novel motor performance, whereas TMS-based disruption of SMA would not be so impactful.
Methods: Fourteen right hand dominant subjects performed upper limb reaching trials in two conditions, first during normal robot-mediated reaching trials and second during reaching trials in a novel robot-mediated velocity-dependent force-field. TMS (110% of resting motor threshold) was delivered during movement preparation and targeted to PPC or SMA in separate experiments in the same subjects. Kinematic measures of motor behaviour included movement onset (MO; ms) and summed trajectory error (SUM; m). Values are means +/- standard error and significant differences between PPC and SMA experiments were tested using paired Student t-tests ($p < 0.05$).
Results: SUM was not significantly different in normal reaching between the PPC and SMA conditions (2.7 +/- 0.2 vs. 2.5 +/- 0.2). However, SUM was significantly greater during reaching in a force-field when TMS was applied to the PPC compared to the SMA (4.7 +/- 0.5 vs.3.4 +/- 0.2; $p < 0.01$). MO was not significantly different between PPC and SMA in normal or force-field reaching.
Discussion: These results suggest that disrupting the PPC with TMS during preparation for novel reaching behaviour impairs performance (+74% compared to normal reaching). Disruption of the SMA does not impair novel reaching behaviour as much (+34% compared to normal reaching). The results suggest a greater role for PPC than SMA in novel motor behaviour.
Keywords: Motor control, Robot mediated force-field, Non-invasive brain stimulation

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ELECTROMAGNETIC COMPUTATION AND NEURAL MODELLING TO DETERMINE EFFECTIVE ACTIVATION SITE IN BRAIN CORTEX

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An electric field is induced in the brain cortex by transcranial stimulation using a coil. The electric field applied to the motor cortex can generate an evoked response, which depends on the coil orientation and stimulation intensity. Electromagnetic modelling has been developed to compute the in situ electric field and determine the effect of stimulation parameters [1,2]. Further progress in the understanding of stimulation effects from a microscopic viewpoint is combining electromagnetic computation with neural models [3] that can be used to infer which cortical regions in the brain are activated.
Our aim is to quantify the effect of transcranial stimulation during suprathreshold stimulation, focusing exclusively on direct activation of pyramidal neurons. For that, we implemented a nerve model embedded in a realistic head model. The results show the effective cortical region of stimulation for coil setting delivering a motor evoked potential at motor threshold (Fig 1). The prior knowledge of the activated neuronal structures can be used for planning and dosage control.

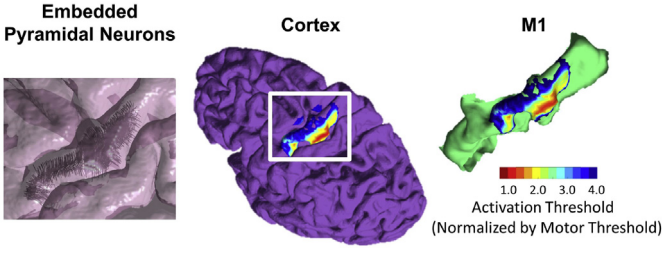

Fig. 1. Effective stimulation region in the brain cortex using multiscale modelling.

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Keywords: Electromagnetic computation, neuronal model, motor area

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PRIMING RTMS IN RESISTANT OBSESSIVE COMPULSIVE DISORDER: IN SEARCH OF A NEW PARADIGM

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Background: Repetitive Transcranial Magnetic Stimulation (rTMS) is used as a therapeutic option for Obsessive Compulsive Disorder (OCD) both in clinical as well as research settings. There have been no consensus with regards to target area and other parameters, though 1 Hz rTMS over Supplementary Motor Area (SMA) is found to be promising. Priming stimulation, which involves high-frequency rTMS followed by low frequency, has been shown to enhance neural response to low-frequency rTMS. As this technique has not been studied in OCD, this randomized sham controlled study was conducted to investigate the effect of adjunctive priming rTMS over SMA in OCD.
Materials and Methods: 30 patients of OCD who were symptomatic after adequate SSRI trial, were randomized into two groups; one group receiving active priming rTMS (G1) and one receiving sham priming rTMS or only rTMS (G2). G1 and G2 received 10 sessions of rTMS with and without priming respectively over 2 weeks. Both rater and patients were blind to the treatment allocation. Assessments were done using YBOCS, HAM D, HAM A and CGI I at baseline, 2 weeks and 4 weeks.
Results: Both groups showed significant improvement in all domains over time. Priming rTMS group was better than rTMS with sham priming in reducing the YBOCS compulsion score ($p<0.023$) as well as scores of HAM A, HAM D and CGI I. None developed any side effects requiring medical attention.
Conclusion: Priming rTMS over SMA is safe and has favorable effects in OCD. It seems to have a predominant effect in reduction of compulsions, presumably rectifying the impaired response inhibition in patients of OCD.
Keywords: Priming, rTMS, OCD, SMA

