Use-dependent biases due to movement repetition are small and unaffected by rewards

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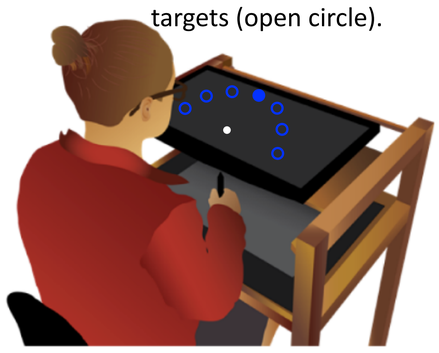
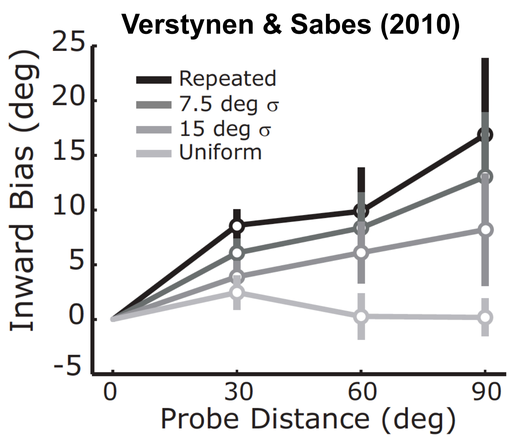
Background & Overview

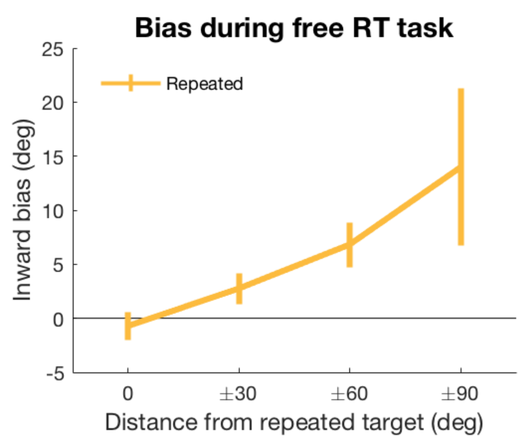
- Practicing a specific movement pattern can bias future movements towards the repeated pattern[1–4]
- Many studies have included some form of reward; as such, different learning systems may contribute to this bias
- We examined use-dependent learning in the absence of extrinsic rewards
- In addition, we examined the roles of action selection and action execution in use-dependent biases
- We also tested whether rewards enhance movement biases, as previously reported[5]

Approximately 7:1 ratio of reaches to repeated target (filled circle) versus probe targets (open circle).



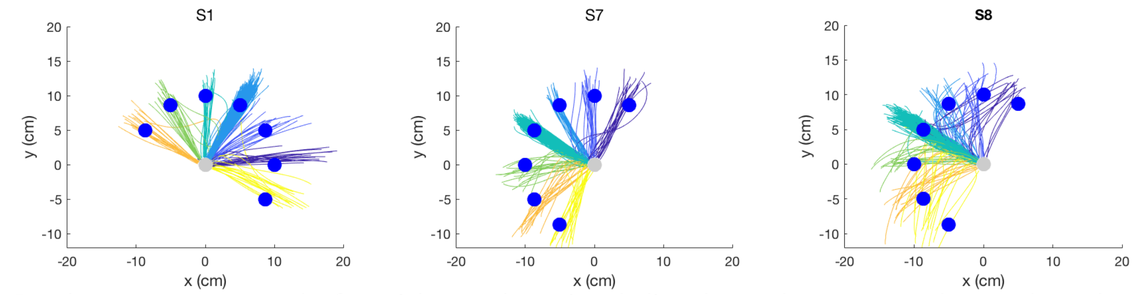


Canonical study on use-dependent learning reports biases towards repeated target of up to 15 deg.



