Sham TMS – A New Approach

Jens Sommer12, Andreas Jansen12, Michael Deppe1, Caterina Breitenstein12, Stefan Knecht12

1 Dept. of Neurology, University of Münster, Germany
2 IZKF, Münster, Germany

Introduction: Transcranial magnetic stimulation (TMS) is a means to stimulate the human cortex non-invasively. One of the major concerns in TMS experiments is the lack of a good sham (placebo) condition to demonstrate the specificity of the effect. Loo et al. [1] and Lisanby et al. [2] defined the following criteria for a good sham TMS:

1. Stimulation of the cortex should be avoided for sham stimulation,
2. identical coil positions,
3. identical acoustic artifacts, and
4. identical scalp sensations should be attained for sham and verum stimulation.

Here we present an economic solution to maximally fulfill these criteria.

<table>
<thead>
<tr>
<th>Sham Condition</th>
<th>cortex stimulation</th>
<th>Ident. coil positions</th>
<th>Ident. Acoustic artifacts</th>
<th>Ident. Scalp sensations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coil tilted at 90°</td>
<td>Yes (½ of verum)</td>
<td>No</td>
<td>Yes</td>
<td>Sham weaker</td>
</tr>
<tr>
<td>Stm. at different site</td>
<td>Yes (same as verum)</td>
<td>No</td>
<td>Yes</td>
<td>Depends on the alternative stimulation site</td>
</tr>
<tr>
<td>Special sham coil</td>
<td>No (center of coil)</td>
<td>Yes</td>
<td>Yes</td>
<td>Approx. Yes</td>
</tr>
<tr>
<td></td>
<td>Yes (at edges ½ of verum)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special sham coil (Magstim [4])</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Clay complex described here</td>
<td>(1/8 of verum)</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

Methods: Two planar figure-of-eight coils are attached back-to-back (see Fig. 1). Between the coils, a mu-metal shield is inserted and fixed with spacers (2 cm distance from shield to each coil). For verum stimulation, the coil adjacent to the subject’s head is triggered and for sham stimulation the coil facing into the air. To probe the physical properties of this coil complex, we measured the induced voltages (U_{pp}) in a pair of wireloops located in front of the verum coil, for the sham and verum stimulation with and without the mu-metal shield (fixed stimulator output of 40% maximal output).

Results: In Figure 2 the induced voltages for the four conditions are displayed. Without magnetic shield, the ratio of sham to verum stimulation is 1:5. Using the magnetic shield the ratio is reduced to 1:8. There is a slight decrease in stimulation power during verum stimulation with the shield (approx. 20% smaller) as opposed to verum stimulation without shield.

Discussion: Sham TMS is a tradeoff between competing quality criteria. So far, the applied sham conditions accepted a reduced cortex stimulation effect to imitate the sensations of verum stimulation. We here focused on the development of a sham condition with only minor cortex stimulation. This was achieved by using a mu-metal shield between a double-coil arrangement. With two coils of the same type and a rigid joint between them, the acoustic artifacts and the vibrations felt on the skin are nearly identical for sham and verum stimulation. The only criterion not fulfilled is the identical scalp sensation arising from scalp muscle stimulation under verum. However, this can be realized by synchronous electrical stimulation of the skin [5].

Reference List:
5. Okabe S, Ujawa T, Karasawa I. 0.2-Hz repetitive transcranial magnetic stimulation has no add-on effects as compared to a realistic sham stimulation in Parkinson’s disease. Mov Disord 2003; 18(4):362-368.