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CHANGES OF MULTISEGMENTAL RESPONSES OF THE CALF MUSCLES DURING TRANSCRANIAL MAGNETIC STIMULATION AND ELECTRICAL STIMULATION OF PERIPHERAL NERVE

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It was suggested that the multi-segmental responses (MMRs) electrically induced monosynaptic and polysynaptic responses was regulated by the numerous peripheral and descending spinal pathways. The MMRs of m. tibialis anterior (TA) and m. soleus (SOL) evoked by transcutaneous electrical stimulation (tSCS) of the spinal cord at the Th11-12 level were studied in 12 subjects during the transcranial magnetic stimulation (TMS) and the electrical stimulation of the n. ulnaris. The changes in the amplitude of MMRs of these muscles were evaluated in two conditions. The combination of subthreshold TMS (90 % of TA MEPs) followed by tSCS at the intervals 0–150 ms was first condition. And the electrical stimulation of the n. ulnaris (intensity of 3 times bigger than the threshold) followed by tSCS at the intervals 0–150 ms was second experimental condition. The duration of the stimulus during tSCS was 1 ms and the intensity of stimulation was from 30 to 100 mA. The results of the study showed that the average amplitude of the MMRs was increased during the electrical stimulation of n. ulnaris with delays between stimuli from 30 ms and more in both SOL and TA ($p<0.05$). MMRs of calf muscles was facilitated during TMS of 20 ms or more in both SOL and TA ($p<0.05$), according to the central motor conduction time for these muscles, which was 17.2 ±0.3ms in

average. In general, the effect of facilitating MMRs in the application of supraspinal modulation was more obvious for SOL than for TA.
The obtained results demonstrated that the claimed method of modulation of the MMRs during stimulation of the motor cortex (TMS) and n. ulnaris can help in identification of residual descending spinal pathways in patients with spinal cord injury.
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Keywords: transcranial magnetic stimulation,transcutaneous electrical stimulation, spinal cord, neuromodulation

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CLOSED LOOP DEEP BRAIN STIMULATION ENHANCES COGNITIVE CONTROL

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Cognitive control is the ability to withhold a default response in favor of an less habitual, but more adaptive response. Deficits in cognitive control are seen in anxiety, depression, obsessive-compulsive disorder, and addictions. We present a series of experiments demonstrating enhancement of cognitive control in humans. First, we will show results from chronic striatal DBS patients, where stimulation enhances control and pre-frontal theta oscillations associated with control. Second, we will present results from the TRANSFORM DBS closed-loop stimulation program. We will demonstrate a neural decoding framework in which we have replicated the earlier DBS results, built a brain decoding algorithm, and improved control using that closed-loop in n=3 patients to date.
Keywords: cognitive control, EEG, theta, ECOG

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VOLUMETRIC INCREASES IN REWARD CIRCUIT CORRELATED WITH IMPROVEMENT OF ANTICIPATORY ANHEDONIA IN DEPRESSIVE PATIENTS AFTER ELECTROCONVULSIVE THERAPY

