

# Improving Sensitivity and Reliability in Motor Assessments

The webinar will start at 12:00 PM EDT

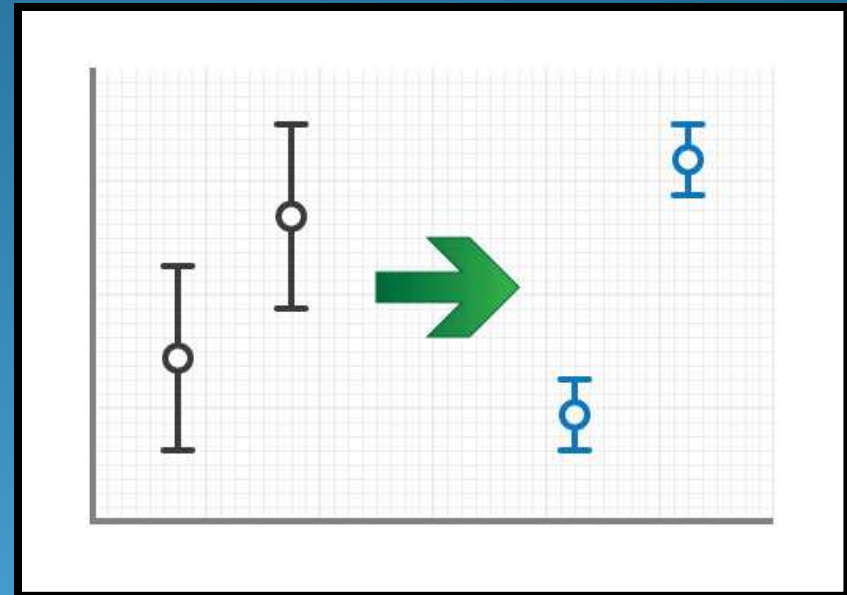


# Topics to be covered

- Problems with clinical trials
- Deep Brain Stimulation (DBS) as a tool to simulate disease progression
- Motion sensor sensitivity to DBS
- Motion sensor test-retest reliability
- Implications for clinical trials
- Kinesia HomeView demo

# Outcomes in Clinical Trials

- Clinical Assessments (UPDRS)
- Patient Diaries
- Motion Sensors
- Sources of error
  - Patient physical/mental condition
  - Variations in testing procedure/interpretation
  - Tester error
  - Learning effects



# Problems with Clinical Trials

- Clinical Assessments

- Bias
- Placebo effects
- Limited Resolution
- Poor intra- and inter-rater reliability

