



Full Length Article

Laterality of repetitive finger movement performance and clinical features of Parkinson's disease



Elizabeth Stegemöller^{a,d,*}, Andrew Zaman^a, Colum D. MacKinnon^b, Mark D. Tillman^{c,d}, Chris J. Hass^{d,e}, Michael S. Okun^e

^a Department of Kinesiology, Iowa State University, Forker Building, 534 Wallace Road, Ames, IA 50011, United States

^b Department of Neurology, University of Minnesota, 717 Delaware St. SE, Minneapolis, MN 55445, United States

^c Department of Kinesiology and Health Promotion, Troy University, Suite 112 Wright Hall, Troy, AL 36082, United States

^d Department of Applied Physiology and Kinesiology, University of Florida, PO Box 118205, Gainesville, FL 32611, United States

^e Center for Movement Disorders and Neurorestoration, University of Florida, 1600 SW Archer Rd, Gainesville, FL 32610, United States

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ABSTRACT

Impairments in acoustically cued repetitive finger movement often emerge at rates near to and above 2 Hz in persons with Parkinson's Disease (PD) in which some patients move faster (hastening) and others move slower (bradykinetic). The clinical features impacting this differential performance of repetitive finger movement remain unknown. The purpose of this study was to compare repetitive finger movement performance between the more and less affected side, and the difference in clinical ratings among performance groups. Forty-one participants diagnosed with idiopathic PD completed an acoustically cued repetitive finger movement task while "on" medication. Eighteen participants moved faster, 10 moved slower, and 13 were able to maintain the appropriate rate at rates above 2 Hz. Clinical measures of laterality, disease severity, and the UPDRS were obtained. There were no significant differences between the more and less affected sides regardless of performance group. Comparison of disease severity, tremor, and rigidity among performance groups revealed no significant differences. Comparison of posture and postural instability scores revealed that the participants that demonstrated hastening had worse posture and postural instability scores. Consideration of movement rate during the clinical evaluation of repetitive finger movement may provide additional insight into varying disease features in persons with PD.

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1. Introduction

Impaired control of repetitive finger movements in persons with Parkinson's disease (PD) significantly impacts the performance of daily living activities. Thus, the performance of repetitive finger movement is used to assess the severity, progression, and treatment efficacy in persons with PD. Clinical measures of impairment in repetitive movements make up 30% of the total score of the motor section of the Unified Parkinson's Disease Rating Scale (UPDRS), and thus weight heavily in the evaluation of severity and laterality (more versus less affected side) of motor disease. Yet, the subjective evaluation of repetitive finger movements often does not account for performance differences among patients.

* Corresponding author at: 240 Forker, Iowa State University, 534 Wallace Rd., Ames, IA 50011, United States.

E-mail address: esteg@iastate.edu (E. Stegemöller).

Two distinct behaviors often manifest when individuals with PD are instructed to perform repetitive finger movements “as quickly and big as possible”; (1) movement rate is kept relatively low and is accompanied by large, low velocity movements (bradykinetic type impairment) or (2) movement rate rapidly increases and is accompanied by low movement amplitude (hypokinesia) and frequent hesitations and arrests (hastening type impairments) (Espay et al., 2011; Stegemöller, Zadikoff, Rosenow, & MacKinnon, 2013). Espay et al. (2011) have presented evidence that various movement components including speed, amplitude, and rhythm show different degrees of impairment and differentially respond to dopaminergic medications. In particular, patients with a bradykinetic dominant impairment show significant improvements in performance with medication whereas those with prominent hypokinesia, hastening and arrhythmia do not improve with medication. For acoustically cued finger tapping, hastening and arrests of movement that emerge when movements are externally paced at rates near to and above 2 Hz are not improved with optimal medication (Stegemöller, Simuni, & MacKinnon, 2009). However, deep brain stimulation of the subthalamic nucleus (STN-DBS) has also been shown to improve movement amplitude but not hastening (Stegemöller et al., 2013). Taken together, the differential performance in repetitive finger movements (bradykinetic or hastening) may represent different functional aspects of PD.

