Physical Therapy Task Ideas

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Abstract: This document contains a list of possible metrics for quantifying physical behavior in awake and ambulatory volunteers who who play these games. These games are meant to slowly improve the physical ability of an impairment of a limb (limb damage/stroke/amputation).

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# Definition of Possible Metrics

Time to Target [s or time ratio]

* The time it takes an individual to reach a target in the virtual environment space. This is compared to healthy hands or healthy volunteers.

Ideal Path Deviation [m]

* The deviation from the straight line path between the home and target positions. This can be calculated a number of ways, but the most straightforward way is to sum the ‘normal’ distance between the path taken and the ideal path for every point along the taken path. Area under curve, total distance,…

Target accuracy [m, m/s]

* How close and through what vector was a target reached? Was is a grazing pass? Did the user stop near the center? …

Target Drift [m]

* Did the volunteer drift out of the target when they were asked to maintain the target position for some time?

Tremor [m]

* Is there a baseline tremor in the home/rest position? How does this tremor increase/decrease with velocity or distance from the rest position? It is easy to think that the more difficult the position (eg: arm extended and raised compared to a supported arm near the body) the more tremor there is. This can be measure in numerous ways: variance in position from the desired location, fit sampled position points to a sphere, and the radius of that sphere is a metric of tremor, complexity of movement path,
* Is there a preferred tremor direction (body referenced? Arm referenced? Gravity referenced?) What is the variance of positon in that preferred direction?

Tremor Drift [m, m/s]

* Does the tremor cause the ‘center’ of the motion to move? How quickly does this occur? Does is approach some position in space or does it approach a specific joint configuration?

Postural Conformation [k-means distance]

* How close is the volunteer to the desired posture of the hand? This can be measure by the distance in k-mean space where each dimension is represented by a joint angle.

Postural Conformation Time/Difficulty [s, deg/sec, k-mean distance]

* How quickly or how perturbed is the transition from one postural state to another?

# Possible Games to Measure Metrics

**Point to Point**

Description: Ask the volunteer to move their hand from one position (rest/home) to another position (target) and hold for some time. Then move back to the home position.

Varieties:

* One handed
* Two handed mirrored (Hands move in a mirrored fashion across the Sagittal body plane)
* Two handed asymmetric (Both hands move independently of each other)

Metrics:

* Time to Target, Target Accuracy, Ideal Path Deviation, Tremor, Target Drift

**Point to Posture**

Description: Ask the volunteer to move their hand(s) from one position and posture to another position and posture.

Metrics:

* Time to Target, Target Accuracy, Ideal Path Deviation, Tremor, Target Drift, Postural Conformation, Postural Conformation Time/Difficulty

**Jigsaw Solver**

Description: Ask the volunteer to grab irregularly shaped puzzle pieces and place them in a specified hole. This require the volunteers to ‘grab’ the piece, ‘rotate’ the piece to match the hole, and ‘release’ the piece for it to fall into place. Think about the game “Perfection”: <https://www.youtube.com/watch?v=O3syQV7WDAU>

As the volunteers become more skilled we can add in extra constraints, like sizing the piece to match the hole, adding time constraints, asking the volunteer to flip the piece along the z-axis. These all increase the demands of manual dexterity on the game. These controls can also be split between the hands. Have one hand which will ‘touch’, move, rotate, and size the object. The other hand can control the ‘grasping’ or if the piece sticks to the first hand.

Varieties:

* Timed
* Untimed
* One handed (Force the volunteer to use a specific hand)

Metrics:

* Time to Target, Target Accuracy, Ideal Path Deviation, Tremor, Target Drift, Postural Conformation

Game Adjustments: As the player gets better tighten up the ‘success radii’ for grasping the object and the correct rotation. This will guide the volunteers to be more precise in their movements.