- Patient Diaries

- Compliance
- Recall bias
- Poor self-assessment

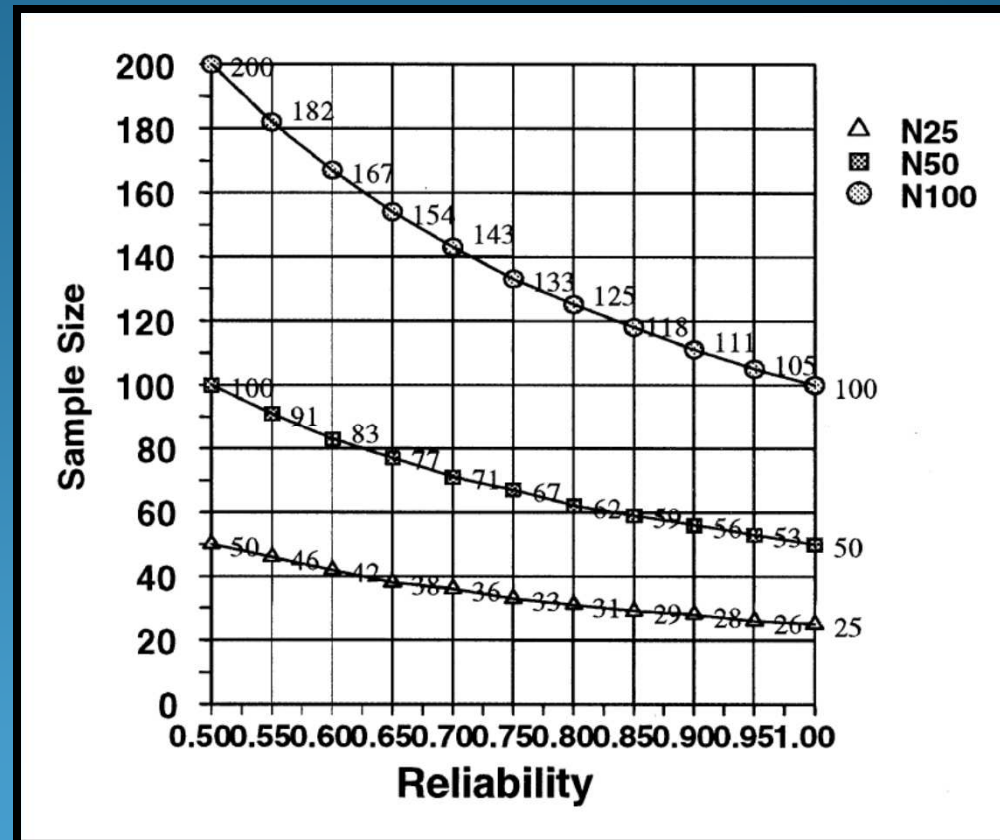
- Motion Sensor Monitoring

- Extraneous patient movements
- Dyskinesias
- Gravitational artifacts
- Sensor noise

# Clinical Trial Sample Size Considerations

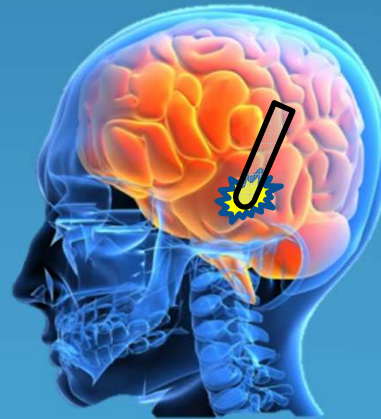
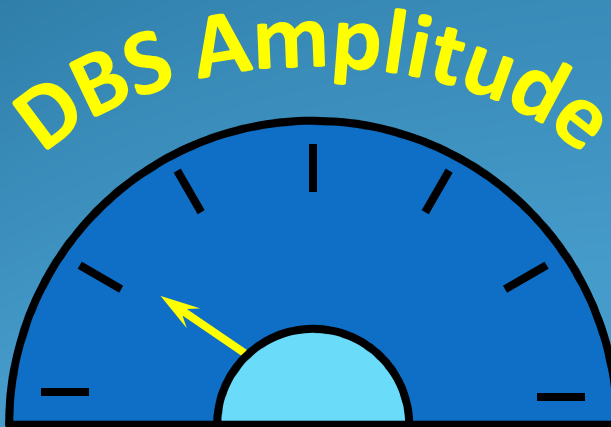
- The required sample size changes as a function of the reliability of the outcome measure.
- Sample size decreases as reliability increases.

Perkins DO, Wyatt RJ, Bartko JJ. Penny-wise and pound-foolish: the impact of measurement error on sample size requirements in clinical trials. *Biological Psychiatry*. 2000 Apr 15;47(8):762–766.



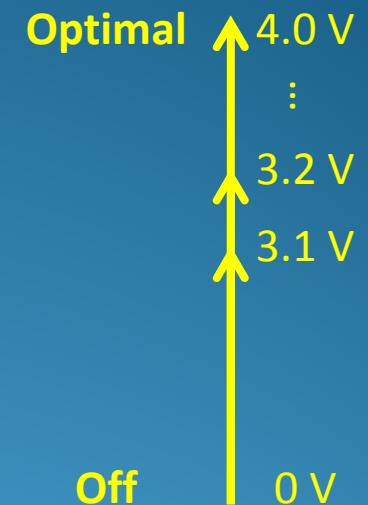
# Deep Brain Stimulation Tool

- Slowly modulate symptoms to simulate multiple disease states with relatively few subjects



# Protocol

- 18 subjects
  - 13 male, 5 female
  - Age 44-76 years
- Tasks were performed **three** times each at **eleven** DBS stimulation amplitudes
- Videotaped for subsequent clinical rating