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Anhedonia is a core symptom in major depressive disorder (MDD) resulting from maladaptive reward processing. Electroconvulsive therapy (ECT) appears to be an effective treatment for MDD patients resistant to first-line pharmacological treatments. However, no previous neuroimaging studies have assessed whether ECT-induced gray matter (GM) volume changes are specifically related to improvements in anhedonia symptoms. Here we aimed to assess the relationship between right unilateral (RUL) ECT-induced brain volumetric changes and anhedonic symptomatology in patients with treatment-resistant depression (TRD).
We evaluated 15 patients with TRD at two time points (before ECT initiation and after ECT completion) using magnetic resonance imaging (MRI) and clinical scales (i.e., Quick Inventory of Depressive Symptomatology [QIDS] and Temporal Experience of Pleasure Scale [TEPS]). The relationship between anhedonia and GM volume changes was assessed with two independent multiple regressions analyses.
The reduction in depression severity and the improvement in anhedonia between MRI1 and MRI2 assessments were significant. Moreover, anticipatory and consummatory TEPS scores did not differ at baseline, but significantly differed after ECT completion. Importantly, our analyses revealed a positive association between change in the reward anticipation and regional GM volume increases in the right amygdala, the right ventral tegmental area/substantia nigra and the right nucleus accumbens. No significant correlations between GM volume changes and clinical severity reduction were observed.
Overall, our findings are in agreement with the psychological and neurobiological dissociation between anticipation and consumption of pleasures. In addition, our results suggest that ECT induces GM volume increase in core nodes of the reward circuitry, selectively associated with improvement in anticipatory anhedonia but not overall syndromal depression severity. We highlight the importance of a dimensional and circuit-based approach to neuropsychiatric pathophysiology. In this sense, future research should evaluate the neurobiological correlates of particular depression symptoms in order to detect symptom-specific predictive response biomarkers for RUL ECT.
Keywords: Treatment-resistant depression, anhedonia, electroconvulsive therapy, brain morphometry

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HIGHER EFFICACY AND LESS INTER-INDIVIDUAL VARIABILITY IN QPS THAN TBS: HEAD TO HEAD COMPARISON STUDY

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Background: Two distinct protocols of patterned repetitive transcranial magnetic stimulation (rTMS), the theta burst stimulation (TBS) which uses biphasic waveform pulses and quadripulse stimulation (QPS) which uses monophasic waveform pulses, are widely known as effective protocols to induce motor cortical plasticity in humans. However, the interindividual variability of after-effects were also present in both protocols. No data are available concerning the efficacy and the variability comparison between TBS and QPS.
Objective: To compare the efficacy and inter-individual variability between both protocols. We hypothesized that QPS would be more effective and have less variable in comparison to TBS.
Methods: This study directly compared effects between facilitatory iTBS and QPS5 and between inhibitory cTBS and QPS50 in the same 31 healthy participants. Motor evoked potentials (MEPs), measured every 5 min for up to one hour after the intervention, were compared to baseline value taken before the intervention. Interindividual variabilities were categorized to responder, non-responder, and opposite responder based on natural variation responses to sham stimulation from 16 different volunteers (8 sham-TBS and 8 sham-QPS).
Results: One-way ANOVA showed time had significant effects on the size ratio of QPS5, QPS50, and cTBS ($\mathbf{p < 0.05}$). Two-ways ANOVA showed facilitatory effects of QPS5 were greater than those of iTBS ($\boldsymbol{p = 0.036}$), and inhibitory effects of QPS50 were much stronger than those of cTBS ($\boldsymbol{p = 0.001}$). The responder rate of QPS was higher than that of TBS (QPS5 vs. iTBS: 68% vs. 39%, QPS50 vs. cTBS: 77% vs. 42%). Opposite-responder rate was smaller in QPS than TBS (QPS5 vs. iTBS: 3% vs. 10%, QPS50 vs. cTBS: 0% vs. 3%).
Conclusions: The present study confirmed the more effectiveness and less variability of QPS as compared with TBS by head to head direct comparisons between these two methods.
Keywords: TBS, QPS, Transcranial magnetic stimulation, Inter-individual variability

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MOLECULAR AND ELEMENTAL CONTRAST MICROSCOPY FOR BIOCHEMICAL FINGERPRINTING OF THE CELLULAR ACTION MECHANISMS UNDERLYING TDCS IN APPETITE CONTROL

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Transcranial direct current brain stimulation (tDCS) has recently emerged as a novel noninvasive alternative for treating food addiction via modulating cortical excitability. Unfortunately, the action mechanism of tDCS has not been precisely defined as complex neurochemical pathways are involved in its molecular effects, and of particular interest are those related to its relation with energy metabolism in the brain. Recently, it was proposed that tDCS may be associated with increased permeability for ions as well as small and large molecules, thus suggesting the interplay between