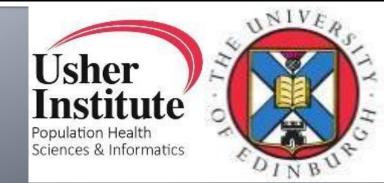
Developing new clinical decision support tools for Parkinson's disease management

Dr Athanasios Tsanas ('Thanasis')

Chancellor's Fellow in Data Science Usher Institute Medical School, University of Edinburgh



Problem with current assessment



Physical presence in the clinic

- Cumbersome for those living in remote areas
- People need to take days off work



Limited time window

- Time consuming
- Snapshot: does not capture daily variability



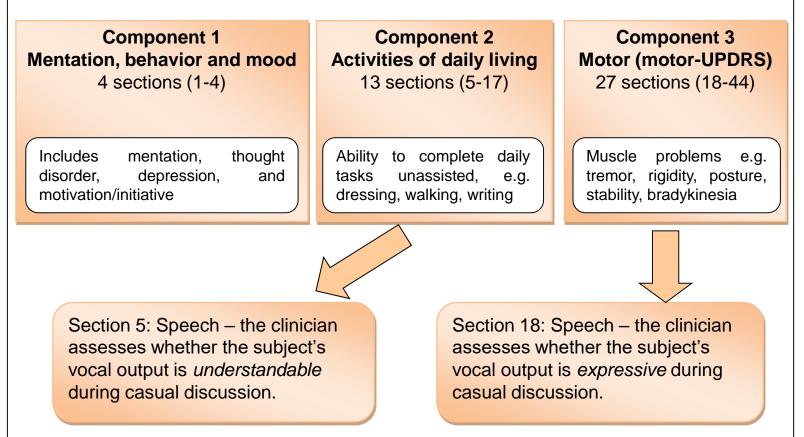
No ground truth

- Subjective, depends on rater's experience
- Inter-rater variability

Quantifying symptom severity

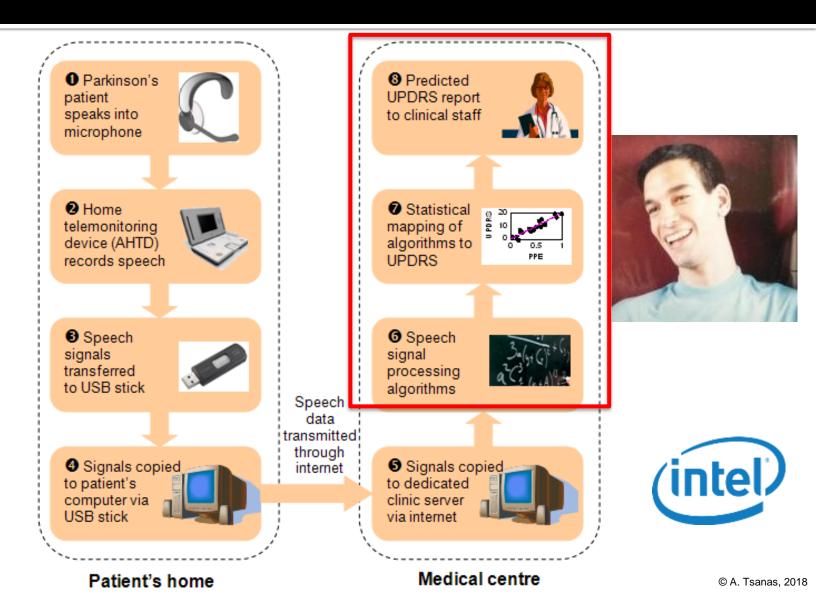
Unified Parkinson's Disease Rating Scale (UPDRS)

comprises three components and 44 sections in total, each section spans the range 0-4

