Finger tapping and cognition in Parkinson's

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Introduction:

Repetitive finger tapping (FT) of the thumb and index finger is used to clinically assess bradykinesia in Parkinson's disease (PD) and is a component of the Movement Disorders Society - Unified Parkinson's Disease Rating Scale (MDS-UPDRS) motor assessment. The association between motor function and cognition in PD has previously been studied by analyzing gait [1]. Our objective was to look for associations between separable components of FT and cognition.

Methods:

57 PD subjects in the ON medication state and 28 healthy controls (HC) participated. Electromagnetic sensors sampling at 60Hz were attached to the index finger and thumb during 30 seconds of repetitive FT. Numerous separable components of FT were derived. Data was analyzed conventionally and by using evolutionary algorithms (EAs), which use Darwinian principles to find 'classifiers' that differentiate between groups. Participants also undertook a range of cognitive tests (*Figure 1*).

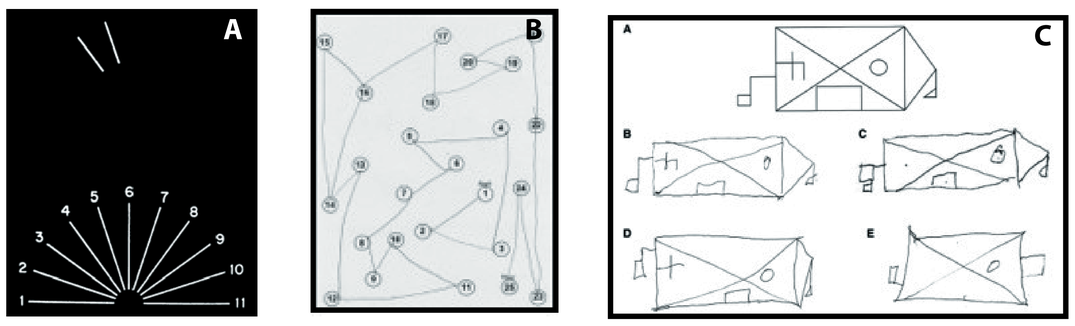

Figure 1: Some of the cognitive tests used.
A) Judgment of Line Orientation (JoLO) tests a person's ability to match the angle and orientation of lines in space. It is a test of visuospatial function.

B) Trail Making Test Part A requires patients to link up consecutive numbers as quickly as possible. It is considered a test of executive function.

C) In the Benson Figure Copy test a participant must copy a complex shape as accurately as possible. It is a test of visuospatial function.

Results:

Demographic data are reported in *Table 1*. PD and HC were not sex matched. PD had smaller mean velocity and amplitude, greater decrement of velocity and greater variability of rhythm than HC.

	PD	HC	p
Age, years (SD, range)	69.2 (8.5, 44-85)	66.0 (7.7, 50-79)	0.096
Gender, M : F	37:20:00	05:23	**<0.001**
Handedness, R: L	51:06:00	22:06	0.215
Disease duration, years	6.2 (4.7, 0.5-20)	-	-
H&Y stage I (%)	8 (14)	-	-
H&Y stage II	46 (80.7)	-	-
H&Y stage III	3 (5.3)	-	-
MDS-UPDRS motor assessment	29.1 (11.5, 3 - 57)	-	-
LEDD, mg/day	638.4 (534.3, 0 – 2836.3)	-	-
GDS 15	3.6 (3.0, 0-13)	1.8 (2.0, 0-6)	**0.005**

H&Y = Hoehn and Yahr,
LEDD = levodopa equivalent daily dose,
GDS-15 = Geriatric Depression Scale, short version.

Table 1: Demographics details.

For PD the two significant correlations between global cognition – determined by Montreal Cognitive Assessment (MoCA) – and separable FT components were frequency (r_s -.24, p 0.017) and rhythm of velocity (r_s -.23, p 0.02). There were a number of correlations between separable FT components and other cognitive tests in PD but not HC (*Table 2*).

References:

1. Lord S, Galna B, Coleman S, et al. Cognition and gait show a selective pattern of association dominated by phenotype in incident Parkinson's disease. Frontiers in aging neuroscience 2014;**6**:249.

2. Litvan I, Goldman J, Tröster A, et al. Diagnostic criteria for mild cognitive impairment in Parkinson's disease: Movement Disorder Society Task Force guidelines. Movement Disorders 2012;**27**(3):349-56.