**Rest Tremor**



**Postural Tremor**



**Finger taps**



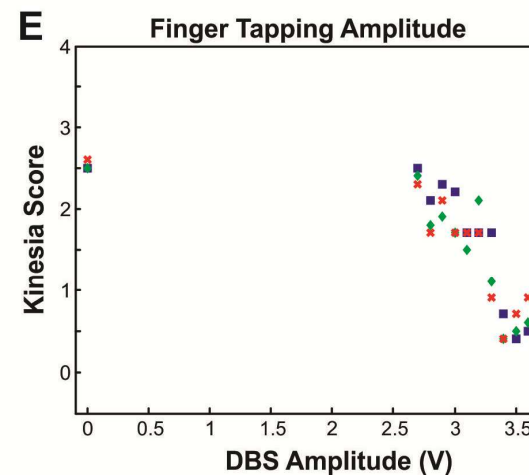
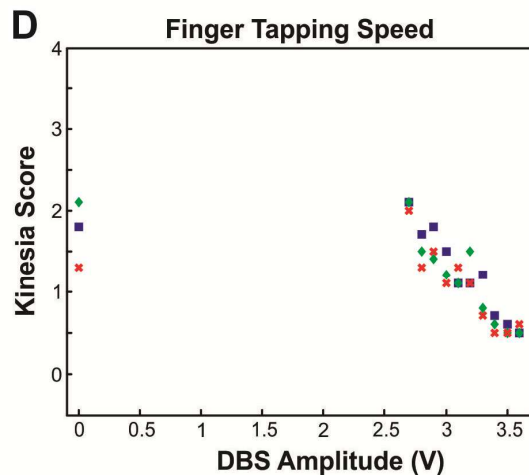
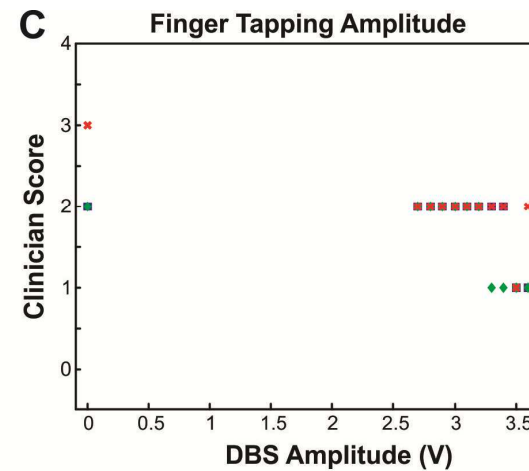
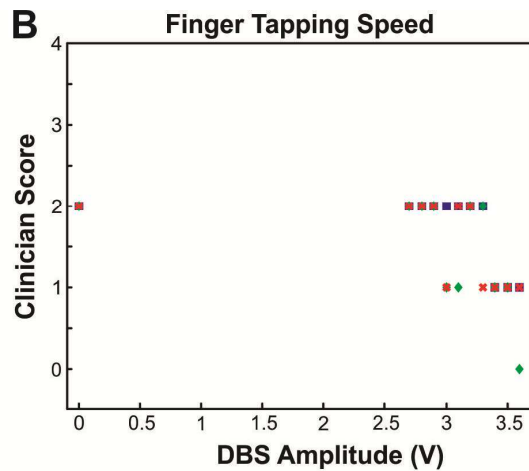
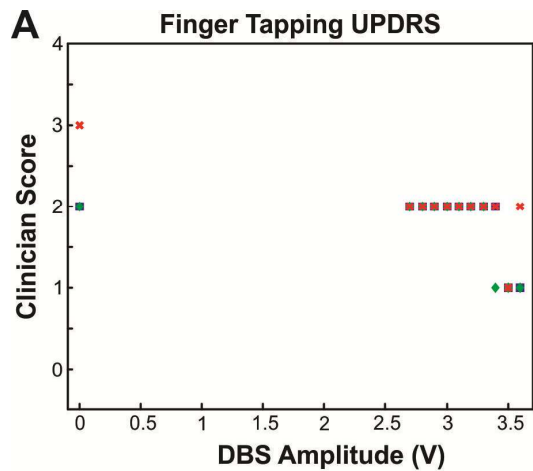
# Assessment

- Unified Parkinson's Disease Rating Scale (UPDRS)
  - Resting Tremor
  - Postural Tremor
  - Finger Tapping (Bradykinesia)
- Modified Bradykinesia Rating Scale (MBRS)
  - Finger Tapping Speed (Bradykinesia)
  - Finger Tapping Amplitude (Hypokinesia)
  - Finger Tapping Rhythm (Dysrhythmia)
- Kinesia HomeView six degree-of-freedom motion sensor
  - 0 – 4 score based on motion data

