Parkinson's Gait: Global Efficacy of DBS and Pharma Therapy

Thursday September 19th, 2013

Starts at 12:00 PM EST

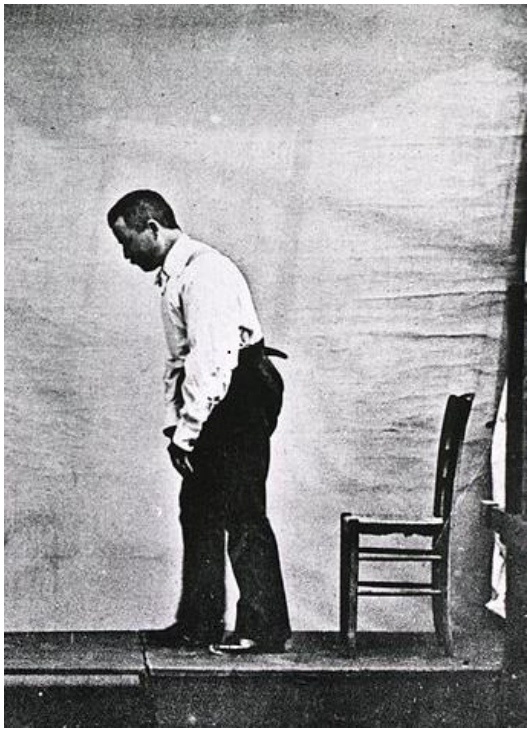
Presented by

Elizabeth Brokaw, PhD

GREAT LAKES NEUROTECHNOLOGIES

Outline

- Parkinson's Gait
- Quantifying Impairment
- Kinesia
  - Discrete: Tasks
  - Continuous: Activities of Daily Living



'Paralysis agitans'
By Albert Londe (1858-1917)

Parkinson's Disease

- Range of Symptoms
- Global Measure of Impairment
- Mobility for Quality of Life
- Increase Fall Risk
  - 68.3% at least one fall

Van Gehuchten (1861-1914)
"Moving Pictures of Parkinson's Disease"
Anne Jeanjean and Genevieve Aubert
The Lancet. 378(9805) 2011

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Parkinson's Disease

Symptom Treatments

- Levodopa
- Deep Brain Stimulation
  - Effects symptoms like tremor quickly
  - Lagging effect on gait of up to three hours

Outcome Measures

- Outcome measures
  - Subjective and low resolution.
- The Unified Parkinson's Disease Rating Scale (UPDRS)
  - Integer scale from 0 - 4.

Gait:

0:	Normal:	No problems.
1:	Slight:	Independent walking with minor gait impairment.
2:	Mild:	Independent walking but with substantial gait impairment.
3:	Moderate:	Requires an assistance device for safe walking (walking stick, walker) but not a person.
4:	Severe:	Cannot walk at all or only with another person's assistance.

Discrete vs Continuous

- High Sensitivity
- Short evaluations
- Standardized tasks

- Global Impairment
- All day
- Everyday activities

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Quantifying Impairment with the Kinesia Sensors

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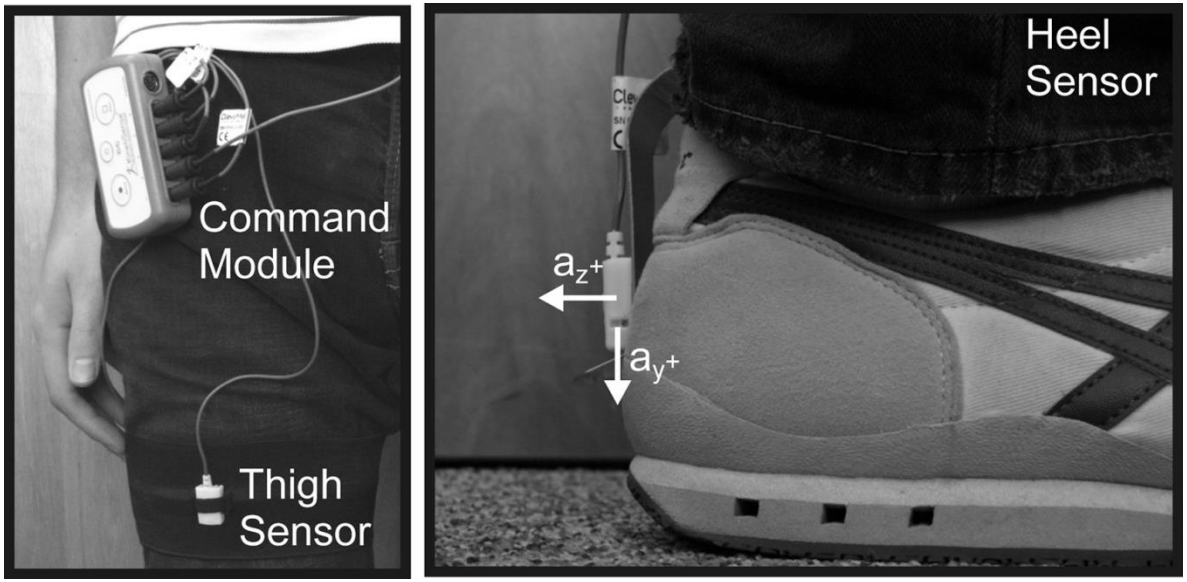
Discrete Evaluation
Kinesia Sensor Placement

