Statistical Methodology

Fast Arm Motor Skill Training (FAST)

NCT05013762

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1. Proposed Study Aims

Aim 1. Compare the effectiveness of short-duration intensive arm speed training with dose-equivalent accuracy training in individuals with mild to moderate impairments due to chronic supratentorial stroke.

Aim 2. Demonstrate that speed training leads to improvements in anticipatory feedforward control after supratentorial ischemic stroke.

Aim 3. Determine the involvement of cerebellar-cortical circuits in recovery of arm movements due to speed training

2. Study Design

To accomplish our proposed study aims, we will individually randomized participants to one of two study conditions: Speed and accuracy condition. The latter serves as our comparison condition. Participants assigned to each study condition will receive a four-day training intervention. Each training consists of 300 trials on an arm tracking task previously published by co-I Shailesh Kantak (Kantak et al. 2017). The task will be especially modified for this study to accommodate the speed and accuracy condition.

Participants will complete three assessment sessions in addition to the 4 training sessions. Assessments will be given as follows: a baseline pre-test, 1 post-test (3 days post-treatment), and 1 retention test (1 month post treatment). We will ensure that the licensed therapists who conduct these assessments will be blinded to group assignment.

In the language of experimental design, we will use a one-between, one-within subjects design. The between-subjects variable is study condition; the within subject variable is time (assessment).

3. Randomization

The statistician will administer the randomization protocol. Participants will be randomly assigned to a speed or to an accuracy condition. To ensure that the two groups have comparable performance at baseline, we will perform a stratified random sampling: Participants with right and left hemisphere damage will be separately stratified based on baseline movement time (MT) of reaching movements, and then randomized in to one of the two groups- speed or accuracy. This will ensure that both experimental groups will have a similar distribution of the side of damage and baseline performance.

4. Hypotheses and Proposed Analyses

Our primary hypothesis is that, compared to accuracy training, speed training will improve movement time, and smoothness, and speed-accuracy trade-off of arm reaching movements for up to 1-month post-training. Our secondary hypothesis is that, compared to accuracy training, speed training will improve arm and hand function, as measured by the Box and Block test and the ARAT, for up to 1-month post-training.

The drivers for this study design are **n**, the number of participants randomly assigned to each condition and **t,** the number of assessments (pre-, post-, and 1 month post training). The effect of primary interest is the time x Condition interaction that tests whether the time course of the response differs between our two conditions.

5. Measures

At each assessment (pre-training, post-training, and 1 month post-training), we will obtain data from each participant on the following tests:

1. Kinematic assessment of the paretic arm during planar reaching
2. Kinematic assessment of non- paretic arm during planar reaching

3. Action Research Arm Test (ARAT)
4. Box and Block test

6. Control of Heterogeneity

We will use formal training protocols to minimize heterogeneity due to different personnel administering the interventions and clinical tests. All personnel will well trained and retrained regularly to ensure that their performance meets pre-specified criteria for treatment fidelity. Additionally, these personnel will meet regularly to share their insights and to discuss any concerns that they have. Dr. Winstein and Rosario will monitor implementation fidelity.

7. Statistical Analyses

Movement time will be computed from the time the hand leaves the start position and stays in the final position for 0.2 sec. Movement smoothness will be assessed by the number of peaks in the velocity profile. All analyses will be performed with linear mixed models, with subjects as random effects (using the R toolbox *lme4*). Reaching data (MT and number of velocity peaks), speed-accuracy trade off, as well as clinical data (and Box and Block, ARAT) will be analyzed with Group (accuracy vs speed) and Test (pre, post-, 1 month-post- training) as factors. Holms-Bonferroni corrections will be used for multiple comparisons.

8. Power Analyses

Our study is powered based on the change in the Box and Block test in our previous Park et al. study on fast reach training (Park et al. 2016, NNR). We detected a change from of 21 ± 1.9 blocks from pre-training to 26.3 ± 2.4. This represents a 23 %change, which is above the minimum detectable change of 18% change. A power analyses performed with G-Power given these number returned 20 subjects per group at alpha = 0.05 and power = 0.8 levels. Based on our experience in similar studies, we expect a 10 % drop out rate. In addition, we will recruit two participants in each group to pilot the methods. We will therefore recruit 24 participants per group.