Sir,

We agree with Dr Wernig that enhancement of activity after spinal cord injury can be obtained by mechanical stimulation, electrical stimulation of the skin, reduction of body weight support and enhanced excitability including Jendrassik manoeuvres. Therefore in our study we assessed this excitability continuously. In all four of our research participants with repeated Jendrassik manoeuvres there was no detectable EMG activity below the level of lesion [Supplementary Fig. 2 in Angeli et al. (2014): neck flexion with resistance]. Neck flexion with resistance is one way to induce the Jendrassik manoeuvre and in many individuals with cervical level injury may be the only way because grasping their fingers bilaterally and pulling is not possible due to the severity and level of injury. In addition, when we provided repetitive sensory cues within categories of mechanical stimulation and reduction of body weight support, no increase in EMG activity was observed as was reported by Angeli et. al. (2014). Dr Wernig refers to Supplementary Videos 3 and 4 concluding that these are because of the Jendrassik manoeuvre mechanisms because of their significant exertion. However, when the stimulator is off these same exertions (Fig. 3), as quantified by the EMG activity of the intercostal muscles above the lesion, demonstrate that the Jendrassik manoeuvre alone cannot elicit motor activity below the lesion. Dr Wernig appears to make his conclusions from the video alone. The EMG activity in the figures show discrete movements of the toe and ankle without the ‘seemingly all-or-none multi-joint flexion mass’. In addition, in the flexion and extension leg movements there is alternation of flexor and extensor activity, a feature not observed in Jendrassik manoeuvres as we reported previously with Dr Wernig and thus are very aware of this phenomenon (Maegele et al., 2002).

Dr Wernig suggests that the missing movements of multi-joint flexion without epidural stimulation in the present patients were due to technical reasons including too low effort by the research participants. The evidence demonstrating that the research participants modulated the level of force by activating a selective group of motor neurons while the movement was synchronized auditorily with a tone cue or visually with a sine wave (Figs 4, 6 and 7) is not consistent with the mechanism simply being by modulation via level of ‘effort’ from a Jendrassic manoeuvre. Also, it should be recognized that these experiments were conducted repeatedly with and without stimulation randomly, with the same instructions and by all available measures the same effort was provided by the individuals. It would be highly unlikely that all four individuals would not attempt to move with the stimulator off and be able to do so consistently within the experimental paradigm of randomization, varying of voltage intensities with the stimulator on. Our experience is that these research participants follow our instructions and understand the importance of obtaining unbiased results. In addition, for the months prior to them being able to generate voluntary movement...
they conducted repeated Jendrassik manoeuvres with no EMG activity detected below the lesion and they had no knowledge of the expected result. Also, the time duration for the generation of activity was the same for all experiments. We did allow for delayed responses although we did not show activity beyond the 2 s because it was not one of the main points of the study. While we did not show the data, there was no activity observed at all at longer time points that would be consistent with the Jendrassik manoeuvre response.

Dr Wernig discusses well-known literature related to activity-dependent plasticity (learning) and locomotor training. This publication was not related to locomotion directly. We agree with Dr Wernig that these are important experiments to conduct. We also agree that in this publication our stimulation configuration resulted in little or no direct activation of the ventral motor pools, a condition that would have precluded voluntary control via spinal interneurons. We did monitor Jendrassik manoeuvres extensively. There is no claim in this publication of standing or stepping carrying full body weight support as the report was focused exclusively on voluntary movements of the joints of the legs.

References