Intact Savings in Patients with Cerebellar Degeneration

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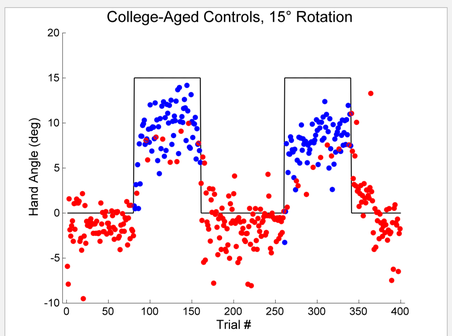
Introduction

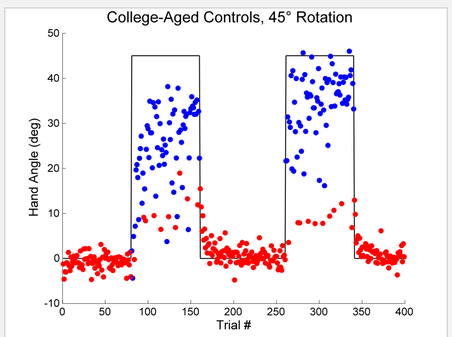
When a visuomotor perturbation is introduced during a reaching task, good performance can be restored in one of two ways: visuomotor adaptation and the use of aiming strategies. Cerebellar ataxics show deficits in compensating for such perturbations, an effect attributed to impaired adaptation of an internal model by the damaged cerebellum. Although the impairment is limited to the adaptive process, ataxics do not commonly develop aiming strategies to correct for reach errors. Here we show that if cerebellar ataxics are provided with an arbitrary cue indicating the presence of a rotation, they are able to develop an aiming strategy to compensate for it. Moreover, upon encountering the rotation again ataxics recall this aiming strategy to show faster relearning.

Cueing Aiming Strategies

Previous Work

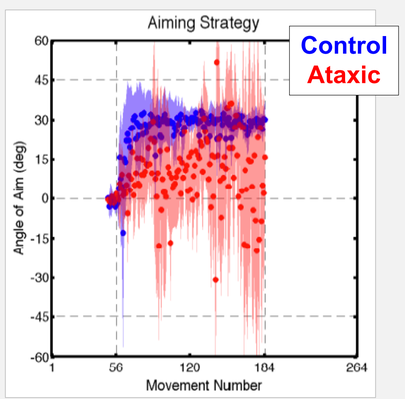
Large Rotations Induce Strategy Use and Savings





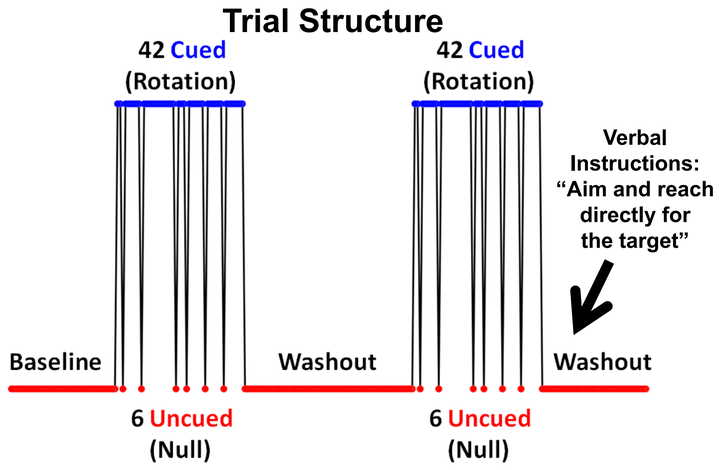
In an earlier study, we exposed college-aged participants to a 15° or 45° rotation, in a similar cued rotation trial paradigm. Only the 45° group showed a separation in hand angle for trial type. Also, savings was only observed in the 45° group. Note different y-axes scales.

Ataxics Reporting Aim



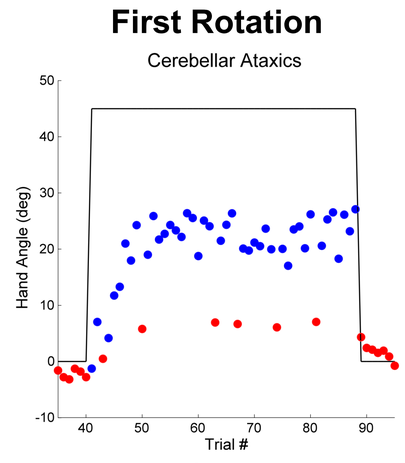
In an previous experiment, we probed explicit strategy use with a verbal report of aiming location. Cerebellar ataxics showed highly variable strategy use, raising the question of whether strategy development requires the cerebellum.

