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## Objective:

To assess the feasibility of measuring Parkinson's disease (PD) motor symptoms with a multi-sensor data fusion method. More specifically, the aim is to assess validity, reliability and responsiveness of the methods to treatment.

## Background:

Data from 19 advanced PD patients (mean age: 71.4, mean years with PD: 9.7, mean years with levodopa: 9.5) were collected in a single center, open label, single dose clinical trial [1].

PD patients performed three tests of leg agility, hand rotation, and walking. Data from hands while walking were also collected.

The tasks were performed starting from baseline, at the time of morning dose (150% of the normal levodopa equivalent dose), and at follow-up time points until the medication wore off.

Movement disorder experts rated the videos of PD patients on six items of UPDRS-III motor section, treatment response scale (TRS), and dyskinesia.

## Methods:

Time- and wavelet- domain based features were calculated for each dataset. The feature sets were then combined resulting in a fusion set. Using stepwise method, most important features were selected and used in machine learning methods. Three machine learning methods of support vector machines, decision trees, and linear regression (LR) were employed.

Validity of the scores from machine learning methods to TRS were examined by Pearson correlation coefficients (R) and root mean squared error (RMSE).

Test-retest reliability of the methods during baseline measurements were examined by intra-class correlation coefficient (ICCs) and their 95% confidence intervals (CI).

Responsiveness of the scores from machine learning methods to levodopa effects was assessed by calculating the effect sizes [2].

## Results:

**Validity:** LR was the best performing method when using the fusion of the feature sets (R = 0.95; RMSE = 0.34).

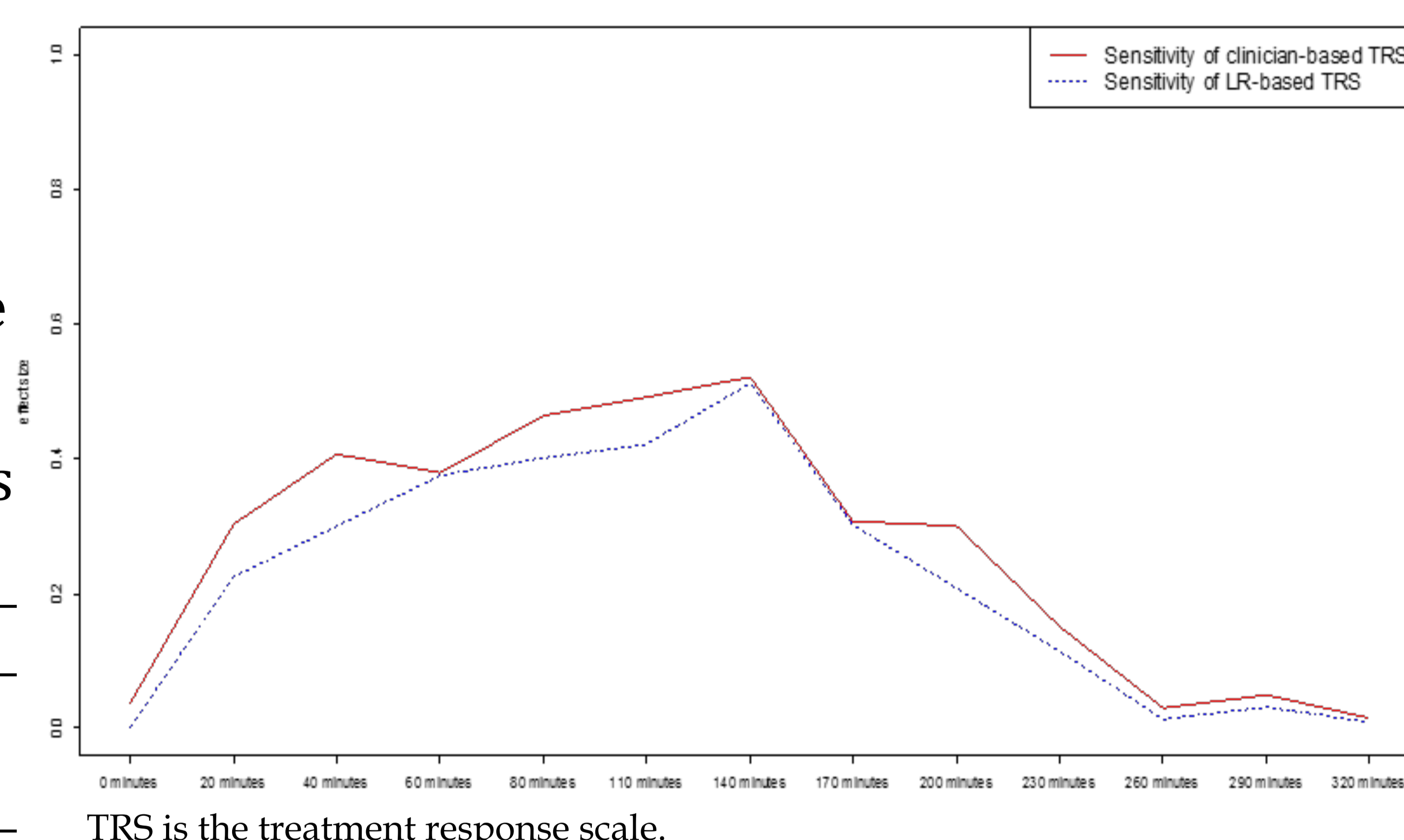
### Test-retest reliability:

	TRS	LR-based scores
ICC	0.82	0.82
CI	0.53-0.94	0.52-0.94

**Responsiveness:** The effect sizes from LR-based scores were responsive to Levodopa treatment changes.

Validity of LR-based method to **other clinical ratings** was further examined.

	UPDRS #23	UPDRS #25	UPDRS #26	UPDRS #27	UPDRS #29	UPDRS #31	Dyskinesia
LR-based scores (R, RMSE)	(0.71; 0.42)	(0.70; 0.46)	(0.73; 0.46)	(0.64; 0.29)	(0.85; 0.29)	(0.89; 0.32)	(0.86; 0.31)



**Classification accuracy** of LR method to separate patients and healthy controls was **84%**.

## Conclusions:

Scores from multi-modal motion sensors:

- Are useful for automatic quantification of Parkinson's disease (PD) motor symptoms severity.
- Can be used to measure the changes in motor symptoms related to Treatment Response Scale.

## References:

- [1] M. Senek, S. M. Aquilonius, H. Askmark, F. Bergquist, R. Constantinescu, A. Ericsson, et al., "Levodopa/carbidopa microtablets in Parkinson's disease: a study of pharmacokinetics and blinded motor assessment," *Eur J Clin Pharmacol*, vol. 73, pp. 563-571, May 2017.
- [2] C. G. Goetz, G. T. Stebbins, K. A. Chung, R. A. Hauser, J. M. Miyasaki, A. P. Nicholas, et al., "Which dyskinesia scale best detects treatment response?," *Mov Disord*, vol. 28, pp. 341-6, Mar 2013.