

BIMANUAL COORDINATION TRAINING TO IMPROVE UPPER LIMB FUNCTION POST STROKE

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STROKE

- A stroke is a medical emergency affecting the arteries and eventually the brain
- Blood flows from the heart to rest of the body through the arteries, supplying O₂
- When blood flow to the brain is interrupted and O₂ isn't being supplied, brain cells begin to die rapidly
- This results in a stroke

Significance

- Outcomes include paralysis, or weakness, to one side of the body due to damage in the correlated regions of the brain
- Stroke may also result in fatality
- In the United States, stroke is the 4th leading cause of death, killing over 133,000 people each year

Significance

- The numbers are projected to increase to approximately 3.88% of the population over 18 years of age by the year 2030
- The estimated cost of stroke in the United States in 2010 was \$71.55 billion (Ovbiagele et al., 2013).

Past Research

- Most stroke patients regain use of lower limbs and relearn how to walk, but 30-60% fail to regain functionality in the upper limbs (Kwakkel, et al., 1999)
- Current body of research has focused on improving paretic limb, or affected limb, through constraint-induced therapy

Our Study

- The study is a bimanual coordination training program aimed at improving the functionality of both upper limbs in post stroke participants
- Our methodology includes the use of a human-joystick-computer system with two oscillating dots moving on a screen.

Study Design

- Conventional Therapy vs. Bimanual Training Protocol

6 week Physical Therapy

6 week Bimanual Training

- Baseline ↓ Midline ↓ Final

Functionality Tests

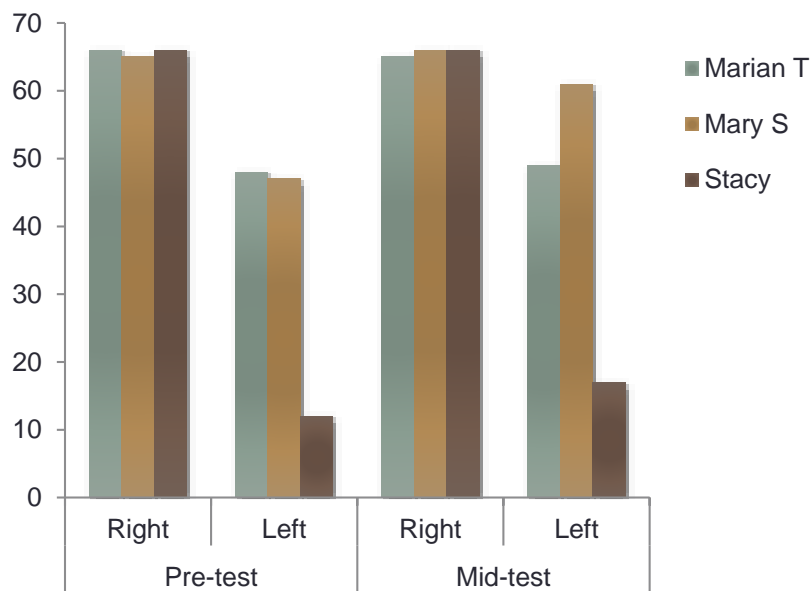
- Test used as baseline test, midline test, and final test includes 3 simple bimanual tasks
 - Buttering a piece of bread
 - Placing tennis balls back in their container
 - Putting on a mesh jersey
- Fugl Meyer Assessments are also made of each participant at baseline, midline, and final

Data Analysis

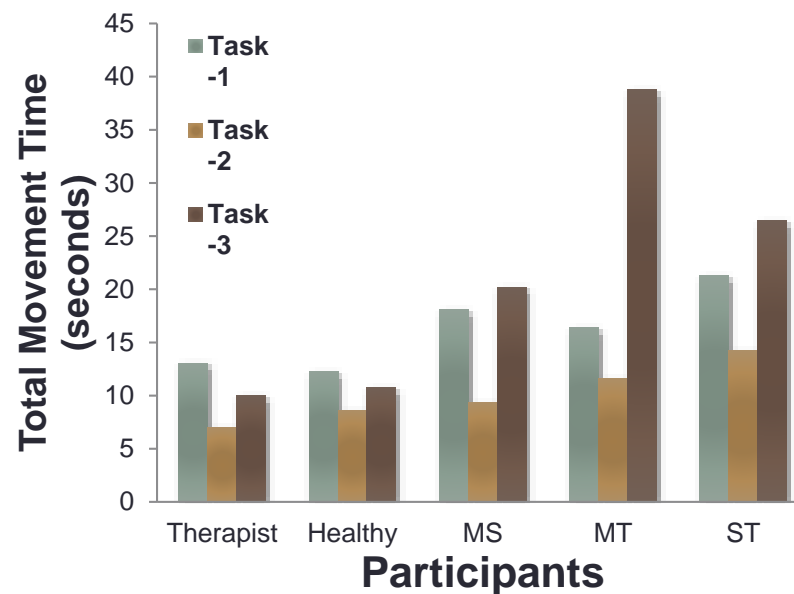
- Video recordings of the PT performing each of the three tasks serve as the model for replication
- Participants attempt to replicate the PT's performance of each task
- Data from videos of the participants is compared to the PT model
- Control is provided by video of a healthy subject replicating the PT model

Results from Baseline

FMA Tests



DURATION OF MOVEMENT



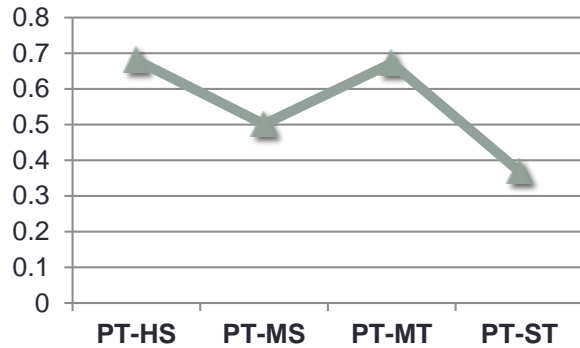
Further Analysis

- From the PT demonstration video of each task, we analyzed where most movement occurs
- Each task was analyzed in 3 separate planes:
 - X axis, left to right
 - Y axis, up and down
 - Z axis, front to back
- This provided movement in 3 dimensions