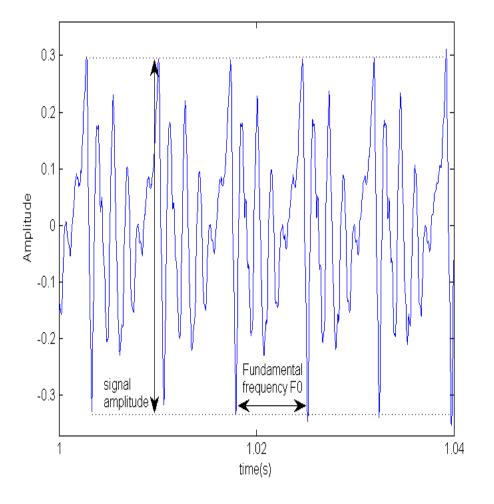


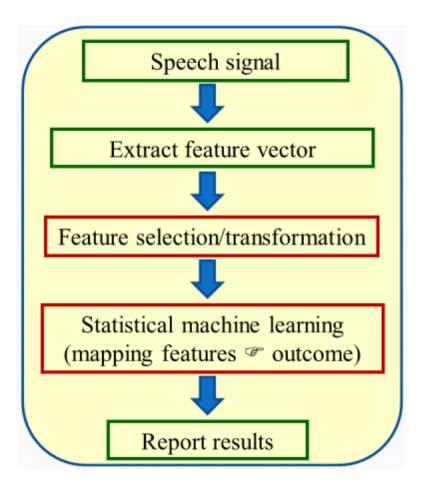
Proposed solution

Telemedicine: the dawn of a new era

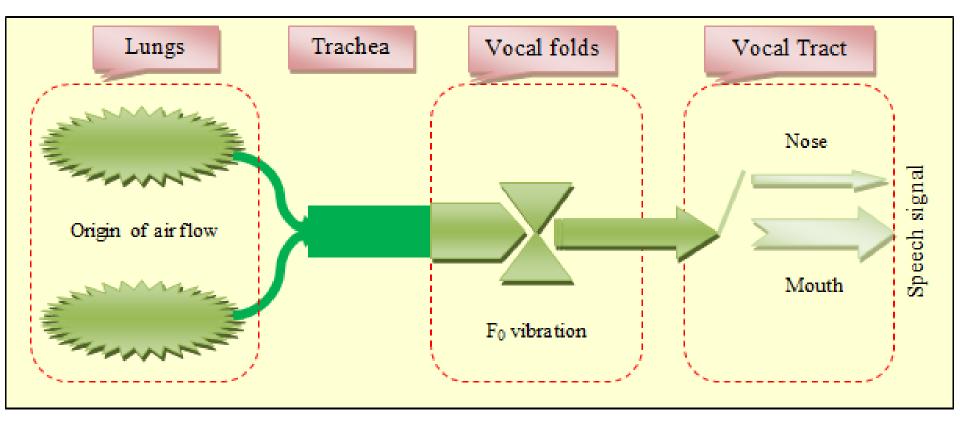


Time-series & pattern recognition





Voice production mechanism



Feature extraction

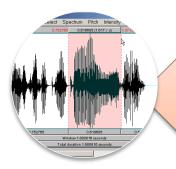


Perturbation algorithms

- Amplitude changes
- Frequency changes

Repeatability (entropy)