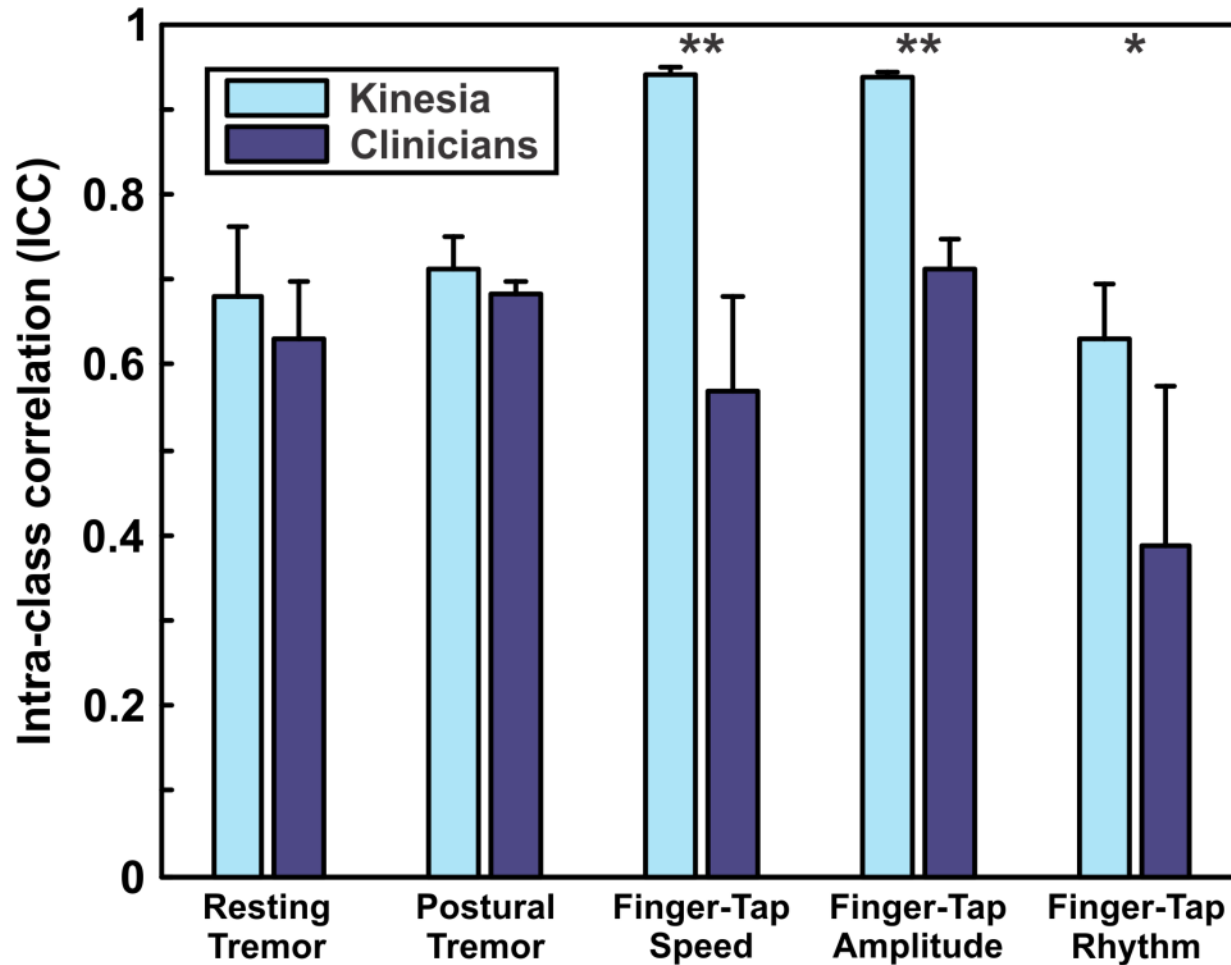




# DBS Modulation

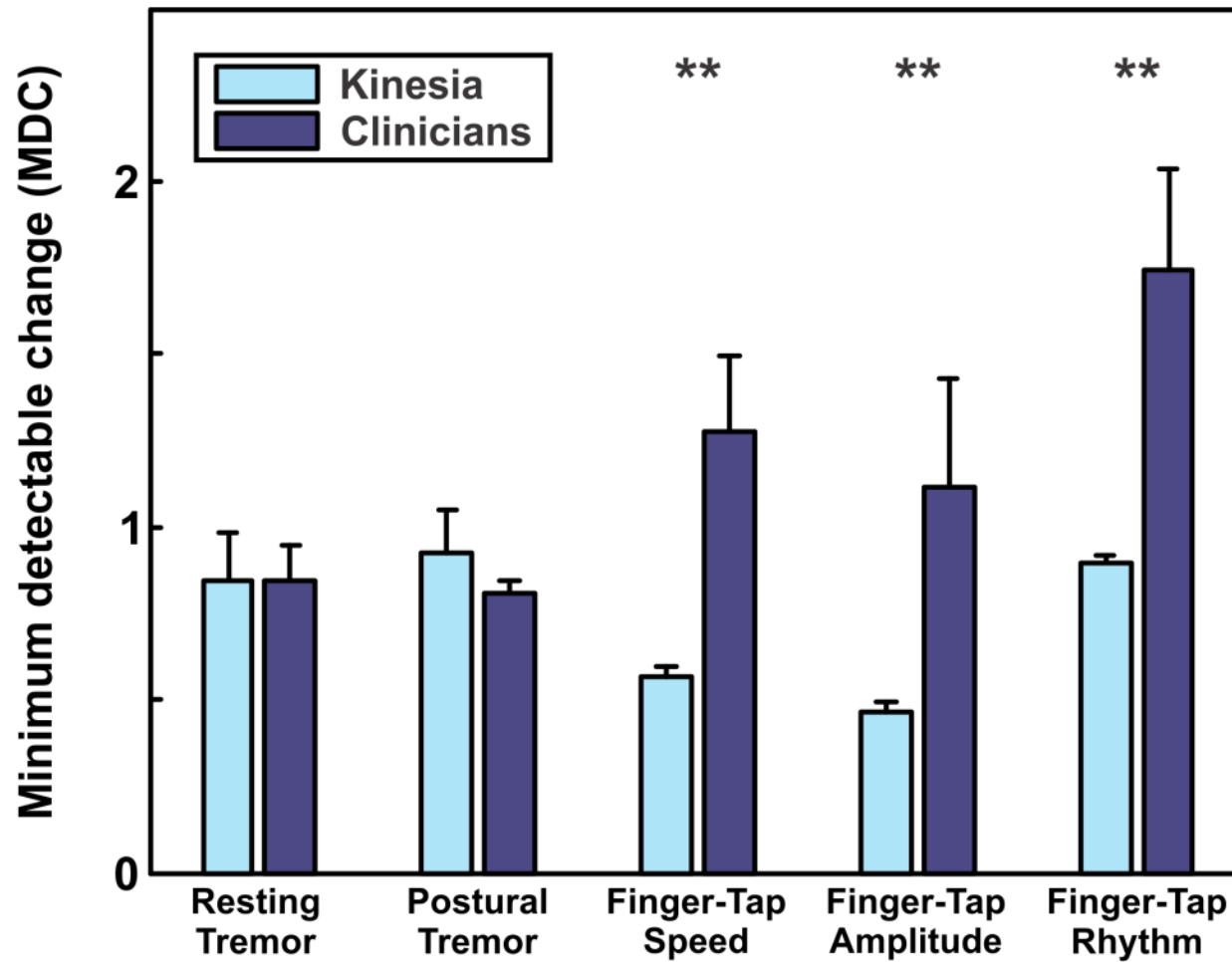


# Intraclass Correlation (ICC)



\* p<0.01  
\*\* p<0.001

# Minimal Detectable Change (MDC)



\*\* p<0.001

# Sample Size Implications

	Clinician ICC	Kinesia ICC	Percent fewer subjects	Number of subjects based on Clinician	Number of subjects based on Kinesia
<b>Rest Tremor</b>	0.63	0.68	7.3	100	93
<b>Postural Tremor</b>	0.68	0.71	4.2	100	96
<b>Speed</b>	0.58	0.94	38.3	100	62
<b>Amplitude</b>	0.69	0.94	26.6	100	74
<b>Rhythm</b>	0.48	0.63	23.8	100	77





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Overview

Patients

Studies

Upload

Admin



# Change the way you see PD

1 Create Study

2 Upload Study

3 Review Study

Setup Study  Pending Upload  Scoring In Process  New Report Ready  Archived Report

Results per page: 10

Status	Start Date	Last Name	First Name	Last Modified
<input checked="" type="checkbox"/> Pending Upload	04/06/2011	Doe	John	04/06/2011 7:54:29 AM
<input checked="" type="checkbox"/> Archived Report		Smith	Jim	02/04/2011 3:19:46 PM
<input checked="" type="checkbox"/> Archived Report		Smith	Jim	02/04/2011 3:19:40 PM
<input checked="" type="checkbox"/> Archived Report	02/28/2012	Smith	Jim	10/07/2010 11:39:47 AM
<input checked="" type="checkbox"/> Archived Report	10/07/2010	Doe	John	10/07/2010 11:36:08 AM
<input checked="" type="checkbox"/> Archived Report		James	Georgia	10/07/2010 11:21:11 AM
<input checked="" type="checkbox"/> Archived Report		Smith	Jim	10/07/2010 11:07:16 AM
<input checked="" type="checkbox"/> Archived Report		Doe	John	10/07/2010 11:02:35 AM
<input checked="" type="checkbox"/> Pending Upload	10/07/2010	Doe	John	10/07/2010 10:20:44 AM
<input checked="" type="checkbox"/> Archived Report	10/09/2011	James	Georgia	10/07/2010 9:43:00 AM