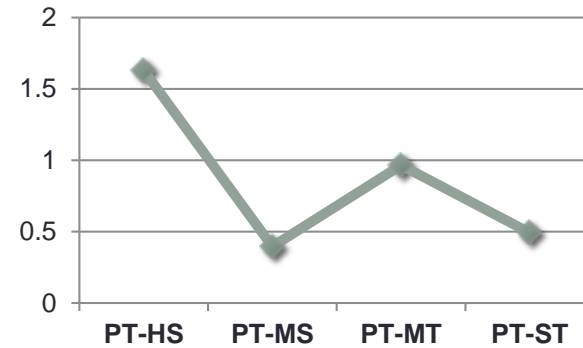
Similarity of PT-Participant CRPs

Similarity Index = (Cross-correlation Coefficient/RMSE)

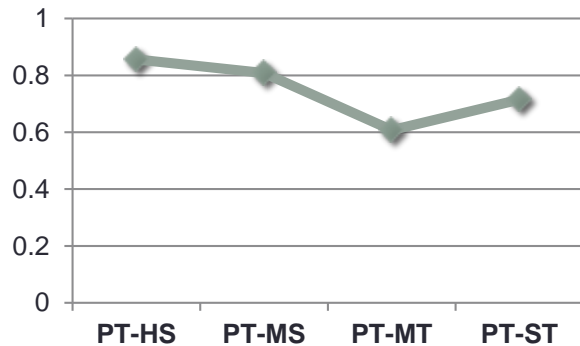
Task-1-Z



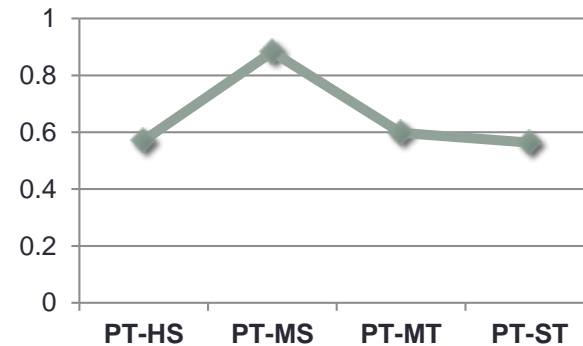
Task-2-Y



Task-3-Y



Task-3-Z



Our Intervention

- All bimanual tasks occur in a phase relation ranging from 0° to 180°
- Both types of coordination come naturally to humans
- 3D analysis of the PT video model specified the continuous relative phase required of each task

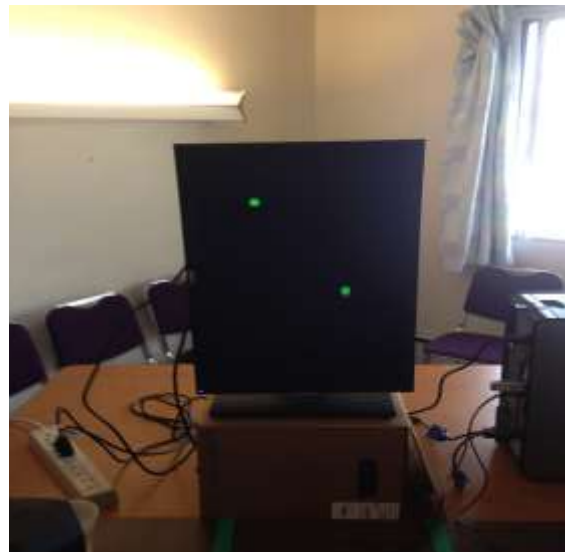
Example:

- Task 1 – Buttering the Bread
 - An 85° continuous relative phase was assigned to the Z axis
 - Practice is achieved by moving two oscillating dots on a tilted screen in the 85° phase, with the use of two joysticks



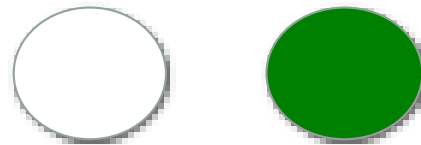
Example:

- Task 2 – Placing the tennis ball back in their container
 - An 80° continuous relative phase was assigned to the Y axis
 - Practice is achieved by moving two oscillating dots on a screen in the 80° phase, with the use of tilted joysticks



Feedback of Accuracy

- Feedback is given to the participants, communicating whether or not the dots are moving in the correct phase relation
- This is done by changing the color of the dots from white to green
- If the dots are green, the continuous relative phase is being achieved, and vice versa



Our hope

- After the Bimanual training is complete it is hoped that significant improvements will be demonstrated in performing each of the 3 tasks in the final test
- Furthermore, it is hoped that an effective bimanual training protocol might be established as part of therapeutic practice in the rehabilitation of stroke patients

References:

- Kwakkel, Gert, Kollen, Boudewijn J., Wagenaar, Robert C., (1999) Therapy Impact on Functional Recovery in Stroke Rehabilitation: A critical review of the literature. *Physiotherapy*. 85, 7, 377-39.
- Ovbiagele B, Goldstein LB, Higashida RT, Howard VJ, Johnston SC, Khavjou OA, et al. (2013) Forecasting the future of stroke in the united states: a policy statement from the American Heart Association and American Stroke Association. *Stroke*. 44, 2361–2375.