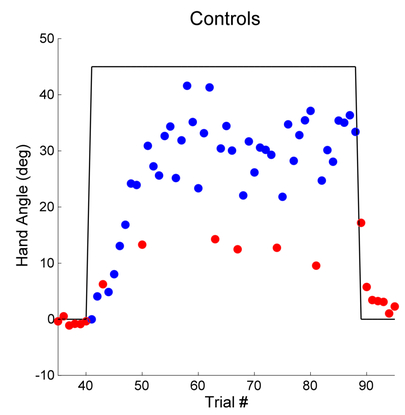
Trial Structure



Trial Design – All **Uncued** trials had a veridical mapping of the cursor to hand. Trials that were **Cued** with a colored cursor had a 45 degree rotation.

First Rotation

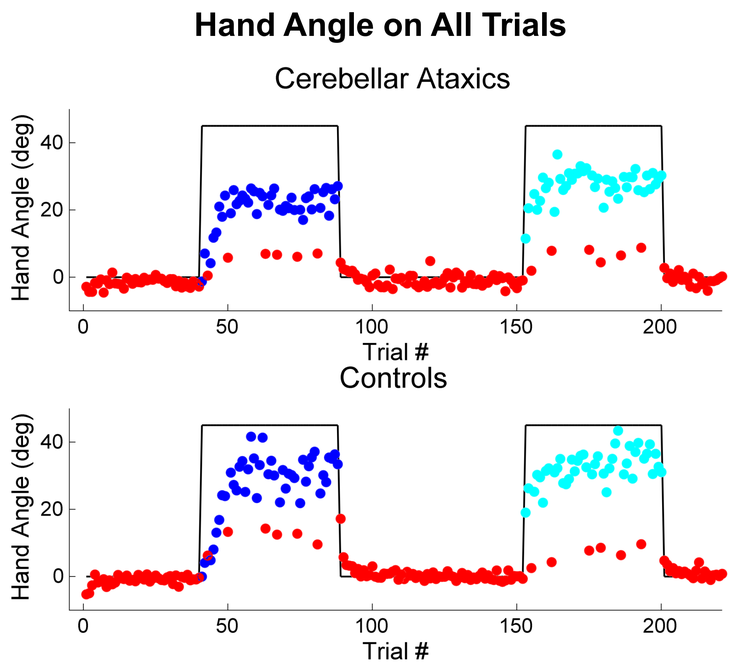




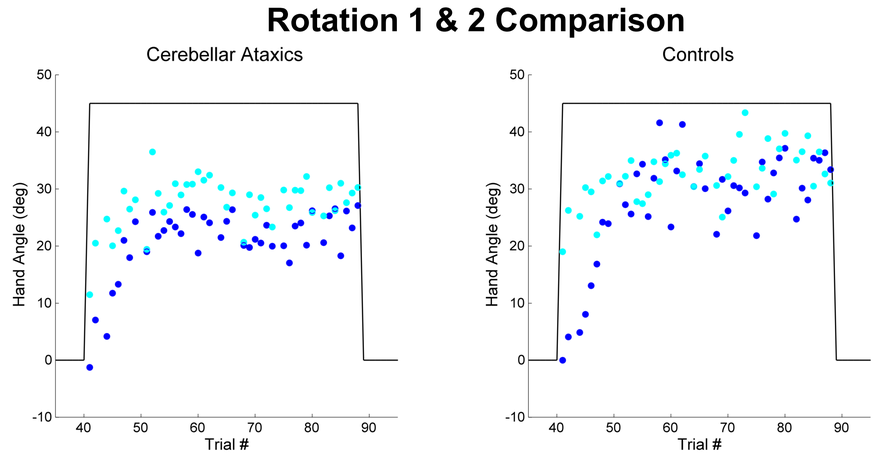
Hand angle for both trial types in the first rotation - When an arbitrary **color cue** is paired with a rotation, cerebellar ataxics are capable of using it to reduce errors to a mean level very similar to that of control participants.

Savings

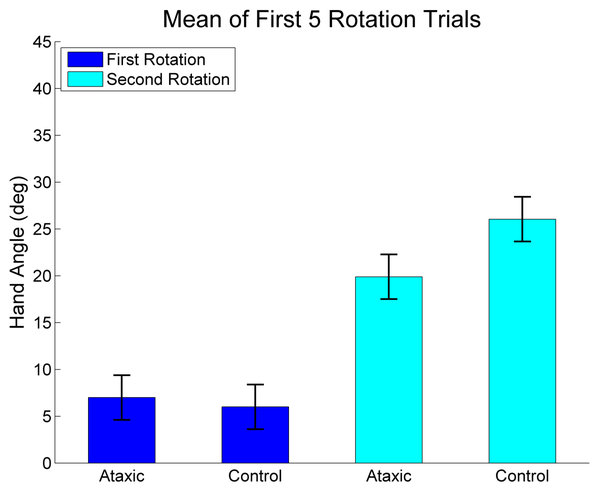
Hand angle for all trials - In the full experiment time series, it is clear that both groups are completely washed out before encountering the second rotation