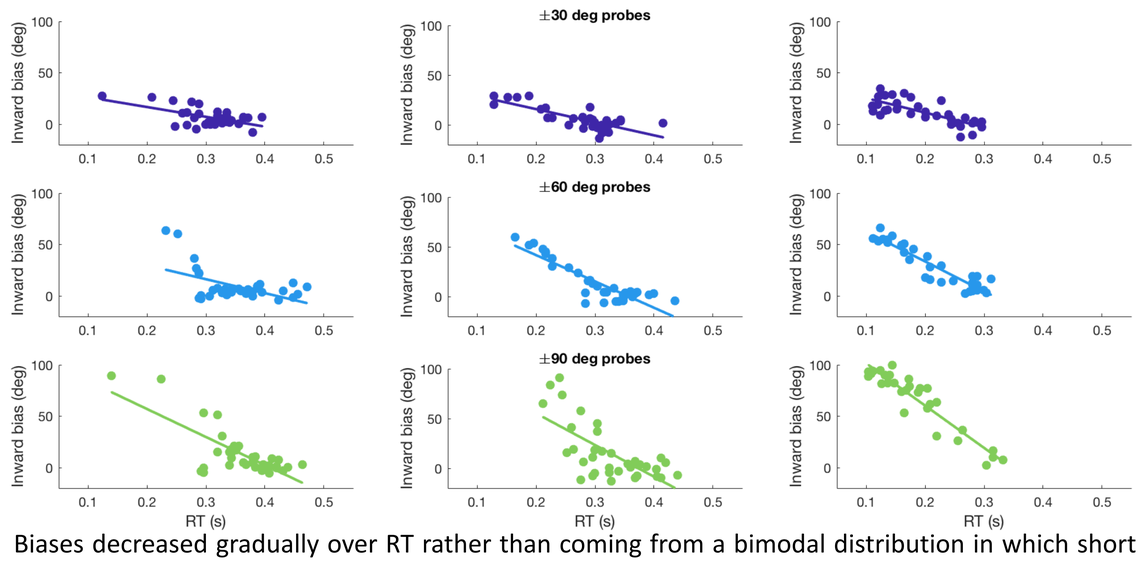
Using a similar paradigm as VS, we also observed a large inward bias of initial heading angles (n=10).

Bias results from mixture of straight and curved movements



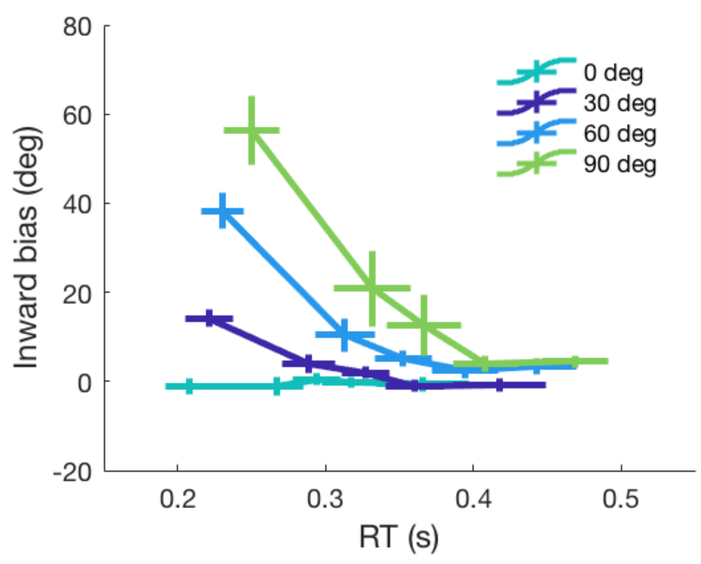
Reaches were composed of straight reaches aimed directly to the target and curved reaches initially heading towards locations ranging between the repeated target and the probe.

Inward biases of initial heading angles varied continuously



Biases decreased gradually over RT rather than coming from a bimodal distribution in which short RT reaches were guesses to repeated target and long RT reaches were accurate reaches to probes.

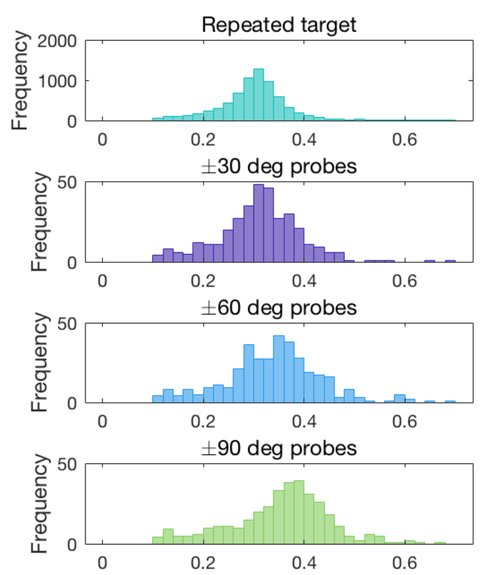
Bias varies as a function of RT

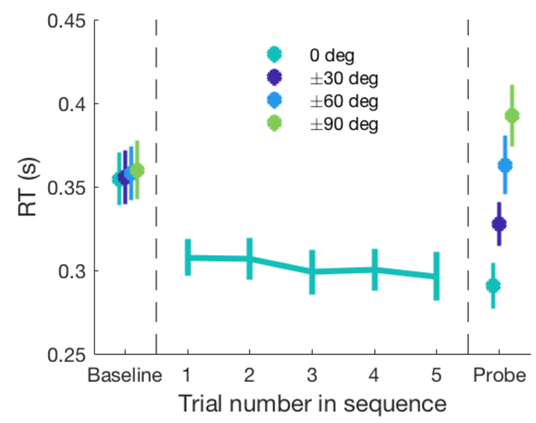


Each subject's reaches were grouped into quintiles based on RT duration. For all probes, biases were inversely related to RT, consistent with a previous report using a forced response task[4].

