular substrates of cerebellar plasticity, such as Purkinje cell long-term depression (LTD). Our synthesis reveals that prior literature often lacks mechanistic depth and fails to integrate findings across structural, functional, and clinical domains. We conclude by proposing future research directions involving advanced neuroimaging, artificial intelligence, and targeted neuromodulation, thereby clarifying the cerebellum's integrative roles and underscoring its translational potential for novel therapeutic strategies.

Keyword: Ataxia; Autism Spectrum Disorder; Cerebellum; Cerebral Cortex; Cerebro-cerebellar Loops; Long-Term Depression; Neuroimaging; Neuromodulation; Neuroplasticity; Schizophrenia.

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