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Anti-Saccades in Cerebellar Ataxias Reveal a Contribution of the Cerebellum in Executive Functions

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Objective: Increasing evidence suggests a cerebellar contribution to modulate cognitive aspects of motor behavior and executive functions. Supporting findings come from studies on patients with neurodegenerative diseases, in which however, given the extent of the disease, the specific role of the cerebellum, could not be clearly isolated. Anti-saccades are considered a sensitive tool to test executive functions. The anti-saccade underlying neural network, consisting of different cortical areas and their downstream connections including the lateral cerebellum, has been largely clarified. To separate the role of the cerebellum with respect to other cortical structures in executive control, we compared the anti-saccade performances in two distinct cohorts of patients with cerebellar disorders (with and without cerebral cortical involvement).

Methods: Eye movements during the execution of anti-saccades were recorded in 12 patients with spinocerebellar ataxia type 2 (a cortical-subcortical neurodegenerative disease), 10 patients with late onset cerebellar ataxia (an isolated cerebellar atrophy), and 34 matched controls.

Results: In the anti-saccade task, besides dynamic changes already demonstrated in the pro-saccades of these patients, we found in both groups of cerebellar patients prolonged latency with larger variability than normal and increased directional error rate. Errors, however, were corrected by cerebellar patients as frequently as normal. No significant differences were found in patients with and without cortical involvement.

Conclusion: Our results indicate, in a large cohort of cerebellar patients, that the cerebellum plays a critical role in the regulation of executive motor control not only, as well known, by controlling the end of a movement, but also modulating its initiation and reducing reflexive responses that would perturb voluntary actions.

Keywords: frontocerebellar network, goal-directed actions, cognitive functions, latency, error

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Abbreviations: ACC, anterior cingulate cortex; BG, Basal Ganglia; DLPC, dorso-lateral pre-frontal cortex; FEF, frontal eye field; ICARS, International Cooperative Ataxia Rating Scale; LOCA, late-onset cerebellar ataxia; OMV, oculomotor vermis; PEF, parietal eye field; PPC, posterior parietal cortex; SCA2, spinocerebellar ataxia type 2; SEF, supplementary eye field; SMA, supplementary motor area; TMS, transcranial magnetic stimulation.