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:01 AM	4.0	3.5	2.5	2.4	2.2	0.0
7:02 AM	SINEMET (100mg)					
7:32 AM	3.4	3.3	1.7	1.4	1.0	0.0
8:01 AM	3.0	3.0	1.8	1.8	1.2	0.0
8:34 AM	2.9	2.8	1.3	1.2	1.0	0.0
9:00 AM	2.8	2.4	1.2	1.1	1.2	0.0
9:23 AM	2.8	2.6	1.0	1.0	1.0	0.0
10:00 AM	2.6	2.8	1.0	1.0	1.0	0.0
10:33 AM	3.2	3.3	1.5	1.9	1.5	0.0
11:01 AM	3.5	3.5	2.3	2.2	2.0	0.0
11:30 AM	3.7	3.8	2.0	2.0	1.8	0.0
12:00 PM	SINEMET (100mg)					
12:01 PM	3.3	3.8	2.6	2.7	2.0	0.0
12:32 PM	3.2	3.4	1.8	1.9	2.0	0.0
1:08 PM	2.6	3.1	2.0	1.4	1.8	0.0
1:28 PM	2.6	2.9	1.5	1.2	1.7	0.0
2:00 PM	2.7	2.7	1.3	1.0	1.5	0.0
2:32 PM	2.9	2.6	1.0	1.2	1.7	0.0
3:00 PM	3.0	2.9	1.1	1.5	1.3	0.0
3:29 PM	3.3	3.1	1.4	1.7	1.7	0.0
4:02 PM	3.8	3.6	1.6	1.8	1.8	0.0
4:30 PM	3.9	3.8	1.9	1.9	2.0	0.0
5:01 PM	3.9	3.9	2.5	2.4	2.0	0.0
5:15 PM	SINEMET (100mg)					
5:29 PM	3.5	3.6	2.1	2.2	2.0	0.0
6:02 PM	3.3	3.5	2.0	2.1	1.6	0.0
6:30 PM	3.0	2.9	1.9	2.0	1.5	0.0
7:00 PM	2.8	2.5	1.5	1.8	1.3	0.0
7:33 PM	2.6	2.6	1.2	1.5	1.1	0.0
8:04 PM	2.6	2.6	1.0	1.4	0.9	0.0
8:30 PM	2.9	2.8	1.2	1.5	1.1	0.0
9:02 PM	3.3	3.2	1.3	1.6	1.4	0.0
9:33 PM	3.5	3.6	1.6	1.8	1.8	0.0
10:00 PM	3.8	3.9	2.0	1.9	2.1	0.0
Mean	3.2	3.2	1.6	1.7	1.6	0.0
Fluctuation	0.4	0.5	0.5	0.4	0.4	0.0



