



## Closed loop stimulation for tremor was invented in 1980



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Deep brain stimulation  
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### To The Editor

Parmenides, the pre-Socratic Greek philosopher from the fifth century BC stated: “Nothing comes from nothing”. This idea was also shared by the pioneer of human stereotactic neurosurgery, Ernst Spiegel, who “held the belief that there is nothing that appears in the literature without some precedent in an older article” [1].

It was with great interest that we read the paper of Tan et al. [2] on the potential of implementing a closed-loop stimulation for essential tremor (ET) based on decoding voluntary movements and postural tremor through thalamic Local field potentials (LFP) recorded from the deep brain stimulation (DBS) electrodes. This group has been instrumental in developing closed loop “adaptive” stimulation paradigms for Parkinson’s disease (PD) based on recording through the DBS electrodes the beta activity from the subthalamic nucleus [3–5].

The rationale for their current study on ET was that conventional continuous stimulation may deliver unnecessary current to the brain since tremor mainly affects voluntary movements and sustained postures in ET. They demonstrated that LFPs recorded from the ViM thalamus can be used to detect both voluntary movement and postural tremor, and they stated that their work lay the foundation for developing a closed-loop DBS system which continuously updates the decision on whether to stimulate based on activities recorded directly from the point of stimulation, in order to save battery power and minimise side effects in patients with ET.

It is worth here to remember that this idea of closed loop DBS for tremor was born in Southampton, United Kingdom, seven years before the start of the “modern” era of DBS [6,7]. Neurosurgeon Jason Brice and neurologist Lindsay McLellan published in 1980 in *The Lancet* a paper titled “Suppression of intention tremor by contingent deep-brain stimulation” [8]. They wrote: “Severe intention tremor of the upper limb was suppressed in three patients with multiple sclerosis by stimulation in the contralateral midbrain and basal ganglia with stereotactically placed bipolar electrodes. Permanent electrodes were implanted in two patients.” They used a “Medtronic type 3880” lead placed “in the junction between thalamus and midbrain on each side. The initial target was 20 mm behind the anterior commissure, 6–8 mm below the

intercommisural plane and 10 mm from the midline”, and they stated that “The optimum range of stimulus frequency was 75–150 Hz ...”

The interesting and unique feature of their DBS procedure –which is why they labeled it “contingent” DBS in the title of their paper– was that “To reduce the total amount of stimulation delivered to the patient, the transmitter was controlled by a switching device triggered by electromyographic signals from the deltoid muscle of the appropriate arm. This switched on automatically as soon as the deltoid muscle was activated and switched off 5–7 s after activation ceased. In this way stimulation was given contingently or “on demand”.”

They reported that “striking result has been achieved in the two successful patients by continuing stimulation over the period of observation–to date 6 and 5 months ... The procedure has enabled a totally disabled patient to feed herself, light her own cigarettes, fasten her own buttons, and control bed light and radio. The second patient has achieved control in both limbs, enabling her to use a fork and spoon and to write, wash, and dress herself more easily.” [8].

We are of course aware that Essential tremor (ET) is not multiple sclerosis (MS). On the other hand, the DBS procedure of Brice and McLellan was performed to treat the tremor of MS. Although these forms of tremor have different aetiologies, they do share common features such as being postural and intentional tremors. Indeed, historically, MS tremor has been treated surgically by ventrolateral thalamotomy/subthalamotomy and by DBS in the ventrolateral thalamus/zona incerta.

It is to the credit of Brice and McLellan to have been the first to have had the idea of, and to have implemented with the tools of their time, a physiological closed loop DBS method for controlling postural and intentional tremor “on demand”, i.e. when needed by the patients. For this, they certainly deserve to be remembered.

### Conflicts of interest

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

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