- Sensors on the thighs, back of feet and sternum.



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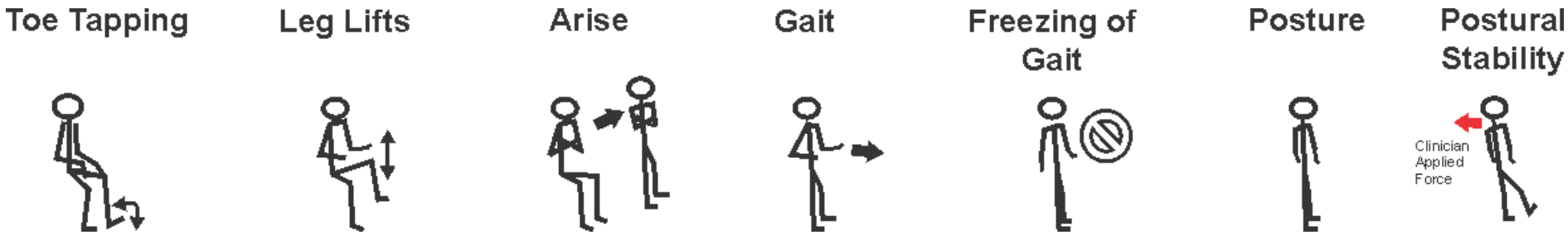
Evaluation Protocol

- 42 individuals with Parkinson's disease.
  - 19 evaluated with DBS on and off.
- Unified Parkinson's Disease Rating Scale tasks



- Scored by three evaluators.

University Hospitals

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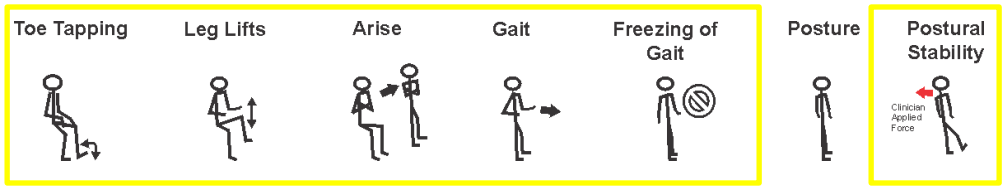
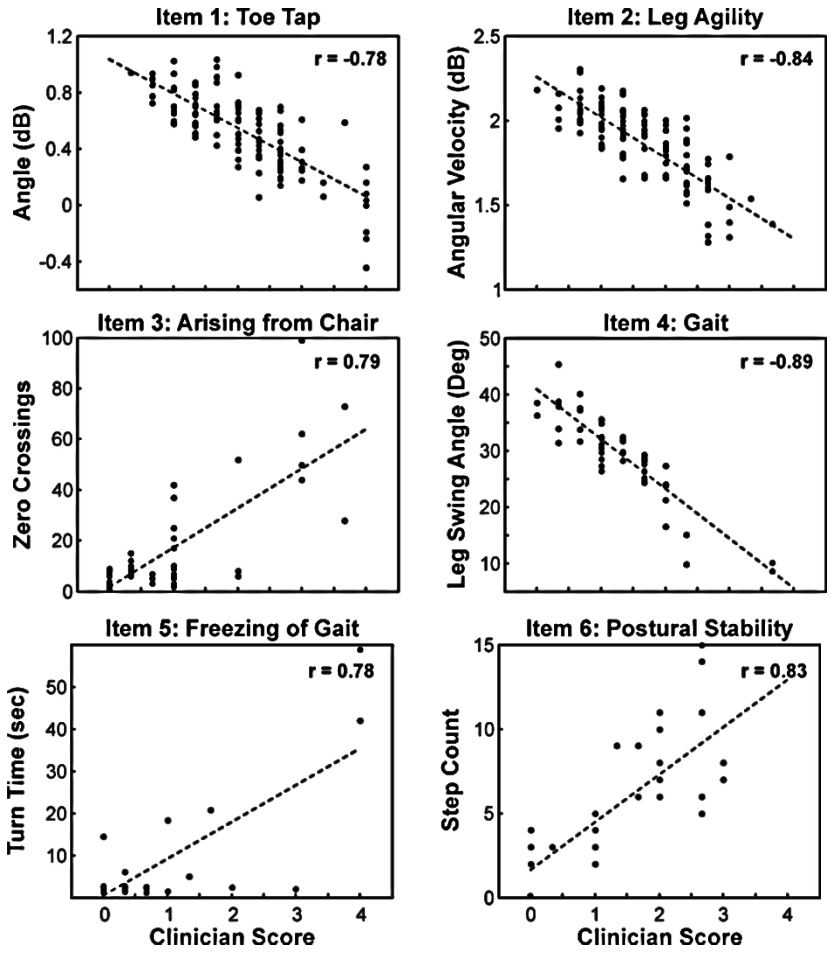
Published:

Mera, T. O., Filipkowski, D. E., Riley, D. E., Whitney, C. M., Walter, B. L., Gunzler, S. a, & Giuffrida, J. P. (2013). Quantitative analysis of gait and balance response to deep brain stimulation in Parkinson's disease. *Gait & posture*, *38*(1), 109–14. doi:10.1016/j.gaitpost.2012.10.025

Clinical Evaluation Results

- Good correlation (>0.7) for all but one task
- Clinically relevant





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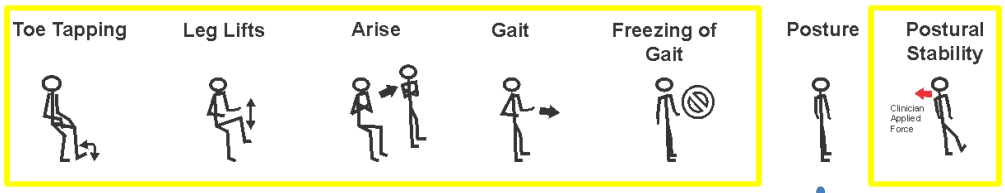
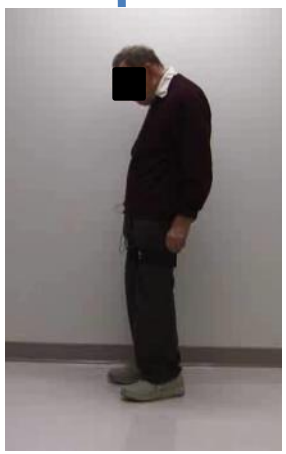
Clinical Evaluation Results



UPDRS Posture Score of 3



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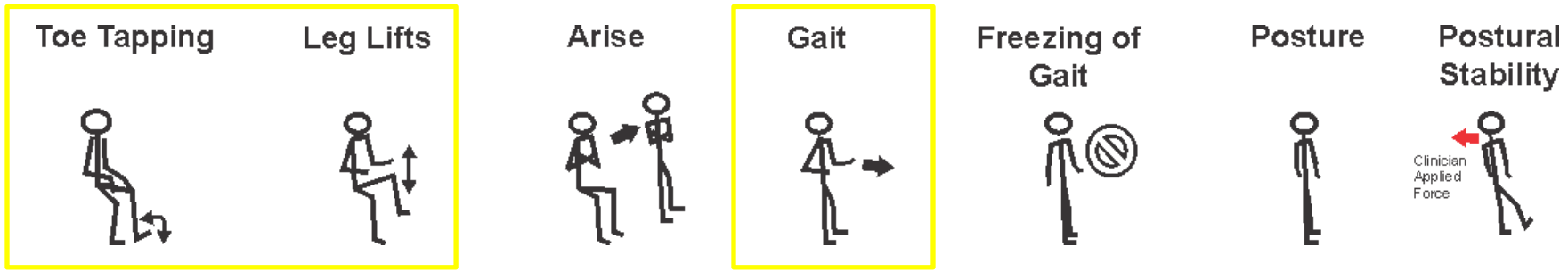
Clinical Evaluation Results
DBS Effect