Despite unconstrained RTs in the current experiment, many RTs were very fast. This suggests that the training location may have been the default movement plan, and in some trials, this plan was triggered before a new plan to the probe location was instantiated[6].

Shift in RT distributions due to practice

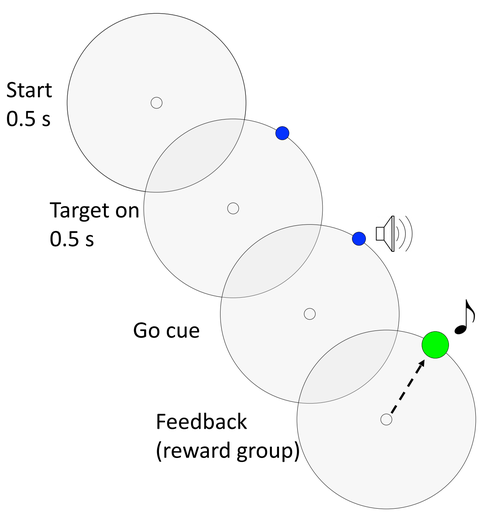




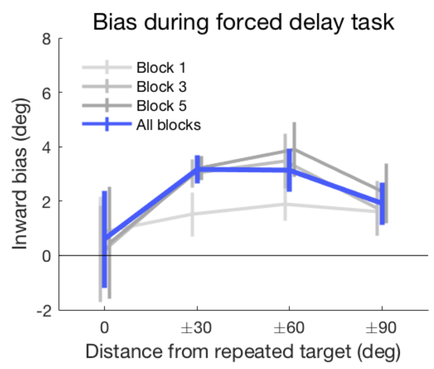
Histograms of RTs show that RT increases with the probe angle (left). Furthermore, although RTs to the probe target decreased with practice (above)[7], there was an increase in RT relative to baseline for the most distal probes.

Enforcing a 500 ms delay abolishes majority of bias

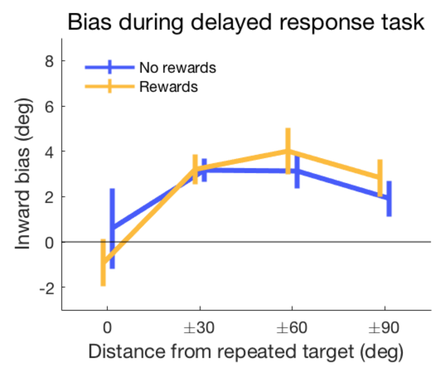
Protocol



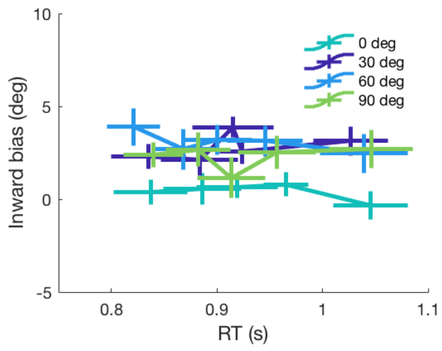
No rewards group (n=16/group) did not receive any feedback regarding reach accuracy.



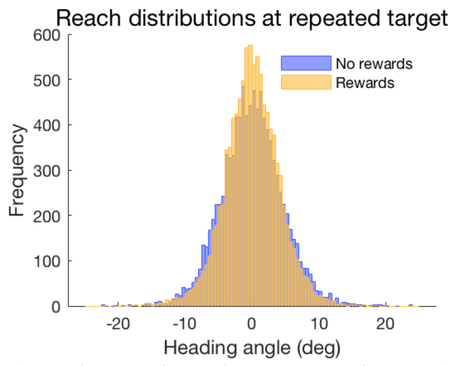
Bias reduced to ~20% of magnitude observed in first experiment.



Small action execution bias remains; however, rewards did not enhance this effect.



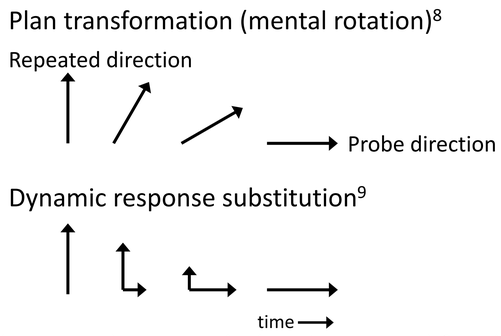
No clear relationship between bias and RT



Reward group showed sensitivity to binary FB

Discussion

- Bias magnitude was strongly related to RT duration[4]
- Different models to explain intermediate reach angles:



- RTs to repeated target decreased[7], but increased for distal probes
- Enforced delay removed most of the bias, further supporting idea that biases are primarily due to action selection
- Rewards had no impact on amount of bias, but were associated with less variability in reaches to repeated target

References

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