

# Movement Disorder Society Unified Parkinson's Disease Rating Scale Motor Examination Retains Its 2-Domain Profile in Both *On* and *Off* States

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The Movement Disorder Society (MDS) Unified Parkinson's Disease Rating Scale (UPDRS) was developed to cover the motor and nonmotor aspects of Parkinson's disease (PD), and its Part III measures objectively observed motor signs with 33 items.<sup>1</sup> Prior item response theory (IRT) analyses of Part III confirmed 2-domain tremor and nontremor constructs, each with a distinct relationship to overall PD severity.<sup>2,3</sup> Given that tremor and nontremor signs of PD may respond differently to medication (*on* vs. *off* states), it is clinically and statistically important to test if the 2-domain construct is retained in both conditions.

From the MDS-sponsored Scale Translation program,<sup>4</sup> we used full MDS-UPDRS scores from 7963 PD patients with medication state registered (6218 *on* and 1745 *off*). We applied IRT modeling to estimate discrimination parameters using the R package *mirt* (R Foundation for Statistical Computing, Vienna, Austria). A higher discrimination value means that the item is more powerful for determining the individual's overall parkinsonian severity,<sup>2</sup> and its magnitude can be judged with the following thresholds: none = 0, very low = 0.01 to 0.34, low = 0.35 to 0.64, moderate = 0.65 to 1.34, high = 1.35 to 1.69, very high  $\geq 1.70$ .<sup>5</sup> We tested the internal consistency of the 2-domain overall structure in the *on* versus *off* states separately. Specifically, we fit 2 IRT models to 23 nontremor items (items 3.1–3.14 measuring bradykinesia, rigidity, gait, and posture, with a total score range of 0–92) and 10 tremor items (items 3.15a–3.18 measuring tremor, with a total score range of 0–40) separately, both based on the *on* and *off* states. The discrimination parameters were “high” and “very high”

across all items for Part III in both states (*on* state: mean,  $1.963 \pm 0.408$ ; *off* state: mean,  $2.125 \pm 0.394$ ; Table 1). The discrimination scores under the *off* state were generally higher than those under the *on* state, as expected with a disability/impairment measure. The discrimination profiles confirmed the distinct functions of tremor versus nontremor domains in clinical *on* and *off* states.

A consistent scale performance with high internal construct thresholds (how individual items or clusters relate to the overall measure of PD severity) occurred for both *on* and *off* scores. This finding empowers the scale, especially for dealing with longitudinal studies of disease progression, motor fluctuations, and clinical trials where *on* and *off* states may occur. Our limitations include a cross-sectional design without the same patient studied under *on* and *off* and unbalanced numbers of patients scored during *on* and *off* states. Nonetheless, this study indicates that the clinimetric structure of the MDS-UPDRS Part III has validity and uniformity for assessing PD disease “state” (*on* vs. *off*) as well as “trait” (diagnosis of PD).

## Acknowledgments

The Rush Parkinson's Disease and Movement Disorders Program is a designated Clinical Center of Excellence supported by the Parkinson Foundation.

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**Keywords:** clinimetrics, item response theory, medication states, Parkinson's disease.

Relevant disclosures and conflicts of interest are listed at the end of this article.

Received 9 August 2022; revised 23 August 2022; accepted 30 August 2022.

Published online 00 Month 2022 in Wiley Online Library ([wileyonlinelibrary.com](http://wileyonlinelibrary.com)). DOI: 10.1002/mdc3.13566

**TABLE 1** Discrimination parameters of all MDS-UPDRS Part III items from fitting 2 IRT models to 23 nontremor items and 10 tremor items separately based on the *on* and *off* states

Item number	Source of information	On State		Off State	
		Nontremor	Tremor	Nontremor	Tremor
3.1	Speech	1.459		1.380	
3.2	Facial expression	1.528		1.591	
3.3a	Rigidity–neck	1.405		1.538	
3.3b	Rigidity–RUE	1.345		1.575	
3.3c	Rigidity–LUE	1.447		1.591	
3.3d	Rigidity–RLE	1.573		1.729	
3.3e	Rigidity–LLE	1.608		1.879	
3.4a	Finger tapping–right hand	2.024		2.025	
3.4b	Finger tapping–left hand	2.173		2.376	
3.5a	Hand movements–right hand	2.293		2.340	
3.5b	Hand movements–left hand	2.251		2.341	
3.6a	Pronation–supination–right hand	2.109		2.062	
3.6b	Pronation–supination–left hand	2.095		2.207	
3.7a	Toe tapping–right foot	2.018		2.573	
3.7b	Toe tapping–left foot	2.010		2.737	
3.8a	Leg agility–right leg	2.302		2.725	
3.8b	Leg agility–left leg	2.376		2.973	
3.9	Arising from chair	1.797		2.054	
3.10	Gait	1.792		2.286	
3.11	Freezing of gait	1.395		1.655	
3.12	Postural stability	1.511		1.896	
3.13	Posture	1.642		1.947	
3.14	Global spontaneity of movement	2.095		2.497	
3.15a	Postural tremor–right hand		2.238		2.215
3.15b	Postural tremor–left hand		2.041		2.140
3.16a	Kinetic tremor–right hand		1.919		1.910
3.16b	Kinetic tremor–left hand		1.661		1.842
3.17a	Rest tremor amplitude–RUE		2.634		2.571
3.17b	Rest tremor amplitude–LUE		2.648		2.514
3.17c	Rest tremor amplitude–RLE		2.267		2.059
3.17d	Rest tremor amplitude–LLE		2.213		2.295
3.17e	Rest tremor amplitude–lip/jaw		1.901		2.107
3.18	Constancy of rest tremor		3.017		2.508