- Kinematic features show increased impairment with DBS-Off for three of the tasks ($p<0.05$)



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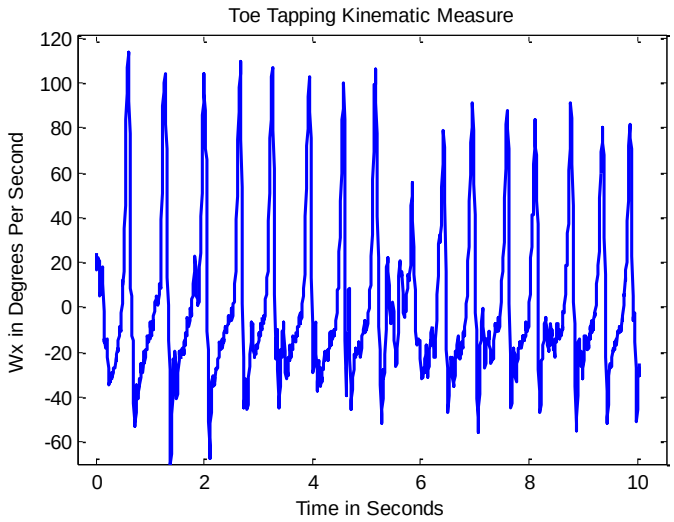
Usability

- Simplified for Clinic and Home Use
  - 5 sensors → 1 sensor
- Information into clinician relevant form
  - Toe angle amplitude → UPDRS equivalent score



→

0: Normal:	No problem.
1: Slight:	Any of the following: a) the regular rhythm is broken with one or two interruptions or hesitations of the tapping movement; b) slight slowing; c) amplitude decrements near the end of the ten taps.
2: Mild:	Any of the following: a) 3 to 5 interruptions during the tapping movements; b) mild slowing; c) amplitude decrements midway in the task.
3: Moderate:	Any of the following: a) more than 5 interruptions during the tapping movements or at least one longer arrest (freeze) in ongoing movement; b) moderate slowing; c) amplitude decrements after the first tap.
4: Severe:	Cannot or can only barely perform the task because of slowing, interruptions or decrements.

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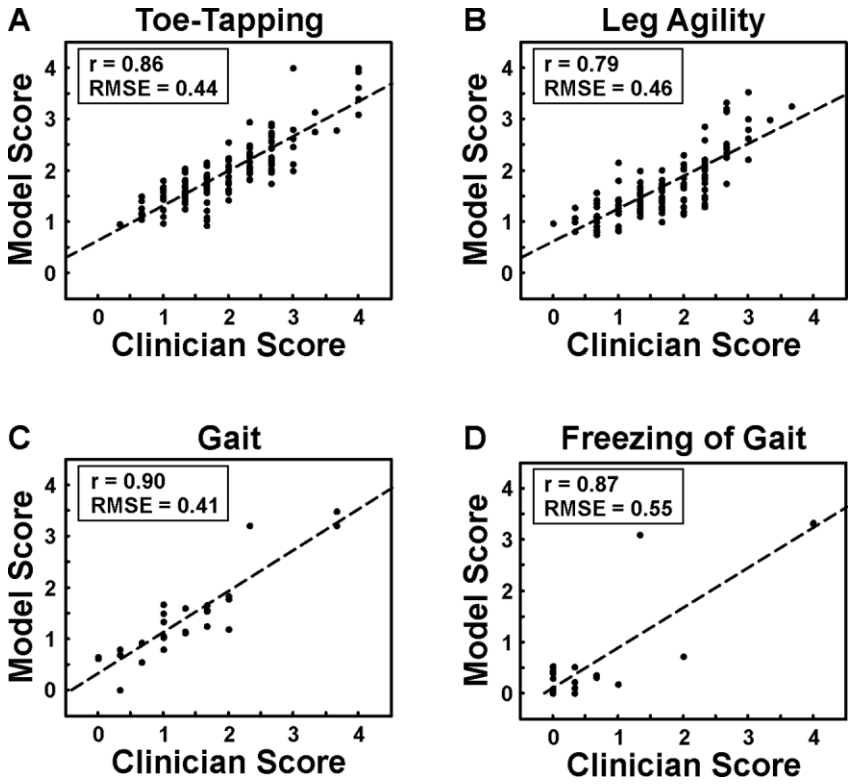
Discrete Clinical Evaluation Results
Single Foot Sensor for Home Use