Increase dose by 200mg, Dose interval unchanged

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
6:55 AM	3.9	3.4	2.6	2.5	2.3	0.0
6:57 AM	SINEMET (300mg)					
7:28 AM	2.5	3.0	1.7	1.4	1.0	0.0
7:59 AM	0.5	1.9	1.8	1.5	1.2	1.3
8:30 AM	0.3	0.9	0.3	0.5	1.0	2.9
9:05 AM	0.1	0.5	0.2	0.2	1.2	3.5
9:33 AM	0.3	0.4	0.0	0.0	1.0	3.8
10:02 AM	0.5	0.1	0.5	0.3	1.0	3.7
10:31 AM	1.5	2.0	1.0	0.5	1.5	2.9
10:58 AM	3.0	3.1	2.3	2.2	2.0	0.0
11:35 AM	3.5	3.4	2.0	2.0	1.8	0.0
11:50 PM	SINEMET (300mg)					
11:56 PM	1.1	2.7	2.3	2.2	2.0	0.0
12:30 PM	0.2	2.0	1.8	1.9	2.0	3.0
1:04 PM	0.1	1.4	2.0	1.4	1.8	3.3
1:38 PM	0.0	1.1	0.8	0.9	1.7	3.5
2:02 PM	0.0	1.0	0.6	1.0	1.5	3.6
2:30 PM	0.2	1.0	1.0	1.2	1.7	2.4
3:07 PM	0.4	0.7	1.1	1.5	1.3	1.1
3:33 PM	0.5	1.3	1.4	1.7	1.7	0.0
4:03 PM	2.6	1.5	1.6	1.8	1.8	0.0
4:28 PM	3.5	2.0	1.9	1.9	2.0	0.0
5:00 PM	3.8	2.2	2.1	2.1	2.0	0.0
5:05 PM	SINEMET (300mg)					
5:39 PM	3.5	2.2	2.1	2.2	2.0	0.0
6:03 PM	2.3	2.0	2.0	2.1	1.6	0.0
6:29 PM	1.7	1.3	1.9	2.0	1.5	0.5
7:05 PM	0.8	1.1	1.5	1.8	1.3	1.0
7:36 PM	0.6	0.8	1.2	1.5	1.1	2.3
8:01 PM	0.3	0.6	1.0	1.4	0.9	3.8
8:28 PM	0.2	1.0	1.2	1.5	1.1	3.7
9:00 PM	0.3	1.1	1.3	1.6	1.4	1.3
9:34 PM	0.3	2.0	1.6	1.8	1.8	0.5
9:59 PM	2.8	2.3	2.0	1.9	2.1	0.0
Mean	1.3	1.6	1.4	1.5	1.6	1.6
Fluctuation	1.3	0.9	0.7	0.6	0.4	1.5



Decrease dose by 100mg, Decrease dose interval by 2 hours

Time	Rest Tremor	Postural Tremor	Finger Taps Speed	Finger Taps Amplitude	Finger Taps Rhythm	Dyskinesia
7:00 AM	3.5	3.2	2.7	2.5	2.4	0.0
7:01 AM	SINEMET (200mg)					
7:31 AM	2.0	2.1	1.9	2.1	2.2	0.0
8:00 AM	0.6	0.7	0.3	0.5	1.0	0.0
8:33 AM	0.3	0.5	0.2	0.2	1.2	0.0
8:59 AM	0.2	0.2	0.0	0.0	1.0	0.0
9:22 AM	0.2	0.0	0.5	0.3	1.0	0.0
9:59 AM	1.1	1.5	1.0	0.5	1.5	0.0
10:32 AM	SINEMET (200mg)					
11:00 AM	1.2	1.3	1.5	1.4	1.5	0.0
11:29 AM	0.3	0.3	0.5	0.6	2.1	0.0
11:59 PM	0.2	0.2	0.3	0.3	1.0	0.0
12:00 PM	0.1	0.0	0.4	0.1	2.3	0.0
12:31 PM	0.2	0.6	0.6	0.1	2.1	0.0
1:07 PM	1.2	1.6	1.7	1.6	1.7	0.0
1:27 PM	SINEMET (200mg)					
1:59 PM	1.0	0.8	1.0	0.9	1.0	0.0
2:31 PM	0.3	0.7	0.3	0.8	0.9	0.0
2:59 PM	0.2	0.5	0.2	0.5	0.9	0.0
3:28 PM	0.0	0.3	0.2	0.8	0.9	0.0
4:01 PM	0.5	0.8	0.9	1.6	1.7	0.0
4:29 PM	1.3	1.7	1.6	2.1	2.1	0.0
5:00 PM	SINEMET (200mg)					
5:14 PM	1.0	1.5	1.0	0.9	1.0	0.0
5:28 PM	0.3	0.6	0.3	0.8	2.4	0.0
6:01 PM	0.2	0.3	0.2	0.5	2.0	0.0
6:29 PM	0.0	0.0	0.2	0.8	1.7	0.0
6:59 PM	0.5	0.2	0.9	1.6	1.2	0.0
7:32 PM	1.3	0.9	1.6	2.1	1.0	0.0
8:03 PM	SINEMET (200mg)					
8:29 PM	0.8	0.6	0.5	0.7	0.5	0.0
9:01 PM	0.0	0.2	0.2	1.1	0.9	0.0
9:32 PM	0.0	0.1	0.9	1.6	1.3	0.0
9:55 PM	0.5	0.6	1.9	2.0	1.9	0.0
Mean	0.7	0.8	0.8	1.0	1.5	0.0
Fluctuation	0.7	0.7	0.7	0.7	0.5	0.0

- Postural
- Amplitude
- Amplitude
- Amplitude
- Motion Averages
- Kinetic
- Rhythm
- Rhythm
- Rhythm