FT component	Cognitive test (r_s)	
Frequency	Trails A (*Executive function*) .34, p 0.001	MoCA delayed recall (*Memory*) -.20, p 0.046
Mean maximum separation	Trails A -.31, p 0.002	JoLO (*Visuospatial function*) (.21, p 0.036)
Mean maximum velocity	Trails A -.25, p 0.013	Benson figure copy (*Visuospatial function*) .20, p 0.047
Rhythm of separation	JoLO -.20, p 0.044	
Rhythm of velocity	JoLO -.22, p 0.028	

Trails A = Trail Making Test Part A,
MoCA delayed recall = Subscore of MoCA memory component,
JoLO = Judgment of Line Orientation

Table 2: Correlations between separable FT components and cognitive tests for PD subjects:

PD was classified into normal cognition (PD-NC, n = 22), PD-mild cognitive impairment (PD-MCI, n = 22) and PDD (n = 10) according to MDS Level 1 criteria [2]. Four of the separable FT components were statistically different between the groups (*Table 3*). Rhythm of velocity was the best classifier in to the three cognitive groups (*Figure 2)*.

FT component	PD-NC	PD-MCI	PDD	p
Frequency (SD, range)	2.13 (0.93, 0.37 – 4.44)	2.42 (0.82, 0.76 – 4.08)	2.82 (0.90, 1.33-4.05)	**0.02**
Mean maximum separation	0.67 (0.15, 0.34 – 1.03)	0.63 (0.17, .27 – 0.96)	0.52 (0.22, .22-0.92)	**0.013**
Mean maximum velocity	4.22 (1.17, 1.74-6.22)	4.20 (1.42, 1.46 – 6.48)	3.14 (1.78, 0.44 – 5.48)	**0.02**
Decrementing separation	-102.81 (98.60, -323.78 – 83.33)	-95.19 (98.78, -340.85 – 46.08)	-138.56 (156.20, -527.97 – 71.75)	0.395
Decrementing velocity	-10.12 (9.51, 29.65 – 7.40)	-7.91 (9.17, -26.37 – 13.70)	-8.87 (11.16, -26.6 – 17.64)	0.599
Rhythm of separation	0.15 (0.08, 0.05 – 0.41)	0.18 (0.09, 0.06 – 0.45)	0.19 (0.07, 0.09 – 0.33)	**0.023**
Rhythm of velocity	0.24 (0.13, 0.07 – 0.68)	0.29 (0.17, .05 – 0.76)	0.42 (0.18, 0.15 – 0.72)	**0.001**

Table 3: Comparison of separable components of finger tapping between PD groups:

EAs were trained to classify unseen FT data into PD-NC, PD-MCI and PDD groups and produced an overall accuracy of ~63% using multi-class area under the curve (MAUC). A better classification accuracy was achieved when differentiating between PDD and either PD-NC or PD-MCI (*Figure 3*).

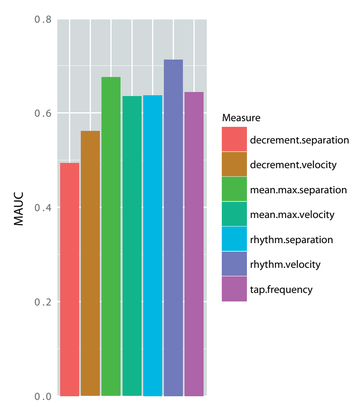

Figure 2: Discriminatory ability of individual separable components of FT into three cognitive groups. Rhythm of velocity is the best classifier

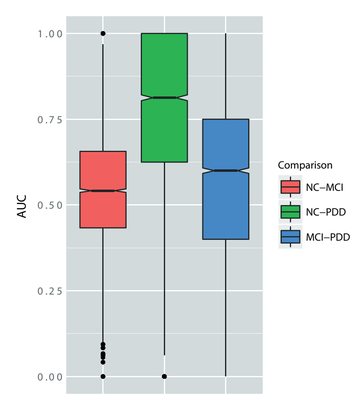

Figure 3: Discriminatory ability of all separable components of FT into two cognitive groups using EAs

Conclusions:

- **A number of correlations between separable FT components and cognitive tests have been identified. These findings require further investigation.**
- **Rhythm of velocity is the best separable component of FT when classifying PD into cognitive groups. Greater impairment of rhythm of velocity correlates with worse performance on a test of visuospatial function and with worse performance on a test of global cognition.**
- **EAs are capable of classifying unseen FT data into three cognitive groups. Discriminating PDD from PD-NC using EAs produces the highest classification accuracy.**