*On* state = 6218 patients with visits measured in the *on* state; *off* state = 1745 patients with visits measured in the *off* state.

Abbreviations: MDS-UPDRS, Movement Disorder Society Unified Parkinson's Disease Rating Scale; IRT, item response theory; RUE, right upper extremity; LUE, left upper extremity; RLE, right lower extremity; LLE, left lower extremity.

## Author Roles

(1) Research Project: A. Conception, B. Organization, C. Execution; (2) Statistical Analysis: A. Design, B. Execution, C. Review and Critique; (3) Manuscript: A. Writing of the First Draft, B. Review and Critique.

Y.G.: 1B, 1C, 2A, 2B, 2C, 3A, 3B

G.T.S.: 1A, 1B, 2C, 2B

T.A.M.: 1A, 1B, 2C, 3B

C.G.G.: 1A, 1B, 2C, 3B

S.L.: 1A, 1B, 2A, 2C, 3A, 3B

## Disclosures

**Funding Sources and Conflicts of Interest:** The research of Sheng Luo was supported by National Institute on Aging (grant numbers: R01AG064803, P30AG072958, and P30AG028716). The authors have no potential conflicts of interest to report.

**Financial Disclosures for the Previous 12 Months:** Yuanyuan Guo has no conflicts with this publication and receives a salary from Duke University. Glenn T. Stebbins has no conflicts with this publication and receives consulting and advisory board membership with honoraria from Adamas Pharmaceuticals, Ceregene, Inc., Cure Huntington's Disease Initiative (CHDI) Foundation/Management, Inc., Cleveland Clinic Foundation, Neurocrine Biosciences, Inc., Ono Pharma USA, Inc., Pfizer, Inc., and Tools-4-Patients; grants and research from the National Institutes of Health, Department of Defense, Columbia University, Dystonia Coalition, CHDI Foundation/Management, Inc., International Parkinson and Movement Disorder Society, The Michael J. Fox Foundation for Parkinson's Research, and Ottawa Hospital Research Institute; and honoraria from the International Parkinson and Movement Disorder Society, American Academy of Neurology, The Michael J. Fox Foundation for Parkinson's Research, Food and Drug Administration, National Institutes of Health, and Alzheimer's Association. Tiago A. Mestre reports no conflicts and consulting or advisory board membership with honoraria received from Abbvie, Biogen, Sunovion, and Medtronic; grants/research from the European Union Joint Program—Neurodegenerative Disease Research, The University of Ottawa Brain and Mind Research Institute, Roche, Ontario Research Fund, CIHR, The Michael J. Fox Foundation, Parkinson Canada, Parkinson Disease Foundation/Parkinson Study Group, LesLois Foundation, PSI Foundation, Parkinson Research Consortium, and Brain Canada; honoraria from Abbvie, International Parkinson and Movement Disorder Society, American Academy of Neurology, CHDI Foundation/Management, Inc., Sunovion, Valeo Pharma,

Roche, and nQ Medical; and a salary from the University of Ottawa. Christopher G. Goetz reports no conflicts with this publication and receives grants/research from funding to Rush University Medical Center from the National Institutes of Health, Department of Defense, and The Michael J. Fox Foundation for Parkinson's Research conducted by Dr. Goetz; honoraria from a faculty stipend from the International Parkinson and Movement Disorder Society; guest professorship honorarium provided by the Charlotte County Medical Society; a web-based education program sponsored by Oruen Ltdk London, United Kingdom; royalties from Elsevier Publishers, Wolters Kluwer Publishers, and Oxford University Press; and a salary from the Rush University Medical Center. Sheng Luo reports no conflicts with this publication and receives consulting or advisory board membership with honoraria from the National Institutes of Health; grants/research from the National Institutes of Health, CHDI Foundation/Management, Inc., International Parkinson and Movement Disorder Society, and Parkinson's Foundation; and a salary from Duke University.

**Ethical Compliance Statement:** The current study has been approved by the Duke Institutional Review Board (Protocol Identification: Pro00107266). Informed patient consent was not necessary for this work. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this work is consistent with those guidelines. ■

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## Supporting Information

Supporting information may be found in the online version of this article.

**Table S1** Demographic characteristics of the datasets