Several factors may explain the differential performance of repetitive finger movements in persons with PD. The presence of tremor and/or rigidity may affect both movement rate and amplitude. Laterality may also be a contributing factor. Interestingly, low rate repetitive finger movement performance (<2 Hz) differs between the more affected side (MAS) and less affected side (LAS) in early stage PD, and this difference decreases with increasing disease severity (Koop, Shivitz, & Brontë-Stewart, 2008; Louie, Koop, Frenklach, & Brontë-Stewart, 2009). However it is unknown if there is a difference between the MAS and LAS in people with PD when movement is paced by a cue at rates greater than 2 Hz. Therefore, the purpose of this study was to examine the difference in repetitive finger movement performance between the MAS and LAS, and the difference in clinical ratings of motor features between performance groups. Participants completed an acoustically cued repetitive finger movement task with both hands, and clinical motor scores were obtained. We hypothesized that 1) repetitive finger movement performance at rates near to and above 2 Hz would be similar between the MAS and LAS, and 2) clinical motor scores would be similar between performance groups (bradykinetic or hypokinetic).

2. Methods

2.1. Participants

Forty-one participants (68 ± 11 years) diagnosed with idiopathic PD were recruited. Basic demographics, disease duration (years since diagnosis), disease type, Hoehn and Yahr (H&Y), and the motor section of the UPDRS were obtained (Table 1). The MAS, disease type, UPDRS, and H&Y were determined by a fellowship-trained movement disorders neurologist blind to the study purpose. Testing was completed in the optimal “on” medication state as prescribed by the currently treating movement disorders neurologist. All participants gave written informed consent prior to inclusion into the study. The University Institutional Review Board approved the procedures.

2.2. Data collection

Participants completed three trials of the movement task with each hand. A series of acoustic tones were presented at a rate of 1 Hz for 15 intervals and then increased by 0.25 Hz every 15 intervals until reaching 3 Hz (Fig. 1) (Stegemöller, Allen, Simuni, & MacKinnon, 2010; Stegemöller et al., 2009, 2013). Participants were instructed to complete an unconstrained finger flexion-extension movement in time with the tones. Participants sat in a chair with the forearm (pronated position), wrist, thumb, and fingers 2–4 were supported by a brace limiting movement to only the index finger. A goniometer was placed on the second finger between the first and second joints to collect the angular displacement of the finger. Movement rate and peak-to-peak amplitude were obtained for each movement and averaged across each tone rate. Movement amplitude was normalized to the peak-to-peak amplitude at 1 Hz to allow for comparison across tone rates since no con-

Table 1
Group demographics.

	Age (mean yr ± SD)	Gender (% F)	Handedness (% L)	MAS* (% Dominant)	Disease Duration (mean yr ± SD)	H&Y (% score ≥ 3)	Disease type (% TD)	UPDRS motor score (mean ± SD)
Fast (n = 18)	71.0 ± 9.3	24.4%	0.0%	36.8%	8.7 ± 4.2	1.3 ± 0.6	61.1%	25.8 ± 12.7
Slow (n = 10)	69.5 ± 15.2	40%	20%	66.7%	8.4 ± 5.2	1.3 ± 0.7	80.0%	24.8 ± 10.3
Normal (n = 13)	63.6 ± 7.6	23.1%	7.7%	30.8%	6.8 ± 3.0	1.1 ± 0.5	30.8%	26.8 ± 9.3
All participants (n = 41)	68.3 ± 10.8	24.4%	7.3%	41.5%	8.0 ± 4.2	1.2 ± 0.6	56.1%	25.9 ± 10.9

For H&Y, the percent of each group in which the score was greater than or equal to 3 is shown. SD = standard deviation; yr = year; F = female; L = left hand; % = percent; MAS = more affected side; H&Y = Hoehn and Yahr; TD = tremor dominant; UPDRS = Unified Parkinson's Disease Rating Scale; n = number in each group. Asterisks designate significant differences at $p < 0.05$.

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