- Pattern consistency
- Variability

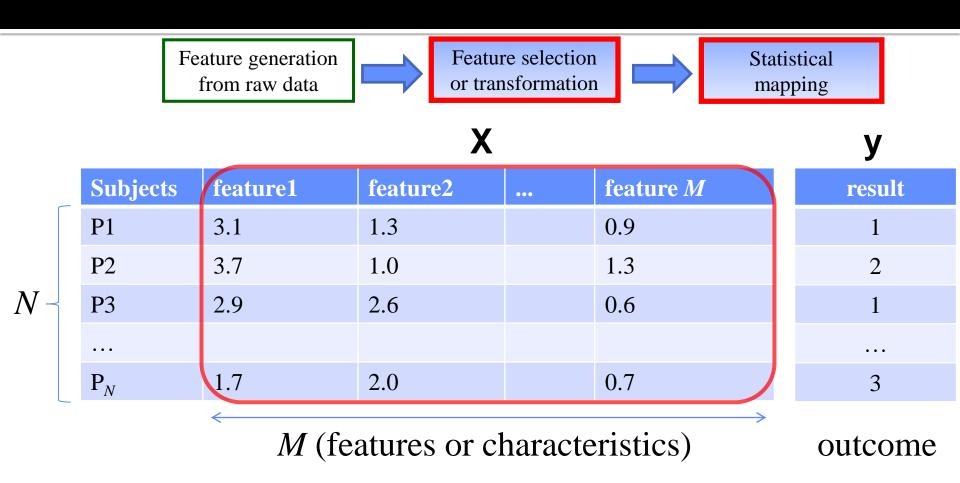


n Entro

Energy

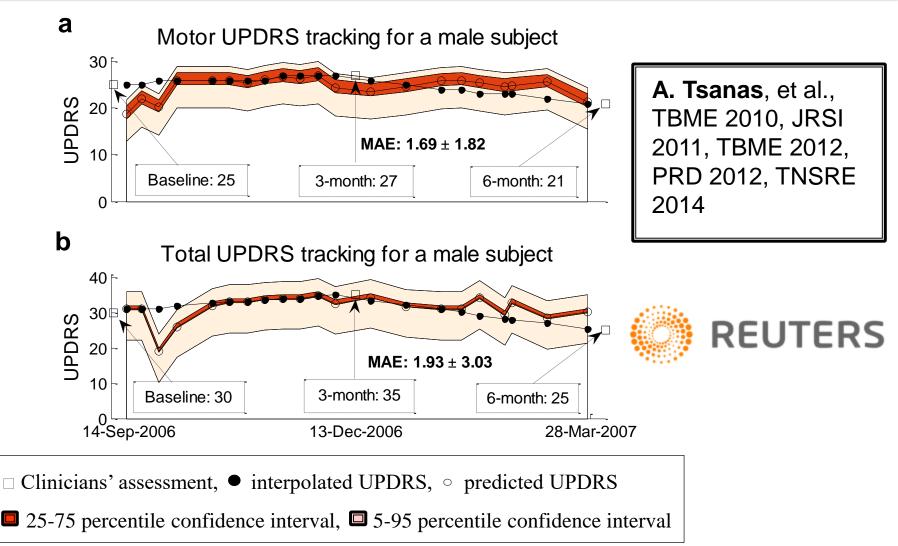
- Duration
- Signal-to-noise ratio concepts

Overview of data analysis

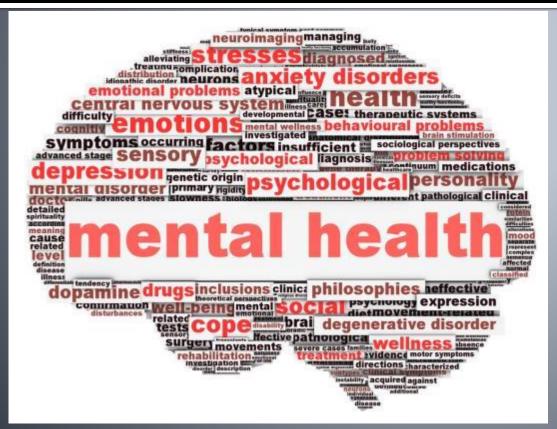


- Depending on the problem, "features" can be demographics, genes, ...
- $\mathbf{y} = f(\mathbf{X})$, f: mechanism \mathbf{X} : feature set \mathbf{y} : outcome

Remote assessment



Mental health telemonitoring Project 2



Oxford Health NHS

NHS Foundation Trust

Problem with current assessment



Physical presence in the clinic

- Cumbersome for those living in remote areas
- People need to take days off work



Patient-led self-monitoring

- Recall bias
- Subjectivity

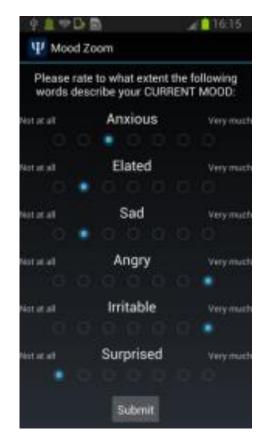


No ground truth

- No way to assess intervention effects
- Inter-rater variability

Proposed solution

Frequent timestamped self-reports



Sensor-based objective monitoring

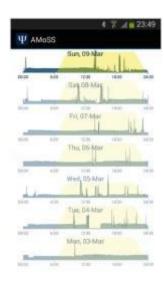


Assessing mental health









- Continuous personalized monitoring
- Objectively quantify mental health
- Identify characteristic patterns

