Discipline: Social and Behavioural Sciences

Title: Cerebellar stimulation by TMS - cerebellar stimulation of healthy persons

Abstract: Although enormous progress has recently been made in understanding the importance of the cerebellum in cognition and affect, its role in social cognition remains unclear and unexplored. To elucidate its functional role in social understanding, one theoretical perspective on the general function of the cerebellum is of particular relevance. This perspective implies that the cerebellum constructs internal models of motor and cognitive processes that involve sequencing and planning of actions in order to automate and fine-tune voluntary motor processes. The predictions of these internal models are continuously checked to see whether the anticipated predictions fit with current behavior and its external and somatosensory consequences. In this sense, the cerebellum is a “forward controller”. This has enormous advantages, because this allows on-line behavior adjustments during execution (rather than adjustments after failure). During evolution, a more advanced function developed which allowed the cerebellum to construct internal models of pure mental processes in the form of event sequences, without involvement of overt movements and somatosensory responses (Ito, 2008; Leggio, et al., 2011; Pisotta & Molinari, 2014). Thus, the cerebellum regulates non-motor mental operations in much the same way as it regulates movements (Andreasen & Pierson, 2008; Bower, 1997; Schmahmann, 1998). To illustrate the role of sequences in social understanding: it makes a difference if someone invites another person to enter a room first (he is courteous) rather than cut in front of her (he is impolite); to see a leader making a decision after the group convened and reached consensus (she is democratic) rather than before (she is autocratic). At a more general level, the ability to build action sequences in a coherent story is a critical cornerstone in the evolution of humankind, involving a cultural shift that unites people into larger civilizations rooted by shared social and religious stories and myths. In this manner, stories glue together people in a united past history that forms a common faith, value and identity (Harari, 2014). With respect to social mentalizing, the main focus of this research, we put forward the novel hypothesis that the (posterior) cerebellum develops and adjusts internal models of social action sequences so that these sequences can be used to make internal predictions that allow quick and accurate understanding of non-observable mental states of other persons, including their goals, beliefs and traits.

Virtual lesions using non-invasive TMS are applied to investigate the sequencing role of the cerebellum on complex social inferences in a healthy control population (n = ±40 per study). TMS allows to investigate the causal necessity of focal areas in the cerebellum in this process. Using a butterfly cone, TMS is applied at the bilateral posterior cerebellum (Ferrari et al., 2015) and is compared with sham (control) TMS. I will use repetitive TMS using a low-frequency (1 Hz) stimulation with at least 600 pulses. Because the effects of a single application of TMS are limited to 15-20 minutes, we will select for each TMS study one or at most two tasks. Performance is measured in terms of increased accuracy or shorter response time on the social sequencing tasks developed at our lab.

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