



## Comment on the letter to editor: Closed loop stimulation for tremor was invented in 1980



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### ARTICLE INFO

#### Article history:

Received 1 April 2019

Accepted 2 April 2019

Available online 4 April 2019

#### Keywords:

LFP: Local field potential

DBS: Deep brain stimulation

Closed-loop control

We thank Professors Blomstedt and Hariz for drawing our attention to the pioneering work of Brice and McLellan on tremor in multiple sclerosis [1]. These authors were the first to realise and demonstrate the potential of closed-loop control in Deep Brain Stimulation. Such control adjusts stimulation parameters in real-time based on continuous feedback input signals that reflect the patient's fluctuating clinical state, and has the potential to increase the therapeutic window available to patient and clinician.

There has been a long search for reliable feedback signals for use in closed-loop of Deep Brain Stimulation for Parkinson's disease and essential tremor. Local field potentials recorded from the Deep Brain Stimulation electrode, cortical recordings (electrocorticography), surface electromyography recordings and measurements from wearable sensors have all been assessed. It is likely that all have a place, and the future may see the use of combinations of biomarkers in closed-loop control. Nevertheless, perhaps the signals with the most potential are those recorded directly from the stimulation electrode [2].

Firstly, these signals are recorded without the need for further intervention. The use of cortical strip electrodes introduces further instrumentation, additional cost and the possibility of increased risk of surgical complications such as haemorrhage and infection [3]. The use of surface electromyography or external sensors requires wireless communication between the neurostimulator and sensor. This consumes extra power, and may introduce a potential vulnerability due to breaks in transmission or hacking. Moreover, peripheral feedback signals lag symptoms whereas central signals can anticipate them. In our study, movement intention was detected from thalamic LFPs 300 milliseconds before the onset of voluntary movements triggering tremor [4].

### Conflicts of interest

The authors have no conflict of interest in relation to this commentary.

### References

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