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Granule cell activity in the cerebellum during delay eyelid conditioning

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Although granule cell activity is crucial in defining the information processing performed by the cerebellum, in vivo single unit recordings of granule cells are scarce. Granule cells, which make more than half of all neurons in the brain, are not currently amenable to in vivo recordings due to their small size. To compensate for this lack of experimental data we performed an optimization analysis that predicts the dynamics of granule cell activity during delay eyelid conditioning. We used a simplified version of a model developed by Mauk and Donegan to optimize granule cell activity given that we have available eyelid conditioned responses for interstimulus intervals ranging from 100 to 750 ms. The solutions found by the optimization algorithm converge on three important aspects of stimulus evoked activity of the granule cells: (a) during stimulus presentation different granule cells become active at different times, (b) for the majority of granule cells the duration of the stimulus evoked responses is not dependent on the duration of the stimulus and (c) peaks of granule cell activity are preceded and/or followed by inhibition. While the first feature has been suggested to be the byproduct of interactions between granule and Golgi cells, the latter two predictions are novel. The utility of these predictions is supported by tests in a detailed simulation of the cerebellum.