- A model to predict UPDRS scores from kinematic measures
- Good correlation to clinician score



Published:

Heldman, D., Filipkowski, D. E., Riley, D. E., Whitney, C. M., Walter, B. L., Gunzler, S. a, Giuffrida, J.P. & Mera, T . Automated motion sensor quantification of gait and lower extremity bradykinesia. *International conference of the IEEE EMBS. 2012.*

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Kinesia HomeView

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Web Interface

Patient Kit
(Home Use)

Applications and Markets

Telemedicine

DBS Programming

Clinical Trials

Kinesia HomeView™

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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

Kinesia HomeView™

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Continuous Evaluation of Impairment

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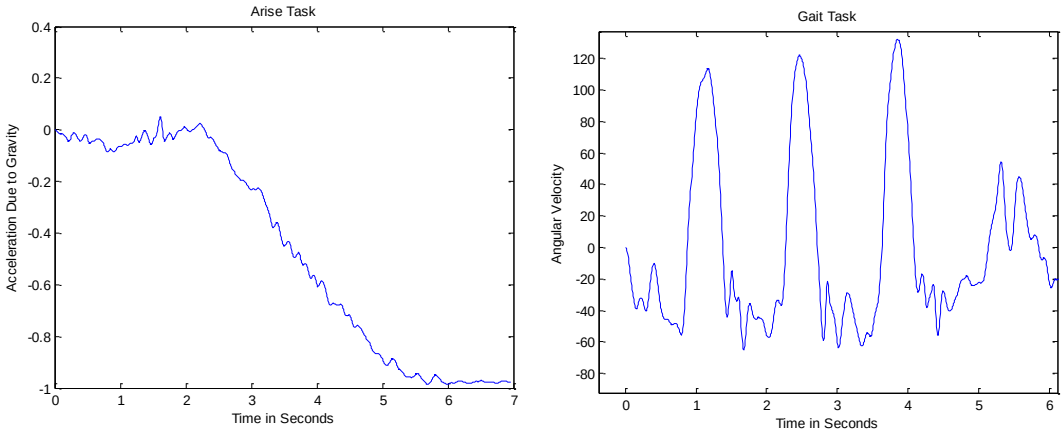
Continuous Evaluation for Home Use

- Activity level and general function
- Low time burden
- Single sensor

Gait ADL Classifications

Sitting **Standing** **Walking**



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Continuous Evaluation for Home Use

- Validate with discrete task data
- Examined gait and arise tasks
- Single Sensor

Arise

Gait

Gait ADL Classifications

Standing and Moving	Standing Still
Sitting and Moving	Sitting Still

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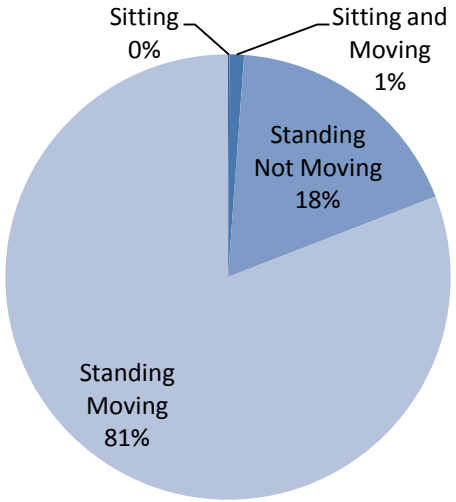
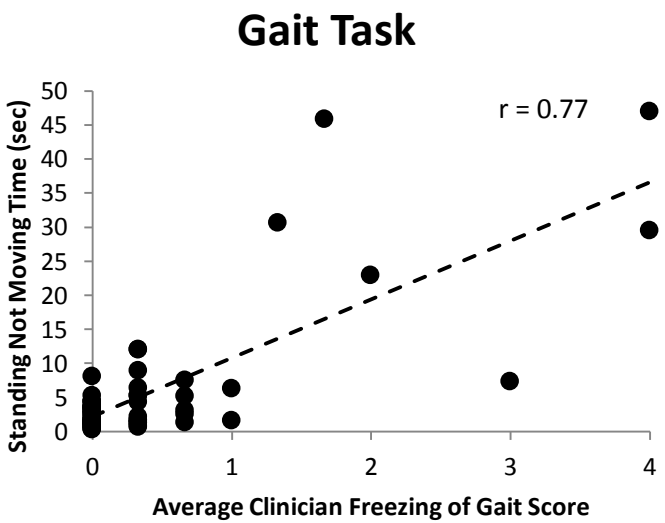
Continuous Evaluation Results
Gait

