

# Electroencephalographic evoked pain response is suppressed by spinal cord stimulation in complex regional pain syndrome

Duarte, Rui; Hylands-White, Nicholas; Beeson, Paul; Mayhew, Stephen; Raphael, Jon

DOI:

[10.1111/ner.12333](https://doi.org/10.1111/ner.12333)

License:

None: All rights reserved

*Document Version*

Peer reviewed version

*Citation for published version (Harvard):*

Duarte, R, Hylands-White, N, Beeson, P, Mayhew, S & Raphael, J 2015, 'Electroencephalographic evoked pain response is suppressed by spinal cord stimulation in complex regional pain syndrome: a case report', International Neuromodulation Society (INS) 12th World Congress, Montreal, Quebec, Canada, 6/06/15 - 11/06/15 pp. e292. <https://doi.org/10.1111/ner.12333>

[Link to publication on Research at Birmingham portal](#)

## **Publisher Rights Statement:**

Eligibility for repository: Checked on 07/12/2015

## **General rights**

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

## **Take down policy**

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact [UBIRA@lists.bham.ac.uk](mailto:UBIRA@lists.bham.ac.uk) providing details and we will remove access to the work immediately and investigate.



# Electroencephalographic evoked pain response is suppressed by spinal cord stimulation in complex regional pain syndrome: a case report

Rui V. Duarte,<sup>1</sup> Nicholas Hylands-White,<sup>2</sup> Paul Beeson,<sup>3</sup> Stephen D. Mayhew,<sup>4</sup> Jon H. Raphael<sup>2,5</sup>

<sup>1</sup> School of Health and Population Sciences, University of Birmingham, Birmingham, UK

<sup>2</sup> Faculty of Health, Birmingham City University, Birmingham, UK

<sup>3</sup> School of Health, University of Northampton, Northampton, UK

<sup>4</sup> School of Psychology, University of Birmingham, Birmingham, UK

<sup>5</sup> Department of Pain Management, Russells Hall Hospital, Dudley, UK

## Introduction

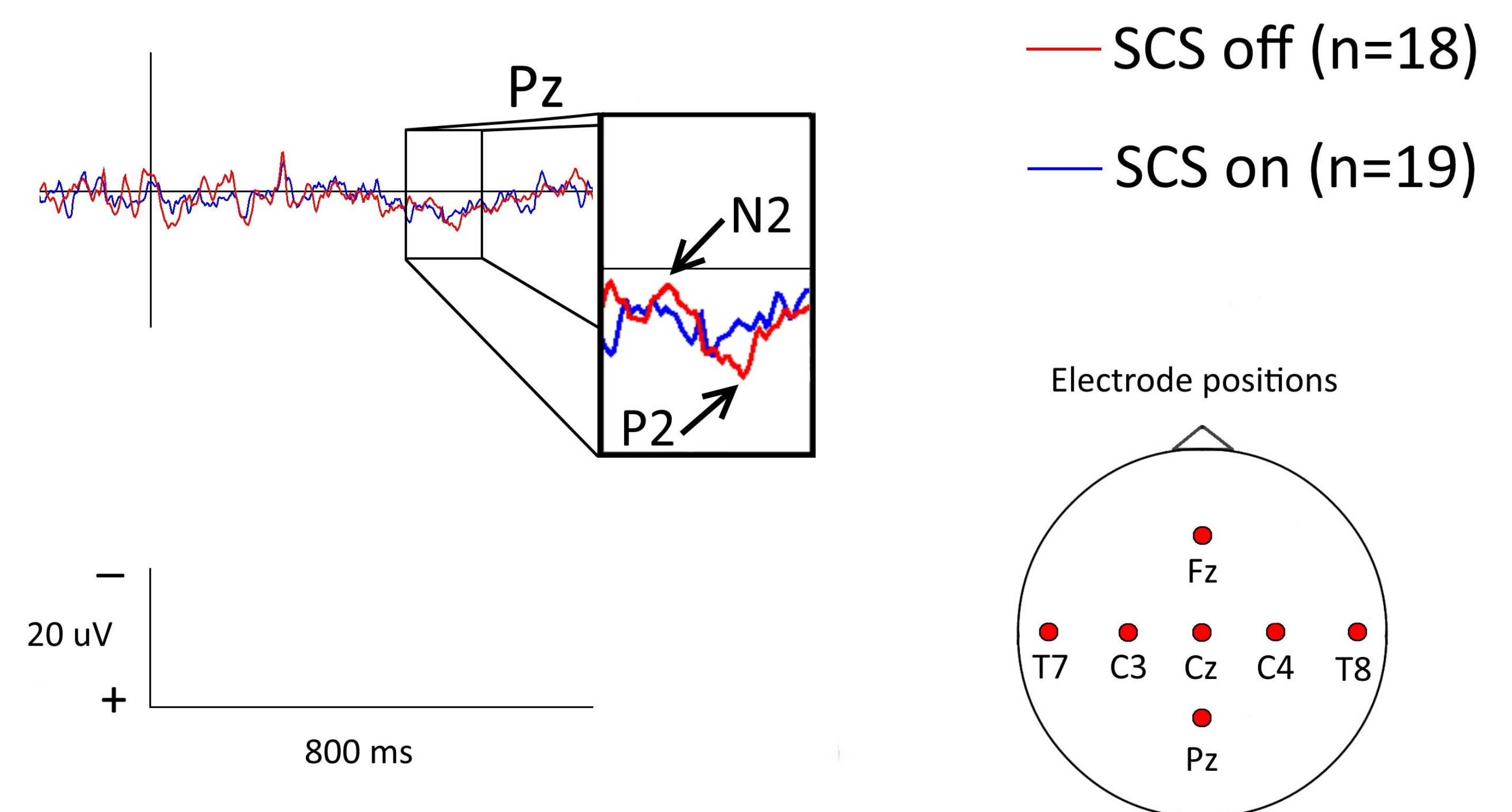
Spinal cord stimulation (SCS) is considered as an option for the management of complex regional pain syndrome (CRPS). Hyperalgesia, an increased pain response to a mechanical or thermal stimulus at normal or increased threshold is a common feature of CRPS. Animal studies have demonstrated that SCS significantly reduces mechanical hyperalgesia. These studies suggest that SCS mechanisms may involve reduction of glial activation at spinal cord level and/or activation of  $\mu$ -opioid and  $\delta$ -opioid receptors. However, in humans it has been observed that SCS had no effect on experimental pain thresholds and did not produce decreased sensitivity for pressure, warmth, and cold induced pain in CRPS patients. The majority of currently available studies on the effectiveness of SCS, including those using quantitative sensory testing (QST) rely on patient reported outcomes such as visual analogue or numerical rating scales. The current case report investigates the effectiveness of SCS based on electroencephalogram (EEG) analysis of contact heat evoked potentials following experimental induction of thermal stimuli.