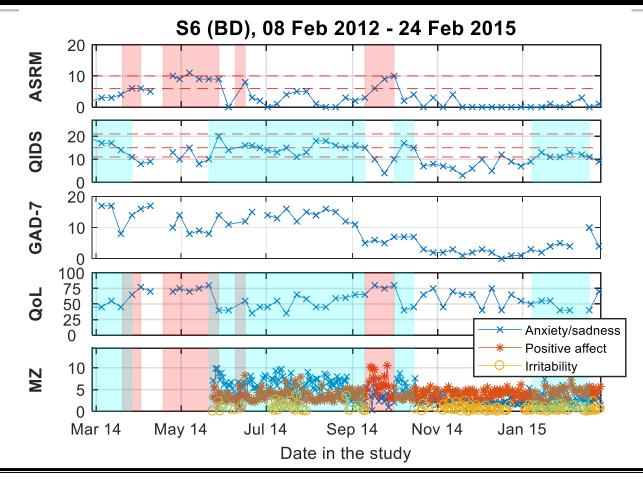
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Not at all	Angry	Very much
461 at all	Irritable	Verymuct
Not at all	Surprised	

Quick Inventory of Depressive Symptomatology—Self-Report (QIDS-SR)

Name tinde the one reports a to each item that best describes you for the pertoeven days

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- Hole at least 30 minutes to fail salespiless than half the time
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- Lionativale up tinight
- they a region, light feep with a few brief systemic parachinishs. twave up at least ance a night, but tao back to depressly.
- 3. Les ten more than once a right and the available 20 minutes or more, more than half the time.
- 5. Writing spheric risky Next differences in a second bar. Statistics in the local interface in
 - More than helf the time I evalues mere than 30 minutes before I next to get up.
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 Education is a specific and the assist a 24-base period including rapy.
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- 3. Estephonger Base 12 hours in a 24-hour period including raps.
- 5. Feeling sect
- Interactive and
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- 3 Theeland nearly all of the time.
- 5. Decreased appendix
- there is no change in ny solat appetite
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- 3. Every stable s20 has period and only although the period of bit or show of expensations to sta-

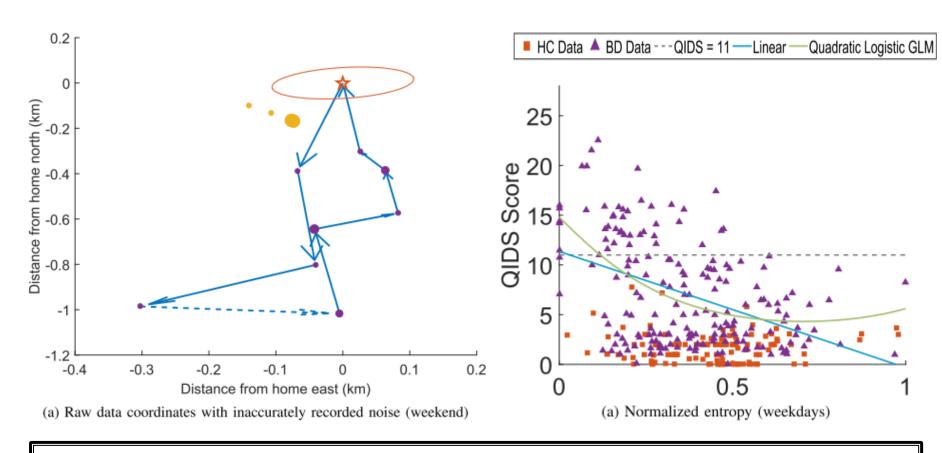
Self-assessment: questionnaires



A. Tsanas et al.: Daily longitudinal self-monitoring of mood variability in bipolar disorder and borderline personality disorder, Journal of Affective Disorders, Vol. 205, pp. 225-233, 2016
A. Tsanas et al.: Clinical insight into latent variables of psychiatric questionnaires for mood symptom self-assessment, JMIR Mental Health, Vol. 4, pp. e15, 2017



Geolocation and depression



N. Palmius, A. Tsanas, K.E.A. Saunders, A.C. Bilderbeck, J.R. Geddes, G.M. Goodwin, M. De Vos: Detecting bipolar depression from geographic location data, **IEEE Transactions on Biomedical Engineering**, Vol. 64, pp. 1761-1771, 2017



