Quantitative assessment of movements with inertial sensors in Parkinson’s disease

A major problem in the field of Parkinson's disease (PD) is that there is no objective assessment tool for PD symptoms to date. At the moment data are mostly collected with questionaires, interviews, or clinical scales. This makes the assessment of changes in the course of the disease, due to training or due to medication very difficult for patients and medical staff. A way to solve this issue is the objective measurement of movements (in patients with PD) with (small) body-worn sensor units containing accelerometers, gyroscopes and magnetometers.

There are four main fields of applications of these sensor units in PD:

1) Measuring symptoms and instrumented clinical scales;

2) Instrumented functional assessments;

3) Quantification of daily activity;

4) Technology-assisted neurorehabilitation;

In the talk examples of these four fields of applications have been discussed.

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Quantitative assessment of movements with inertial sensors in Parkinson's disease

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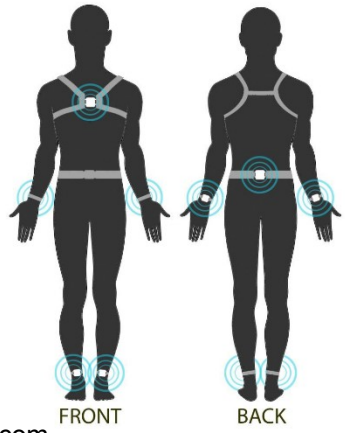
Quantitative assessment with inertial sensors

Objective measurement of movements with (small) body-worn sensor units containing accelerometers, gyroscopes and magnetometers

1



www.apdm.com

2

www.mcroberts.nl

3

www.sense-park.eu

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Parkinson‘s disease (PD)

...is defined by:

- bradykinesia ….

...and one of the following symptoms:

- rigidity,
- rest tremor,
- postural instability.

W. R. Gowers: A Manual of Diseases of the Nervous System,1886

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Why inertial sensors in PD ?

Example of UPDRS items and rating by the audience.

Videos with patients removed.

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Use of inertial sensors in PD for…

- instrumenting clinical scales and measuring symptoms
- instrumenting functional assessments
- quantification of daily activity
- technology-assisted neurorehabilitation

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Instrumenting clinical scales: UPDRS

Figure removed, see figure 1 in Mera et al., J Neurosci Methods., 2012

UPDRS items “rest tremor” and “finger tapping”

Mera et al., J Neurosci Methods., 2012

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Measuring symptoms

bradykinesia and dyskinesia

Graphs removed, see figure 1 in Griffiths et al., Journal of Parkinsons disease, 2012

http://www.innovation.gov.au/industry/PharmaceuticalsandHealthTechnologies/MedicalDevicesandTechnology/PublishingImages/DIISR_CaseStudy_02.gif

A: healthy person

B: bradykinetic PD patient

C: dyskinetic PD patient

Instrumenting functional tests: Timed Up & Go Test

Timed Up and Go Test, Video and accelerometer/gyroscope signal.

Video with patient removed.

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Instrumenting functional tests:

Timed Up & Go Test

31 patients with postural instability and gait difficulty (PIGD)

30 patients with tremor dominant (TD) PD

Differences between PD subtypes in parameters of walking, transitions and turning