- Expected classification
- Time standing correlated with UPDRS Freezing of Gait and Gait Scores (r > 0.7).





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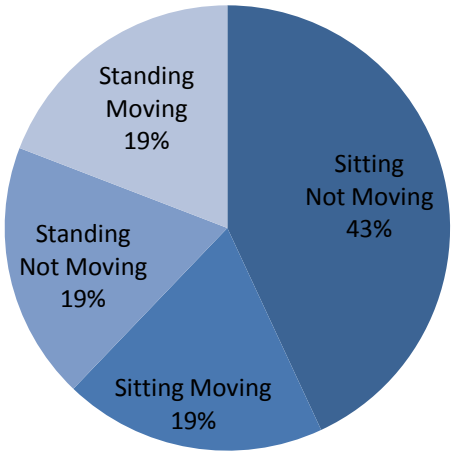
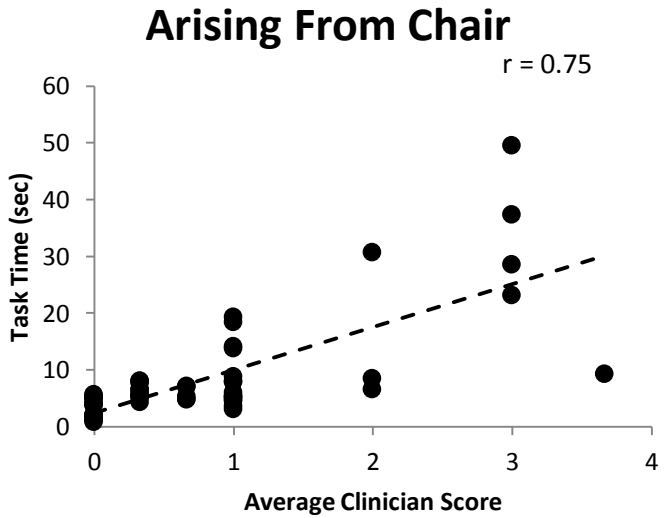
Continuous Evaluation Results
Arise

- Expected classification
- The task time had a good correlation (r > 0.7) with the UPDRS arise score.





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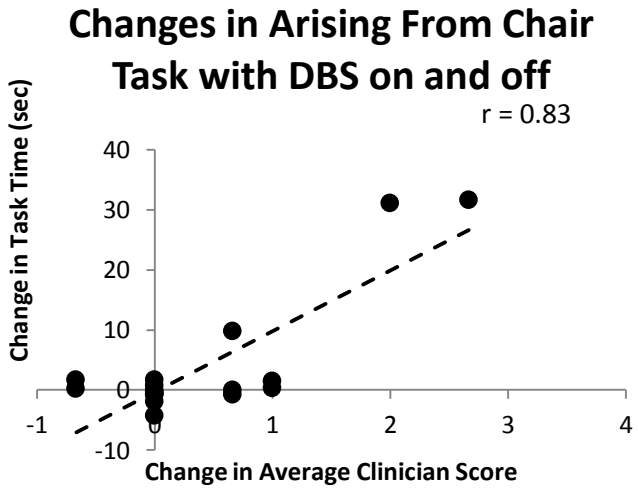
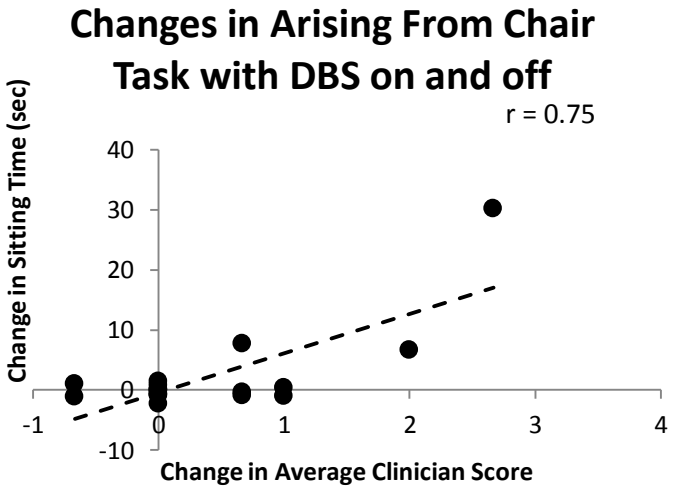
Continuous Clinical Evaluation Results
DBS Effect