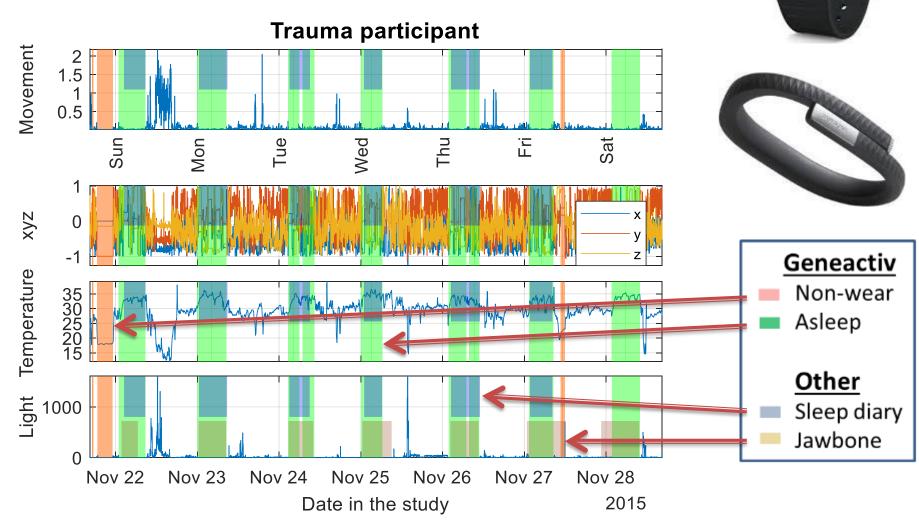
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Raw data	Processed patterns	Features		
Extract data	Pre-process	Characterise		

Sleep detection example



Sleep detection comparisons

	van Hees et a detection algo	al. (2015) sleep orithm	Proposed sleep detection algorithm in this study		
	Sleep onset Sleep offset		Sleep onset	Sleep offset	
Non-					
traumatised	-56±112	22.5±106	-12.5±51	2±30.25	
controls					
Traumatised controls	-81±147	35.5±95.5	-18±50	10±46.75	
PTSD participants	-78±131.25	41.5±122.5	-34±78.25	10±45.25	

Objective signal monitoring



P	ctogran	n: 14004	• (ПС), U	1-Feb-20	14 - 14-	Feb-2014
Sat, 1 Feb	M	Mommon	mann		monter	mmmmml
Sun, 2 Feb	-	monorma	montrala		man	much
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Thu, 13 Feb	-	mum	montermating		mmm	
00:	:00 8:	00 16	:00 24	:00 32	:00 40	:00 48:00

Actogram: 14004 (HC), 01-Feb-2014 - 14-Feb-2014

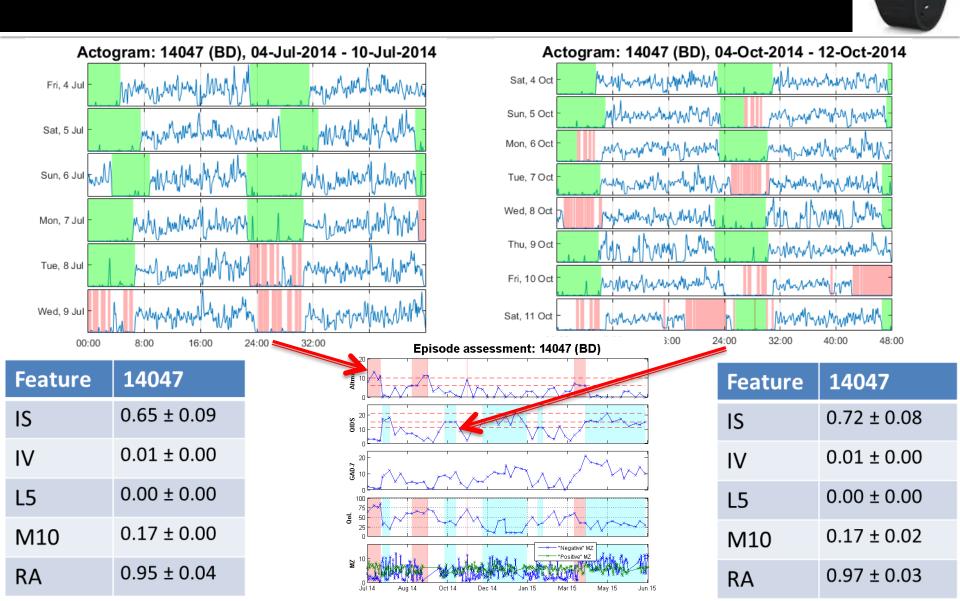
Feature	Subject id
IS	0.66 ± 0.07
IV	0.01 ± 0.00
L5	0.00 ± 0.00
M10	0.16 ± 0.01
RA	0.95 ± 0.02

