Most theories of motor learning are based upon coincident, time-dependent mechanisms of plasticity. However, when investigating motor learning & rehabilitation using TDCS, the temporal parameters of stimulation are particularly non-specific. Typically, 15-20 minutes of stimulation is applied during, and/or prior to, a behavioural task. During this time a number of different behaviours can be performed, not just the behaviour of interest. Despite this, research has shown that TDCS can have relatively immediate effects on neural excitability & firing patterns, even after very short periods of stimulation [1, 2]. We therefore aimed to design a more temporally precise TDCS protocol, whereby event-related TDCS (er-TDCS) is delivered in short ‘bursts’ during specific movements throughout a motor learning task.

Methods & Materials

- TDCS was only applied to movements made during trials with a CCW force-field & associated rightward shift in task display.
- For the M1 & Cerebellar groups, 2mA of anodal TDCS was applied for 1 second, starting at movement onset which was ramped up/down over 1 second during a hold period between trials & a passive return to the home position.
- Sham stimulation was held at 2mA for 10 secs at the start of the adaptation phase, with 10 second ramping periods.
- 60 healthy young adults were pseudo-randomly assigned into either an M1, Cerebellar or Sham stimulation group (n = 20 per group).
- Participants were required to make out-to-in reaching movements during a context-dependent motor adaptation task, where either a clockwise (CW) or counterclockwise (CCW) force-field was applied to their movements [3].
- The CW & CCW fields were always associated with a 10cm leftward & rightward shift in the visual display of the cursor & target respectively, while movements remained in the midline position — creating two distinct learning contexts.

Results

• er-TDCS was only applied to movements made during trials with a CCW force-field & associated rightward shift in task display.

Conclusions

• This result provides initial behavioural evidence that brief periods of TDCS can modulate motor learning, when applied coincidently with movements during a motor adaptation task.
• We propose the temporal coupling between stimulation epochs & movement during the task is important & acts on Hebbian-like plasticity to improve learning.
• Although it is difficult to isolate the exact mechanism responsible for the specific improvement in performance following er-TDCS, it seems likely to be mediated by enhanced time-dependent mechanisms of plasticity (e.g. long term depression) occurring in the cerebellum.

This study highlights new ways in which TDCS may be utilized in research & rehabilitation, with focus on increased temporal specificity.