Proprioceptive precision in reach performance and adaptation

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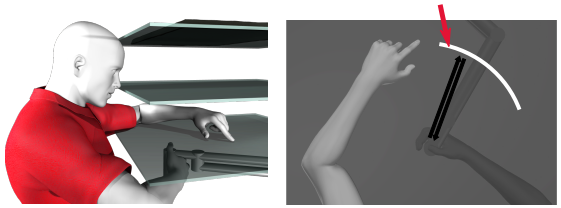
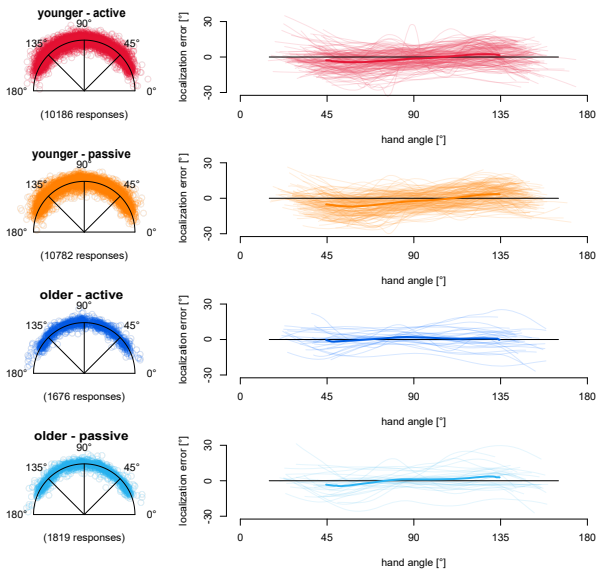
How does the precision of movements and proprioception affect motor control and adaptation? We use a dataset of over 200 participants, collected in the lab where participants 1) made goal-directed hand movements with and without cursor.
2) estimated the location of their unseen hand, both after robot- and self-generated hand-movements. This way we can explore the contribution of proprioceptive signals and efferent signals on localization.
Since participants then also adapted to a visuomotor rotation, we tested if variance in any of the four measures accounted for individual differences in the rate of motor adaptation performance and implicit aftereffects.



Data is from tasks where people localize the endpoint of the outward displacement after self-generated, active (prediction + proprioception) and robot-generated, or passive (proprioception only) movements of the unseen right hand (232 younger and 38 older (54+) participants).



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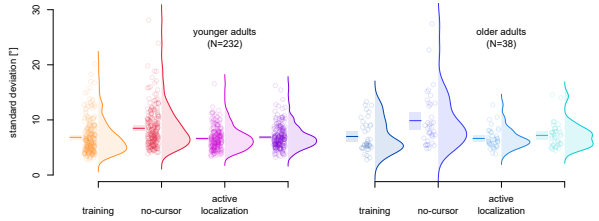
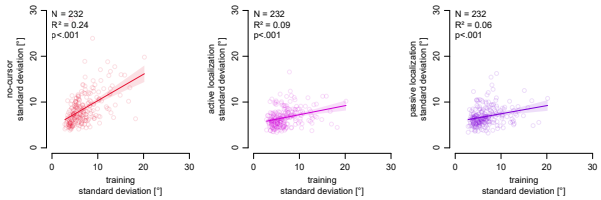
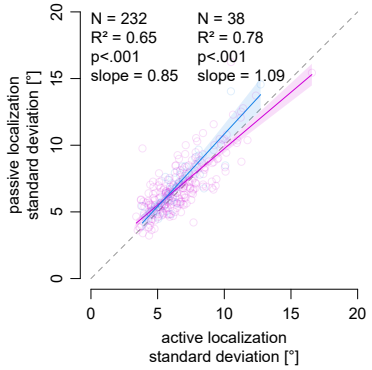
The magnitude of variance is similar across tasks: with no-cursor reaches a bit more variable than cursor reaches and hand localization. Precision in performance and localization did not differ with age.



Is variance in movement and hand-estimates related? While variance in reaches with a cursor correlated highly with those without, they barely correlated with variances in estimates of unseen hand location.

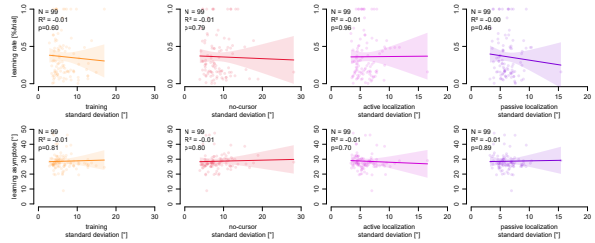


Variance in hand-location estimates when the hand was actively displaced was highly correlated with and only 5% smaller than when the hand was passtively displaced.

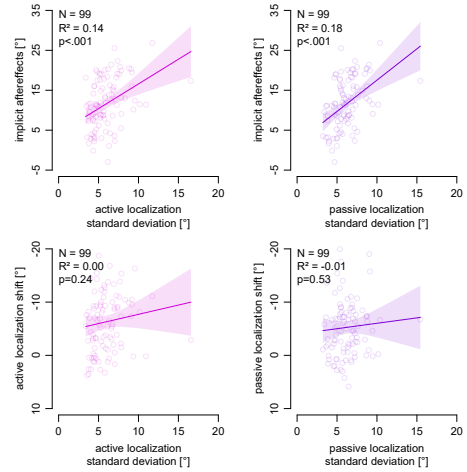


The availability of efferent signals does not contribute much when estimating static hand position.
This also suggests that MLE or Bayesian integration does not apply when combining proprioceptive and efferent-signals for localizing the unseen, static hand.

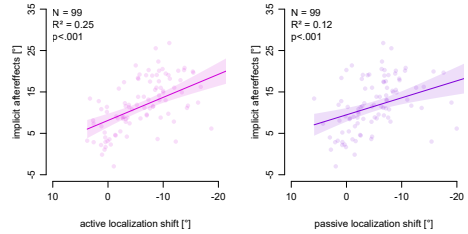
Neither motor nor proprioceptive variance predicted learning rate or extent.



But variance in hand localization does correlate with implicit reach adaptation (top) but not with the size of the shift in estimates of hand location following adaptation (bottom).



The size of the shift in estimates of hand location correlates with reach aftereffects.



Proprioceptive precision appears to predict implicit adaptation but motor learning can not be predicted by any measure of variance