Simultaneous Assessment of Spinal and Supraspinal Activity during Experienced Pain - An Alternative Approach using Information Theory

By
Federico Arguissain

Pain research in humans has systematically involved the application of different experimental painful stimuli and the assessment of the elicited responses in order to investigate mechanisms of pain processing and the efficacy of treatments. Particularly, applying electrical stimulation to the skin elicits two synchronous electrophysiological responses that reflect spinal and supraspinal sensory processing: the nociceptive withdrawal reflex (NWR) and the somatosensory evoked potentials (SEPs). These responses have been traditionally assessed using features that are measured from the averaged signals across several repetitions of the eliciting stimulus (i.e. across trials). The averaging procedure has been typically applied to reduce the inherent across-trial variability of these two responses with the purpose of improving their signal-to-noise ratios. However, an increasing body of work suggests that across-trial variability should be considered by researchers not as a source of noise, but as a functional property of the nervous system that could index modulatory effects, task performance and different clinical conditions. In this Ph.D. project, the Information Theory (IT) framework is proposed as a viable approach to integrate single-trial data and to characterize signal variability which may be useful to analyze simultaneous spinal and supraspinal responses and to provide more insight about the mechanisms involved in pain processing.

In line with this, the main objectives of the present dissertation were to investigate the feasibility of using single-trial values extracted from both NWR and SEPs and to introduce IT as an alternative approach to assess these simultaneous spinal and supraspinal signals.

Study I assessed the level of agreement between two automatic methods and two human observers in the detection and estimation of single-trial SEP features. Study II, quantified the amount of information about graded electrical stimulation that is carried by NWR and SEP features. Furthermore, the information carried jointly by pairs of these features was also assessed. Study III assessed the modulation exerted by two cognitive tasks over SEPs and the NWR during repeated electrical stimulation. Results emphasized the importance of the selection process of single-trial detection estimation methods within the particular experimental protocol. Furthermore, it was shown that the IT framework can be used to quantify the information carried by NWR and SEP features simultaneously. Finally, it was found that the cognitive modulatory tasks were accompanied by changes in the variability of the NWR and SEPs, and this was reflected by differences in the amount of information they carried over repeated presentations of the stimulus.

In conclusion, the IT framework is an appropriate and promising methodology to quantify the relation between spinal and supraspinal activity in pain research.
Program for Ph.D. lecture on

Wednesday 4 November 2015

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Chairman: Associate Professor Laura Petrini
Moderator: Professor Ole K. Andersen

13.00 Opening by the Moderator
13.05 Ph.D. lecture by Federico Arguissain
13.50 Break
14.00 Questions and comments from the Committee
Questions and comments from the audience at the Moderator’s discretion
16.00 (No later than) Conclusion of the session by the Moderator

After the session a reception will be arranged