Graph removed, see figures 1-3 in Herman et al., Exp Brain Res, 2014

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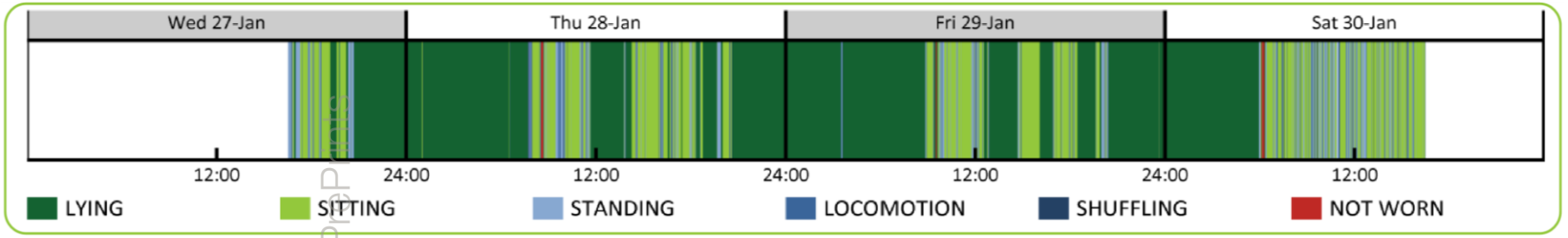
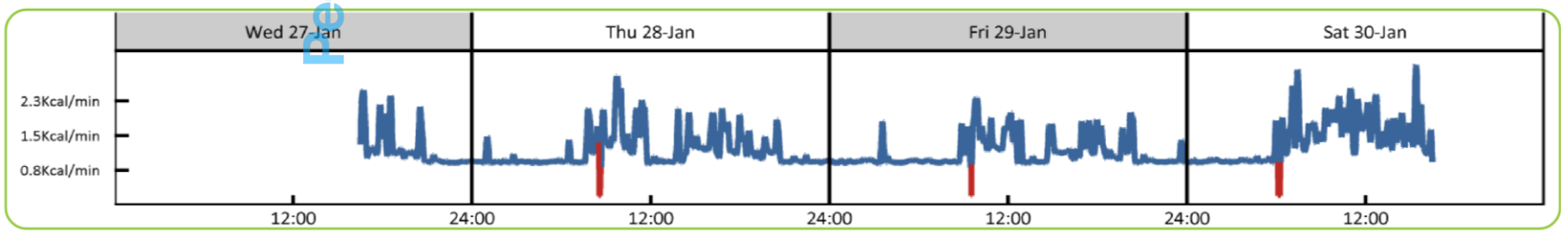
Herman et al., Exp Brain Res, 2014

Quantification of daily activity

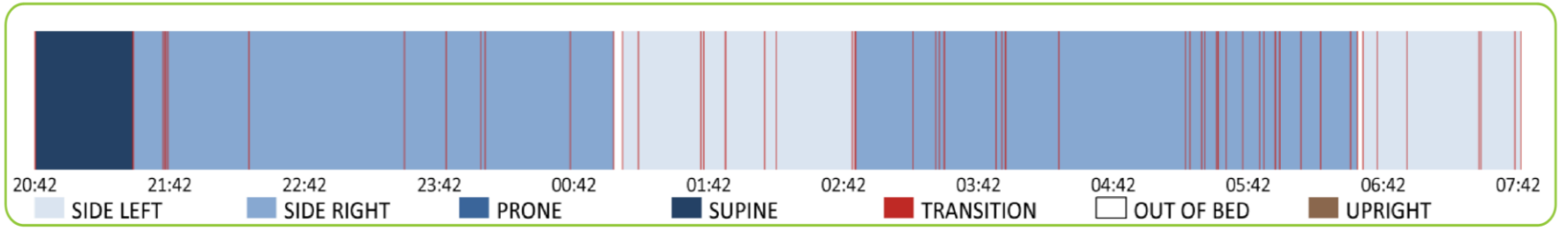
activity



intensity



sleep



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Quantification of daily activity: Concept of bouts

17 PD patients

17 controls

measurement duration 7 days

no differences in volume of sedentary time, but in distribution

Graph removed, see figure 1 in Chastin et al., Mov. Disord, 2010

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Chastin et al., Mov. Disord, 2010

Self-assessment by PD patients



Four sensor units: Three worn during the day, one at night

Covered symptoms

- *Tremor*
- *Gait*
- *Sleep*
- *Hypokinesia/Dyskinesia*
- *(Cognition)*

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Technology-assisted neurorehabilitation: gait