## Case report

The patient developed neuropathic pain in both hands in 1999, when she was 57 years of age. Investigations included magnetic resonance imaging (MRI) of the brain and cervical spinal cord which found only insignificant minor ischaemic areas of brain and spondylitic changes of cervical spine without nerve compression. The patient was considered for SCS on 11/04/2005 and following a successful SCS trial period ( $\geq 50\%$  pain relief during one week trial) had a permanent system with an octopolar lead placed at C4 and dual quadrupolar leads at T10 implanted on 06/11/2006.

Following ethical approval and informed consent the patient switched off the implantable pulse generator (IPG) the night prior to the test session. We induced thermal stimuli using a quantitative sensory testing system on the right hand of the patient with the spinal cord stimulator switched off and with the spinal cord stimulator switched on. The patient reported a clinically significant reduction in thermal induced pain using the numerical rating scale (71.4% reduction) with spinal cord stimulator switched on.

Analysis of electroencephalogram recordings indicated the occurrence of contact heat evoked potentials (N2-P2) with spinal cord stimulator off, but not with spinal cord stimulator on (Figure 1).



**Figure 1.** Scalp distribution of the effect of spinal cord stimulation on contact heat evoked potentials

## Discussion

A deflection in the waveform which resembles the N2-P2 complex that is characteristic of a contact heat evoked potential was observed when the patient had the SCS switched off. There was no observable evoked potential when the patient had the SCS switched on. It should be noted that due to the small number of stimuli used, the EP is greatly affected by noise. In order to confirm and extend this limited observation, future work would benefit from an increase in the number of stimuli. Here, 25 stimuli were used in each condition, which were further reduced to 18/19 after removal of eyeblink artefacts. By increasing the number of stimuli to  $>40$  the average waveform would benefit from an improved signal to noise ratio, making the presence or absence of an EP more obvious. It is possible that EPs were occurring during the SCS on condition, but were obscured by the presence of random noise, and an increase in the number of stimuli would reveal any EP present in the data. We note that it is important to minimise participant discomfort, especially when the study involves inflicting pain on a person already suffering chronic pain. However, the present case study demonstrates the need for more stimuli, if we are to gather higher quality data in the future.

## Conclusion

This case report suggests that SCS for the management of CRPS may contribute to a decrease in both the subjective perception of thermal pain and the neuronal activity evoked by pain stimuli. Further research is warranted to corroborate these results.