Imagine shooting a free-throw in basketball. You can throw it with a high-arcing lob or a more direct throw and both can land in the basket. In fact, for this task, there are an infinite number of combinations of the speed and angle with which you can release the ball and have it go through the hoop. Now imagine repeatedly shooting free throws: Are you going to shoot it exactly the same each time or are there going to be variations in your strategy? You may assume that the changes from one shot to the next are just unwanted noise in your performance. However, this variation in how you repeat the task can contain hidden information. One branch of my research looks at the variability in tasks and teases out information about motor control and, potentially, your health.

A simple task that I used to collect human subject data was a shuffleboard game. This version of the game was even simpler than the one on the cruise ship: The goal was simply to have the puck stop on a target line. To aid in the collection of data, I used a virtual reality environment. Here, I was able to perfectly control environmental variables (e.g. wind, friction, or the flatness of the field) that would make it impossible to run the experiment consistently in the real world. The virtual environment also made it easy to repeat the task hundreds of times without the need to physically reset a puck each time. Subjects operated a physical manipulandum that connected to a computer and displayed a virtual “cue” and “puck” on a screen. Pushing the manipulandum propelled the puck forward until release. Upon released, the puck slowed down due to friction (in the virtual world) until it came to rest. The stopping location and thus the final distance from the target (defined as error) was completely determined by the location where the puck was released and its initial velocity.

I tested 32 subjects using different versions of this shuffleboard game. Each subject completed 250 trials and saw where the puck stopped after each. Using this initial data, I was able to test my data analysis method to determine the stability of participants. How many trials did it take for the subject to correct large errors? An inability to correct errors within a few trials may be indicative of pathology. One next step will be testing the shuffleboard task or another simple “game” as a diagnostic tool. We may find that subjects with neurodegenerative disorders (e.g. Parkinson’s, ALS, or Alzheimer’s) have significantly different stability profiles than “healthy” subjects. This score could act as a biomarker for disease.

Furthermore, these stability differences may extend to a pre-diagnosis measure. In a longitudinal study, subjects in retirement communities could be tested yearly and their scores tracked. Once diagnosed with a condition, their scores can be compared to subjects that remain healthy. In this way, this method could be used as a monitoring and early-warning system. When a patient’s score crosses a threshold, they may be referred for additional testing or early intervention.

Another direction of the research is in training. Looking back to the shuffleboard task, some strategies are more sensitive to deviations in the release position and velocity. If you cannot accurately control how fast you release the puck, releasing it closer to the target results in less error on average than releasing it far from the target. From a coaching and training perspective, analyzing the task mathematically can result in recommendations for repeated sports tasks such as putting, bowling, or dart throwing.

In my group’s current research, we are running another experiment with an improved version of shuffleboard game. In the experiment we are looking at the effect that using your dominant versus non-dominant hand has on stability and error correction. We hope to find links to the usual fine motor control of the dominant hand versus the gross motor control of the non-dominant.

For more information, videos, and links to publications please visit my website at http://bit.ly/jmahoney.