at-home training with closed-loop augmented-reality cueing device

13 PD patients with gait shuffling, festination, and/or freezing;

2 x 30min daily training

Figures removed, see figures 1-2 in Espay et al., JRRD, 2010

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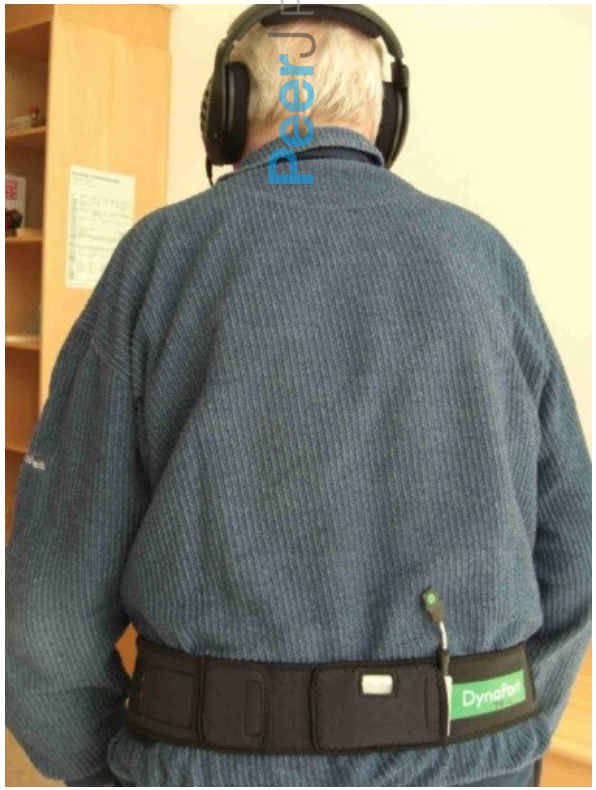
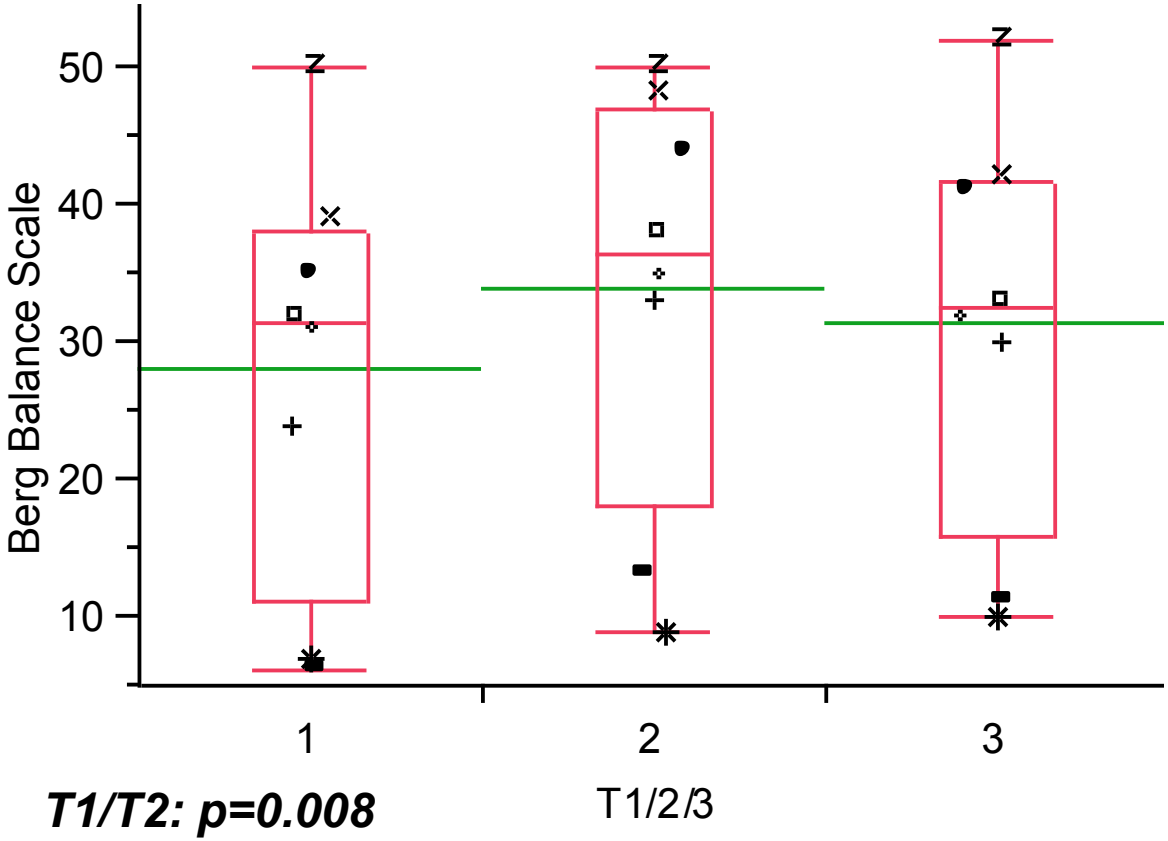
Technology-assisted neurorehabilitation: balance

training with closed-loop auditory biofeedback

8 PSP patients

3 x 45min weekly training





T1/T2: p=0.008

T1/T3: p=0.04

T2/T3: ns

Nicolai et al., Z Gerontol Geriat, 2010

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Thank you for your attention!

http://www.hih-tuebingen.de/funktionelle-neurogeriatrie

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