- UPDRS change in arise (p=0.058).
- Classification shows changes similar to the clinical measure





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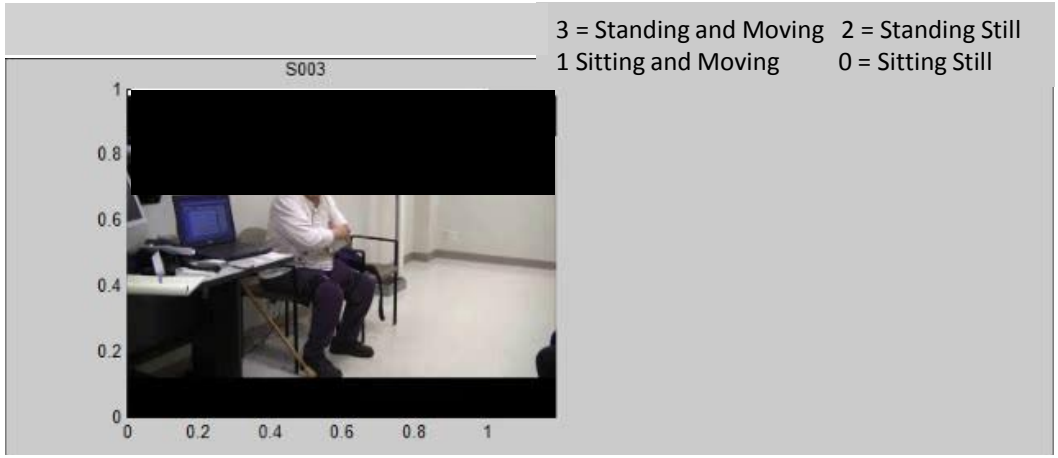
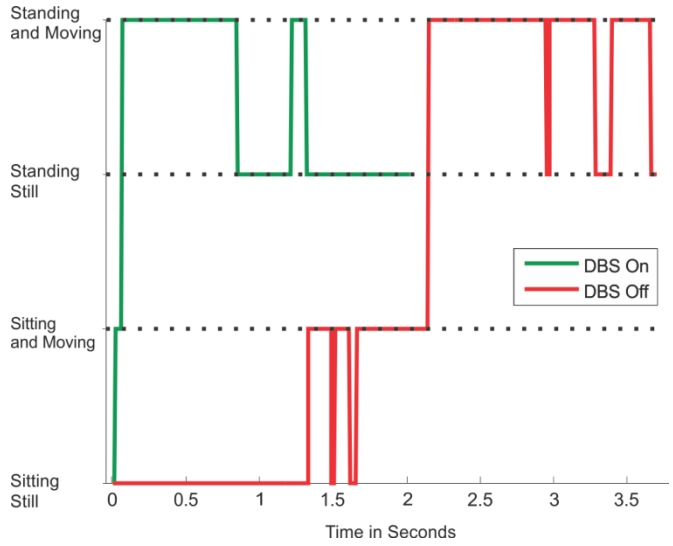
Continuous Evaluation Results
DBS Effect

- Arise task showed a significant increase in time spent sitting and moving with DBS-Off





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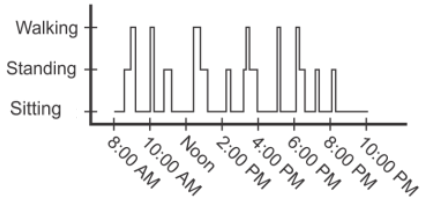
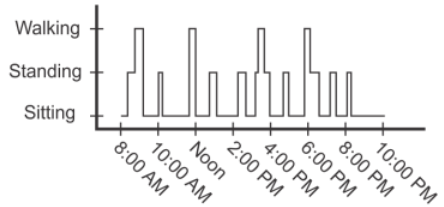
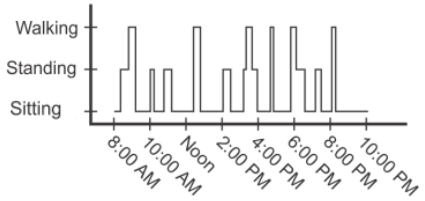
Baseline