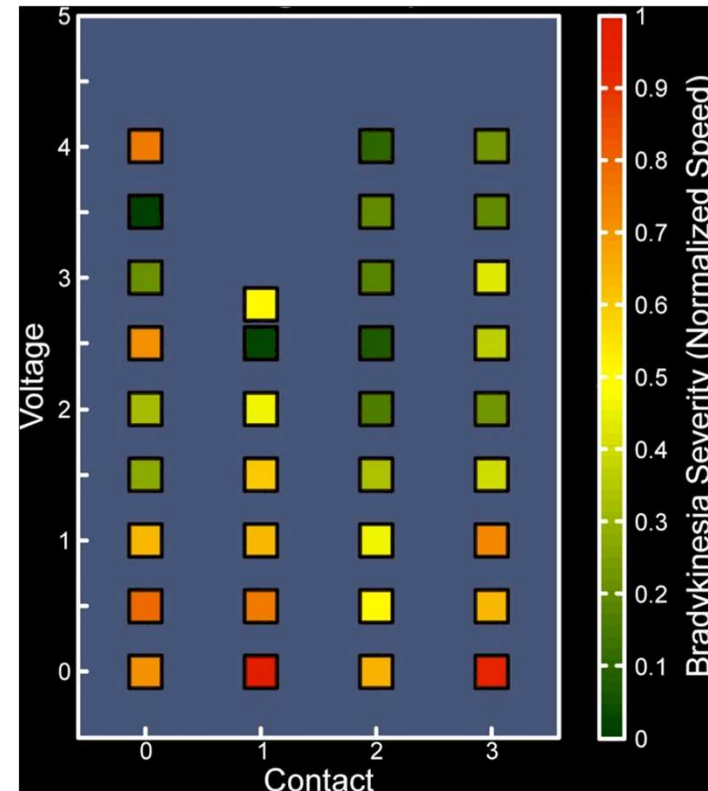
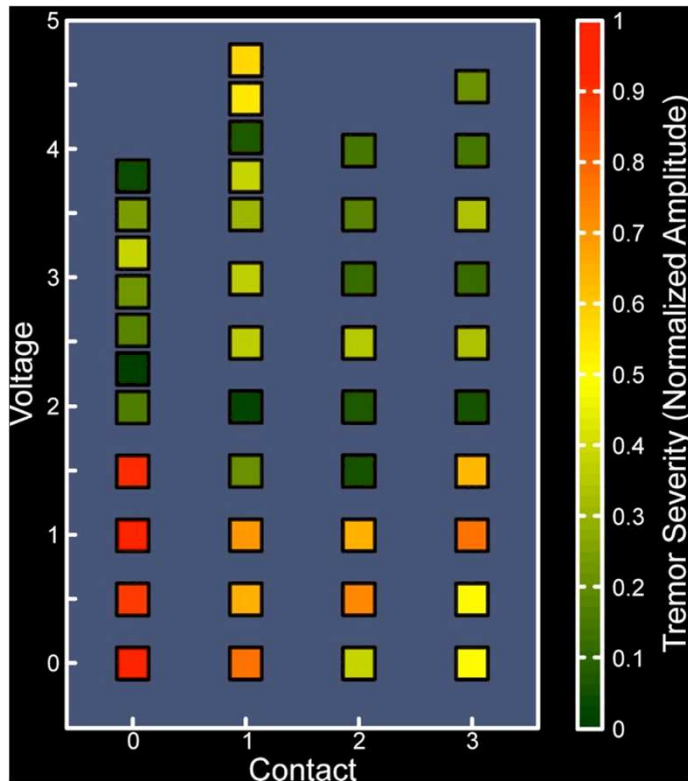
eed  
plitude  
ythm



All Days	Mean Score	2.0	2.0	1.4	2.3	2.0	1.5	1.0	1.5	1.6
	Fluctuation	1.5	1.5	1.2	1.0	1.2	1.1	1.3	1.5	1.1



# DBS Programming



Recently Published



**Kinematic optimization of deep brain stimulation across multiple motor symptoms in Parkinson's disease**

Mera TO, Vitek JL, Alberts JL, Giuffrida JP

*J. Neurosci. Methods*, vol. 198, no. 2, pp. 280–286, 2011.

# Conclusions

- Motion sensors can provide increased sensitivity and test-retest reliability over clinical assessments.
- The increased sensitivity and reliability afforded by motion sensors over clinical assessments **can decrease the number of subjects, shorten the duration, and lower the costs** required to detect significant outcomes in clinical trials.
- Home-based motion sensor monitoring can improve temporal resolution in addition to score resolution.

# Acknowledgements




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