Signal Identification for Visual Electrophysiology

A comparison of signal analysis techniques and their application to clinical electrophysiology of vision.

Akademisk avhandling

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by

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I. Wright, T., Nilsson, J., Gerth, C., Westall, C. 2008. A Comparison of Signal Detection Techniques in the Multifocal Electroretinogram. *Documenta Ophthalmologica*. 117(2):163-70

II. Wright, T., Nilsson, J., Westall, C. 2011. Isolating Visual Evoked Responses: Comparing Signal Identification Algorithms. *Journal Of Clinical Neurophysiology*. 28(4):404-411

III. Wright, T., Cortese, F., Nilsson, J., Westall, C. 2012. Analysis of multifocal electroretinograms from a population with type 1 diabetes using partial least squares. *Documenta Ophthalmologica*. In Press.

Opponent: Professor Michael Bach, Section Head, Department of Ophthalmology, University Medical Center, Freiburg.

UNIVERSITY OF GOTHENBURG

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A comparison of signal analysis techniques and their application to clinical electrophysiology of vision.

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Aims: The aim of this thesis was to investigate the use of objective methods for the analysis of visual electrophysiological recordings. Specifically can signal identification algorithms identify electrophysiological signals and can they be applied to improve clinical testing and analysis?

Methods: Automated signal identification algorithms were applied to multifocal electroretinogram (mfERG) and visual evoked potential (VEP) recordings. To simulate the types of signal identification problems encountered in the clinical environment, recordings were performed on healthy volunteers then artificially modified to represent the effects of disease. A multivariate analysis, spatial-temporal partial least squares (st-PLS) was applied to mfERGs recorded from a population of patients with Type 1 diabetes.

Results: Signal identification algorithms were able to identify mfERG and VEP responses that had been artificially attenuated. The best performing algorithms outperformed human expert observers at identifying preserved mfERG responses. Application of signal detection algorithms increased the quality and reduced the time for recording VEPs. Metrics of algorithm performance demonstrated that algorithms using more prior knowledge about expected waveform morphology performed better than algorithms that were naive. Changes to retinal function in patients with Type 1 diabetes, measured using the mfERG, were detected using st-PLS analysis. The st-PLS analysis revealed information about the spatial and temporal distribution of these changes that was not revealed using traditional analysis methods.

Conclusions: The application of more advanced analytical techniques can increase the accuracy and decrease the time required for clinical testing. Multivariate analysis techniques can reveal novel information about disease etiology.

Key-words: Visual Electrophysiology, Signal detection, Signal-to-Noise Ratio, multivariate analysis, spatial-temporal partial least-squares

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