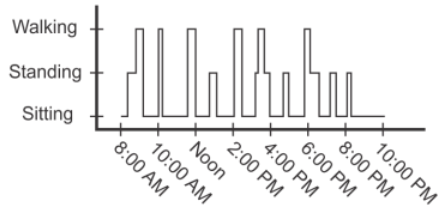
Week 3



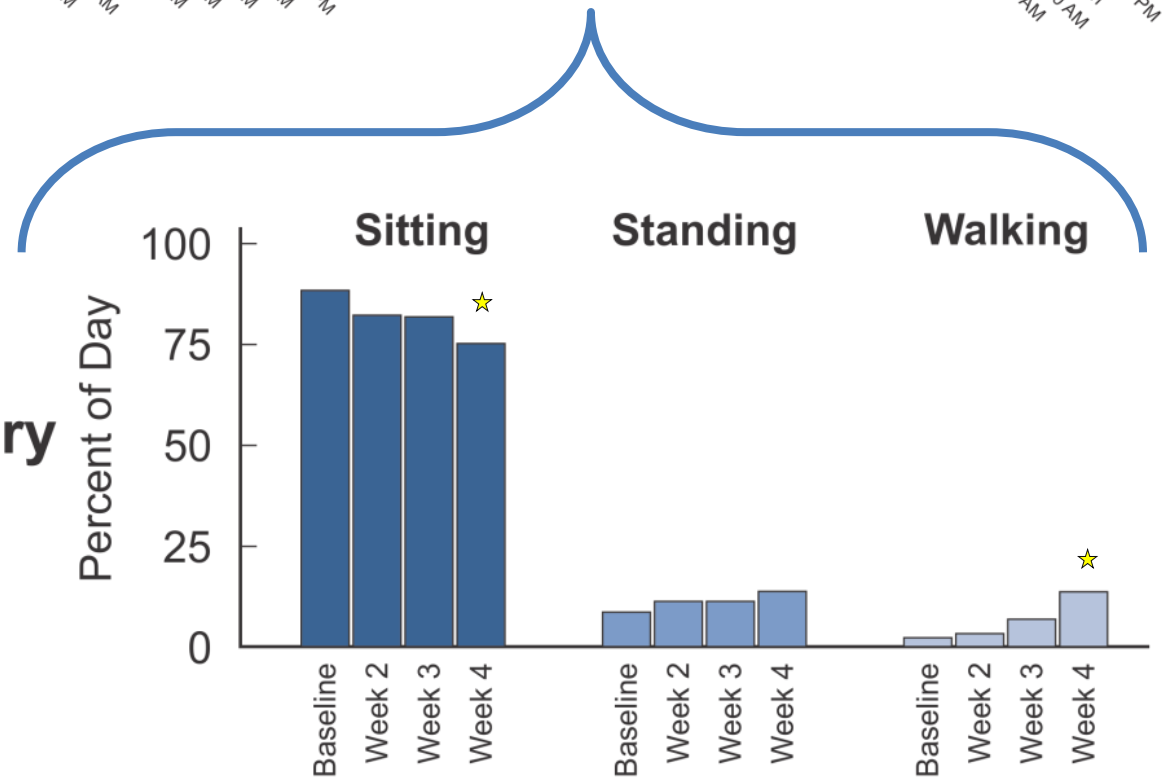
Week 2



Week 4



Summary



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Conclusions

- Gait Impairment Negatively Effects Quality of Life
- Improve Evaluation
  - Quantify
  - Changes through out the day
- The Kinesia motion sensors
  - Collect and quantify clinically meaningful information about gait.

On Going Study

- Further validate models
- Evaluate time based effects of DBS-Off (3 hours)

UNIVERSITY OF Cincinnati

- Alberto Espay
- Fredy Revilla

University Hospitals

- David Riley
- Christina Whitney
- Benjamin Walter
- Steven Gunzler

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Acknowledgements

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Questions

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