Title: Effect of Baseline Variability in Motor Learning

Group Members: Farnaz Abdollahi, Katie Bankieris, Keturah Bixby, Moria Fisher, J. Ryan Morehead

Variability in sensory feedback limits the extent to which participants can correct for a perturbation (Burge et al., 2008). An essential question is whether participant movement execution noise affects motor learning in a similar way. Both Bayesian and reinforcement learning models predict that an increase in motor variability should increase learning rates. However, commonly-used state space learning models do not take participant variability into account (Smith and Shadmehr, 2006). Such models add noise to account for variability more as an afterthought rather than as a contributor to learning.

Method

We analyzed four data sets from the DREAM database and one unpublished set (from Morehead) on adaptation to reaching under perturbation total of 372 participants. Mattar and Ostry (2010) and Morehead (unpub) were visual rotation experiments with one and eight targets, respectively. Mattar and Ostry (2007), Ostry et al. (2010), and Vahdat et al. (2011) were force field experiments with one target. Mattar and Ostry (2007) also included conditions with two, six, and seven targets.

The baseline variability, the end of perturbation block variability, the magnitude of learning from the beginning to end of the perturbation block, and the rate of learning (for subset of 302 subjects) in the perturbation block were extracted from the Maximum Perpendicular Distance per movement for each data set.

Results

Learning rate showed a significant positive correlation with baseline variability ($p<0.025$) [Figure 1]. This correlation remained significant for the force perturbation when groups were divided by perturbation type ($p<0.015$). This effect, however, was not significant for the visual perturbation. Overall, magnitude of learning did not show any significant correlation with baseline variability. However, when separated by perturbation type, performance change was significantly correlated with baseline variability in force perturbation ($p<0.035$) [Figure 2].

Discussion

In our dataset, learning rate was significantly correlated with baseline variability in force-field adaptation tasks, but not visual rotation tasks. Although the effect size was small, we were able to detect the phenomenon with a power of 1.0 because of the large number of subjects available through the DREAM database.

Figure 1. Learning rate and baseline variability in visual rotation and force field.

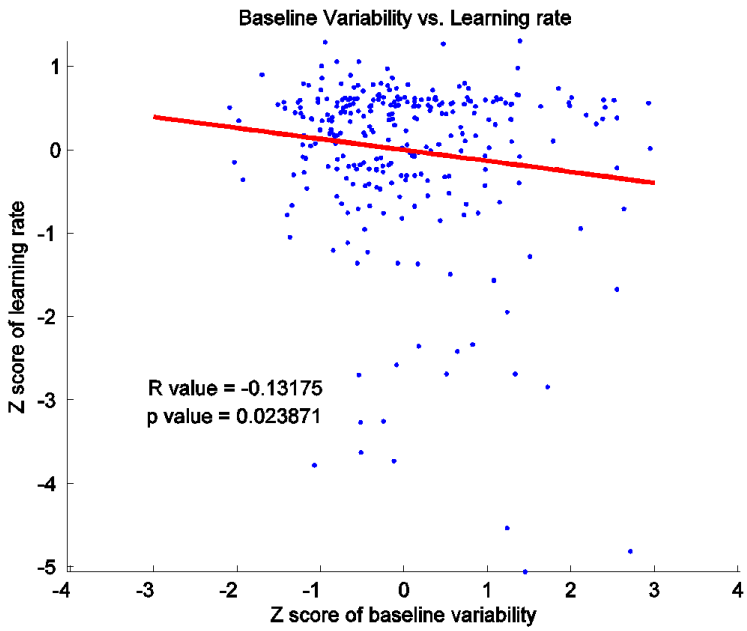

Figure 2. Learning amount and baseline variability in visual rotation and force field.