# 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.[1] 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.[2,3] 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,[4] 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,[2] 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 ≥1.70.[5] 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 ± 0.408; *off* state: mean, 2.125 ± 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).

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**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

**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. ∎

# References

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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