Rotation 1 & 2 Comparison



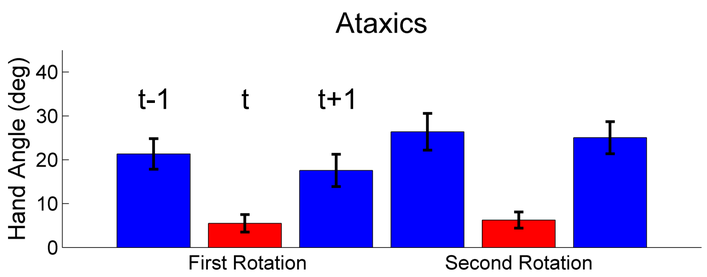
Hand angle for all Cued trials - Savings is primarily observed early in the second rotation for both groups .

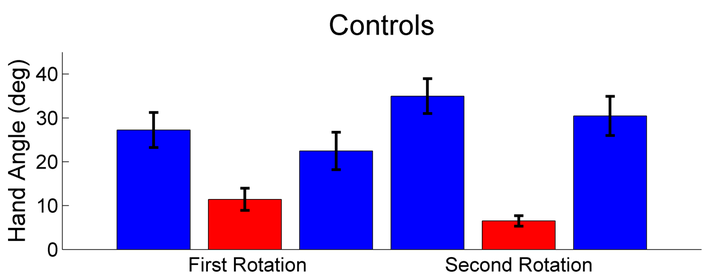


Hand angle for both rotation blocks – Each group shows much faster "relearning" of the second rotation, due to the recall of the aiming strategy that was previously successful.

Switching

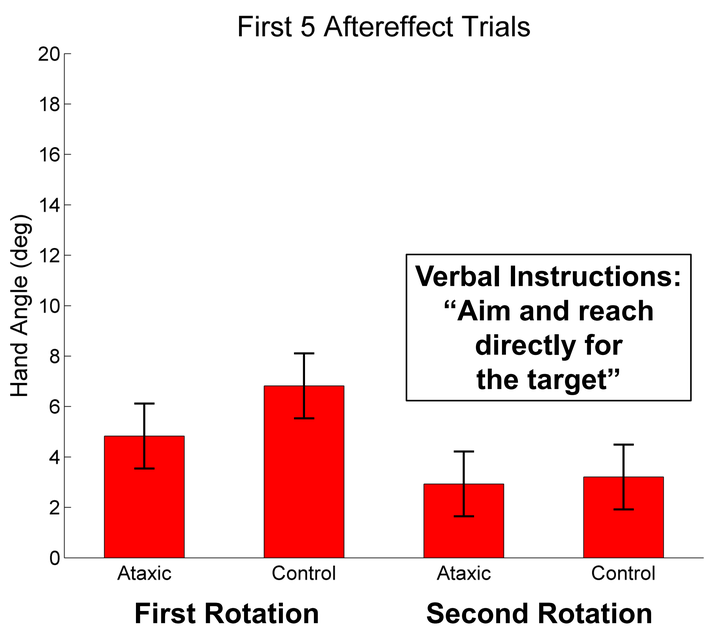
All Switching Trial Triplets





Mean of all Cued and Uncued trial triplets – Both groups are able to switch between the two trial types, although the age-matched controls had a difficulty switching in the first rotation block. Additionally, **Cued** trials immediately following an **Uncued** trial tended to be less successful than **Cued** trials preceding an **Uncued** trial. This diminished in the second rotation, presumably because participants became more skilled at switching and executing the aiming strategy.

Aftereffects



Aftereffects following rotation block– The expected aftereffect is small because adaptation will be centered around the aiming strategy, not the target. We only tested at the target location, however. This lead to an underpowered comparison of implicit adaptation between the two groups. We saw little difference between the first and second rotation block aftereffects, despite the second block having explicit instructions to reach directly for the target.

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Summary

- Cerebellar ataxics do not typically employ aiming strategies even when prompted about aiming direction
- Ataxics can use a cognitive strategy to achieve performance similar to that of controls if one is suggested
- Ataxics are capable of developing an aiming strategy on their own if an arbitrary color cue is present
- The contrast of strategy development across task conditions may be due to the role of the cerebellum in recognizing the current state of the motor system
- Savings in visuomotor adaptation tasks can easily result from recall of a previously successful aiming strategy