(results in form: median±iqr)

IS = interdaily stability IV = intradaily variability RA = relative amplitude = (M10-L5)/(M10+L5)

High IS: good zeitgeber sync ☺ High IV: fragmentation ☺ High RA: good rhythmicity ☺

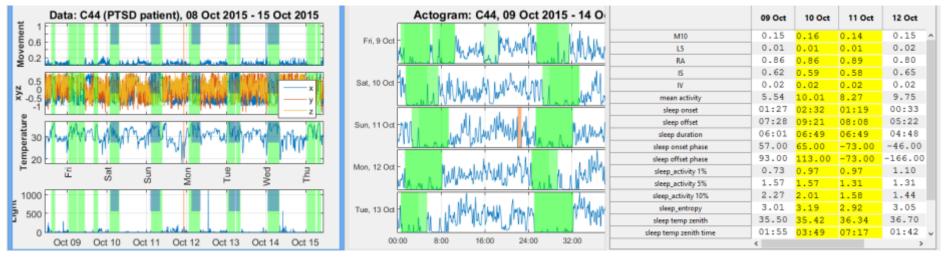
Smartwatch processing



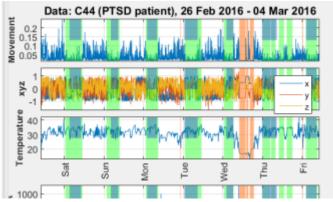
025332

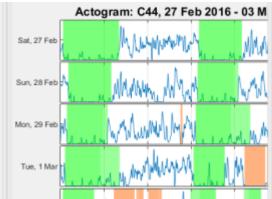
PTSD, before and after treatment

BEFORE CBT



AFTER CBT





	27 Feb	28 Feb	29 Feb	01 Mar	
M10	0.17	0.13	0.15	0.19	^
L5	0.01	0.00	0.01	0.01	
RA	0.92	0.94	0.87	0.91	
IS	0.76	0.69	0.61	0.76	
IV	0.01	0.01	0.01	0.01	
mean activity	9.42	6.51	8.36	7.95	
sleep onset	01:24	01:08	00:49	00:24	
sleep offset	09:18	08:38	10:50	06:09	
sleep duration	07:54	07:30	10:00	05:44	
sleep onset phase	58.00	-16.00	-19.00	-25.00	
sleep offset phase	-86.00	-40.00	132.00	-281.00	
sleep_activity 1%	1.50	1.44	0.92	1.75	
sleep_activity 5%	1.85	1.87	1.48	2.17	
sleep_activity 10%	3.15	2.51	1.74	3.51	

Parkinson's disease revisited

Dundee-Edinburgh Parkinson's Initiative





Esther Sammler



Gordon Duncan



LOngitudinal Monitoring of PARkinson's Disease symptom progression: <u>the LOMPARD study</u>

Anne Steinberg

PhD student Usher Institute Medical School, University of Edinburgh







The LOMPARD study

- Problems: snapshot that is used for clinical decision making, Hawthorne effect, real life, under recognition of NMS
- Aim: create a way to monitor symptoms that is clinically useful for both the patient and the clinical team
- Emphasis on Non-motor symptoms









Study design

- 50 people for 1 year, early- mid stage PD
- Motor Symptoms:
 - Smartwatch and app tasks
- Non motor symptoms:
 - Sleep, Neuropsychiatric, Autonomic
 - At home

- In person assessment:
 - UPDRS, MoCA
 - Pre and post study interview





Study aims

- Provide an insight into symptom progression in real life settings
- Help clinical decision making
- Help in self management of symptoms
- Better outcome measures for clinical trials





Interested in participating?

We are looking for people with early-mid stage PD.

If you are interested in participating or would like more information email me at <u>anne.steinberg@ed.ac.uk</u>

Our vision for PD telemonitoring



Fuse data

Human input

Improve care

Acknowledgments

Esther Sammler Gordon Duncan Dave Breen Tilo Kunath Siddharthan Chandran













