SIMULATION OF PSYCHOPHYSICAL STIMULUS SELECTION PROCEDURES FOR DYNAMIC THRESHOLD TRACKING

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Abstract

Stimulus selection procedures are of importance for adequate psychophysical nociceptive threshold estimation. Various stimulus selection procedures were analyzed by means of simulations. Precision, bias, efficiency, and time constants of the various stimulus selection procedures were determined in a simulation model wherein a threshold is tracked. A new adaptive stimulus selection procedure based on stochastic stimulus selection is proposed as a nociceptive threshold tracking procedure.

Keyword(s): biosignals

1 Introduction

Nociceptive thresholds show dynamic changes during noxious events (e.g. clinical interference, disease, or experimental perturbations) [1].

Continuously estimating (i.e. tracking) psychophysical nociceptive thresholds before, during, and after a nociceptive conditioning stimulus might therefore contribute to the knowledge in mechanisms involved in both ascending and descending pathways of the nociceptive system.

Due to fast dynamic changes in nociceptive function, stimulus selection procedures need to be designed such that thresholds can be estimated efficiently, precise and with low bias.

Various stimulus selection procedures have been proposed for estimation of static, but not dynamic, thresholds [2].

2 Objectives

The aim of this study is to analyze various existing adaptive psychophysical stimulus selection procedures and a new procedure based on stochastic stimulus selection for the use in human nociceptive threshold tracking experiments.

3 Methods

A simulation model for psychophysical threshold tracking was implemented in MATLAB. A logistic function was used as a cumulative distribution curve to simulate psychophysical responses.

The model simulates a 15 minute lasting experiment with a predefined psychophysical parameter set. All parameters do not change except for the threshold; between the fifth and tenth minutes, the threshold changes to a different level and subsequently returns to baseline.

During the experiment, the various stimulus selection procedures are used to simulate response patterns. Both the inter-stimulus-interval (ISI) and inter-transition-interval (ITI, timing between a transition in response) remain fixed during all simulation runs.

The simulation is run 5.000 times per stimulus selection procedure to estimate psychophysical threshold tracking behavior.

4 Results

Results show differences in precision, bias, efficiency, and time constants per stimulus selection procedure.

5 Conclusions

Based on the results found in this study, a trade off in adaptive stimulus selection procedure can be made before starting a nociceptive psychophysical experiment including a conditioning stimulus.

A new adaptive psychophysical stimulus selection procedure based on stochastic stimulus selection is proposed as a nociceptive threshold tracking procedure.

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