Feature development of digital measures for the finger tapping task

Kelly, PJ[a], Ellis, RD[a]

[a] Koneksa Health, Inc.

Introduction

The MDS-UPDRS[1] is considered the gold standard for assessing symptom severity in Parkinson's disease. This scale assesses multiple aspects of daily living. Lower limb/hand dexterity is assessed in the MDS-UPDRS in relation to motor impacts of daily living (Item II.4 to II.8) and in the motor examination (Item 3.4).

The mPower[2] study was one of the first studies to use a smartphone to assess disease symptoms through a set of tasks which ask the patient to move or touch the phone in a specific manner and then collect data from the phone screen, gyroscope and accelerometer. The study enrolled 1087 self-stated Parkinson's patients and 5581 self-stated healthy patients. Data from the trials is available to researchers for analysis

One of the assessments in the mPower study is the Finger Tapping task, as a digital test of hand dexterity, where patients alternately tap two buttons on a smartphone screen. The task records the coordinates and timestamp of each tap.

We define a feature as a direct or derived property of the data which may have utility in measuring symptoms of a disease. In this poster we present our analysis of 6 features of the Finger Tap raw data.

Method

Restricting the dataset to iPhone 6 Plus users who had completed at least 4 finger tapping assessments, we analyzed two subsets of the data:

1. 61 self-stated Parkinson's off-state (task completed immediately before taking Parkinson's medication)
2. 199 self-stated healthy patients - participants not taking any medication for Parkinson's disease.

We examined numerous features of the Finger Tap raw data and for each "feature" plotted the distribution of the feature scores for each cohort subset as a histogram. We then applied the Kolmogorov-Smirnov test to the two distributions. This test can be used to determine whether the two distributions could come from the same population. Given a null hypothesis - that there is no difference between the feature scores for each cohort subset - a p-value threshold of < 0.05 was used to determine which features are able to distinguish between healthy and off-state cohorts.

Conclusions

Of the 6 features examined, results suggest that 3 features (tapping speed, tapping sequence correctness and tapping speed regularity) can help distinguish self-stated off-state and self-stated healthy patients.
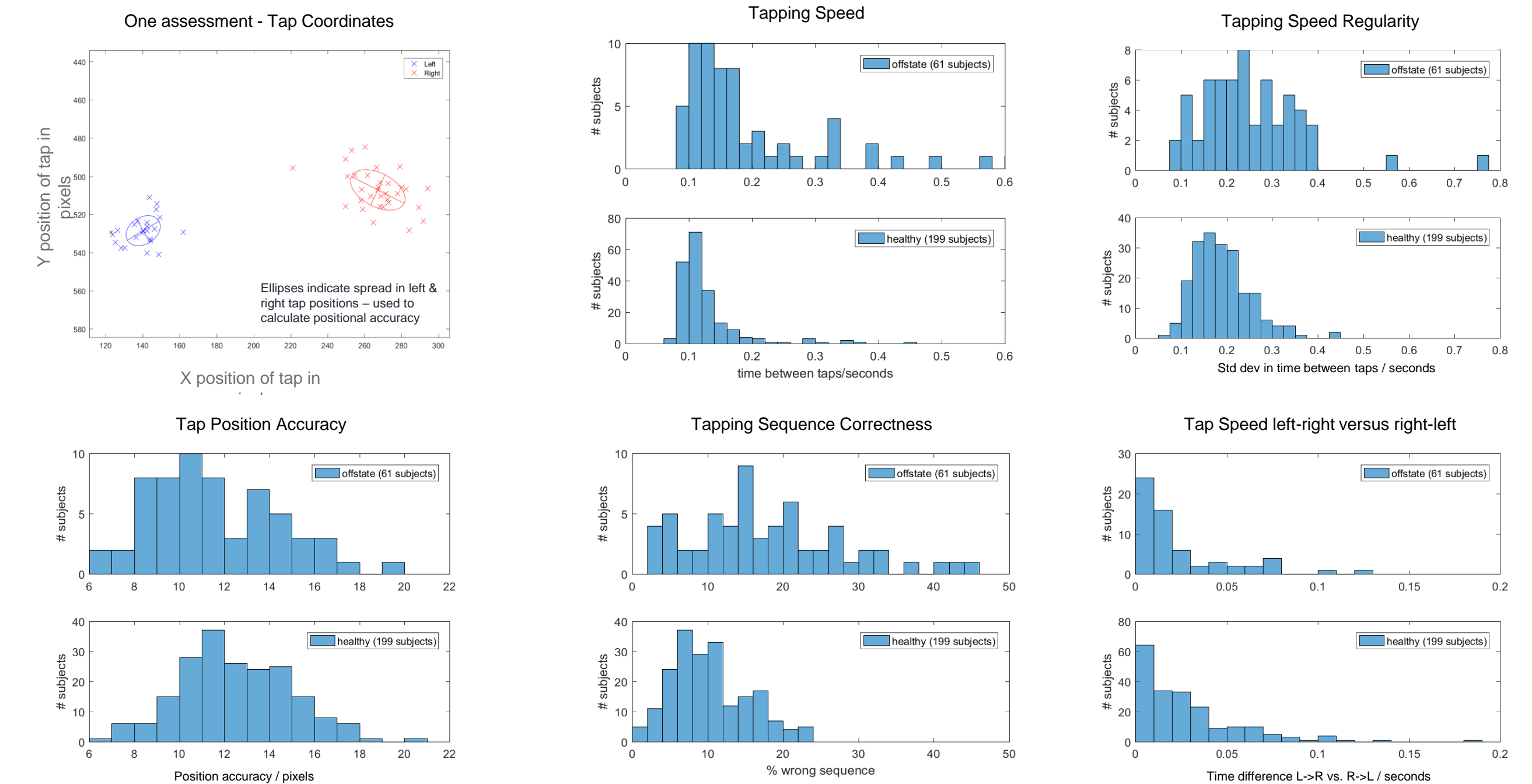
Developing and validating algorithms for digital measures can be supported by analysis of retrospective datasets.

References

[1] Goetz, C. G., et al. (2008). "Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS): scale presentation and clinimetric testing results." Mov Disord 23(15): 2129-2170.
[2] Bot, B., Suver, C., Neto, E. *et al.* (2016, The mPower study, Parkinson disease mobile data collected using ResearchKit. *Sci Data* **3,** 160011

Results

Feature	p-value	Observations
Tapping speed (taps/second)	$6*10^{-9}$	Healthy subjects faster
Tapping sequence correctness	$6*10^{-8}$	Healthy subjects more accurate
Tapping speed regularity	$7*10^{-6}$	Healthy subjects more regular
Tapping positional accuracy	0.007	Off-state subjects more accurate
Tapping speed left-right vs right-left	0.15	Probably not a useful measure
Change in tapping speed	0.29	Probably not a useful measure

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