Robotic assistance in coil positioning improves reliability and comfort

[1,2,3,4]Foucher JR, [2]Lorgouilloux K, [2]Turek J, [2]Pham B-T, [1,2,3]Elowe J, [2,5]Bayle B, [2,5]Renaud P, [2,5]Goffin L, [2,5]Zorn L, [2,5]de Mathelin M, [6]Ginhoux R, [6]Maurin B, [4]Lamy J, [4]Armspach J-P

1 – Strasbourg University Hospital, France, 2 – University of Strasbourg, 3 – INSERM U666, Strasbourg, 4 – LINC, CNRS UMR 7237, Strasbourg, 5 – LSIIT, CNRS UMR 7005, Strasbourg, 6 – Axilum Robotics, Strasbourg, France

Introduction:

In the context of personalized rTMS treatment, coil positioning and monitoring is crucial. Moving it from laboratory to hard working clinical setting might be too much burden for human operators. Robotic assistance could preserve precision without fatigue and a single person could manage several devices. We measured the gain of robotic assistance vs neuro-navigated manual coil placement during MEP mapping in terms of reliability, duration, manipulator and participant feeling.

vs.

Methods:

Ten participants had two 100-positions EMG-recorded MEP sessions with the robot (with and without pre-contraction) and two similar sessions using manual positioning. Five trained operators performed the robotic and the manual sessions of the same subjects. The robot was a prototype from LSIIT and Axilum Robotics. Manual sessions were performed with Brainsight 2 neuronavigation system as positioning assistant and operator was allowed to trigger stimulus based on its own decision.

EMG was recorded on a Keypoint device. Coil position was recorded with a Polaris camera in both settings. None of the operators had any financial interest in any of the companies.

Absolute reliability was defined as the distance between planned and actual positions. Test-retest reliability measured the difference in coil position between the two sessions from the same conditions. Both the participants and the operators evaluated fatigue, easiness and acceptability using visual analogical scales.

Figure 1 **Absolute reliability**
Session with precontraction

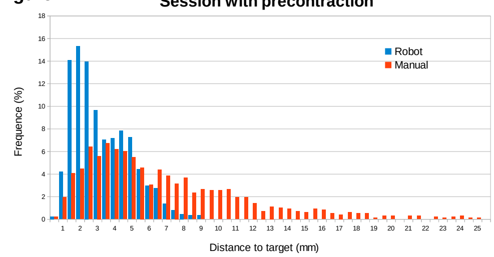
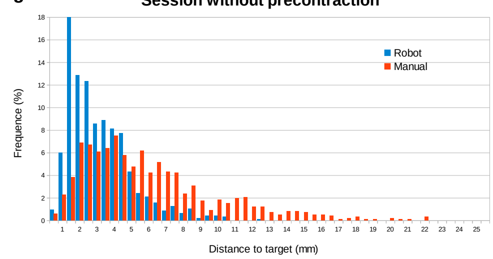


Figure 2 **Absolute reliability**
Session without precontraction



Results:

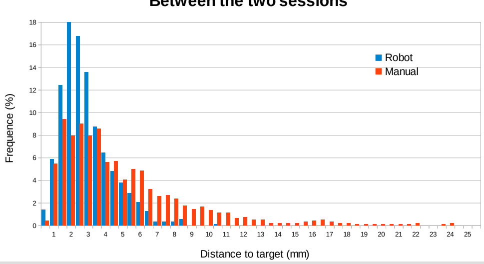
Absolute and test-retest reliability were very significantly improved by robotic assistance (all $p < 0.01$) by a factor of 2 (~3 mm vs ~6 mm). Of special interest was the number of stimulations that were below 5 mm from target: whereas it was as low as 50% in the manual condition, it raised to 90% when the robot controlled coil placement (see table 1 and the histograms on figures 1 and 2). Test-retest showed about the same (see histogram figure 3).

Duration was not significantly different between the two conditions (81 min for both). Participants did not rate one environment as more comfortable, stressful or interesting than another.

	50 %	80 %	90 %	95 %
Robot	3 mm	4,5 mm	5,5 mm	6,5 mm
Manual	5,5 mm	9 mm	12 mm	15 mm

Table 1: Percentage of stimulation bellow a certain distance between coil hot spot and target

Figure 3 **Test-retest reliability**
Between the two sessions



In contrast, the operators rated the robot assistance as less tiring and effortful ($p = 0.04$), more pleasurable and comfortable to use ($p < 0.01$) than manual positioning. Interestingly the difference tends to increase from the first to the second session (with and without pre-contraction).

Discussion:

The purpose of this study was not to demonstrate the superiority of the robotic assistance for performing a MEP mapping. It is not necessary to define targets as a regular grid for this purpose. However test-retest reliability is interesting in this case to look at its evolution in time (post-stroke rehabilitation or post-training effect for example).

The purpose of a good absolute and test-retest reliability is more crucial for multi-session rTMS therapeutic protocols guided by anatomical and/or functional imagery. If we define the requirement of the precision as being better than 5 mm discrepancy, manual placement succeeded only 50% of the time. The robot succeeded in 90% of the time. This value took only account of the hot spot placement, the difference in coil orientation was even much greater in the manual condition (results not shown).

In conclusion, robotic assistance is two times more reliable than manual placement and rated as less tiring by the operators. Regarding the clinical use of personalized rTMS treatment, the robotic placement is definitely essential to avoid operator fatigue when more than one or two sessions are planned per day.

2012 06 21

Correspondence : Dr Jack Foucher - Service de Psychiatrie – Hôpital Civil – 1,Place de l'hôpital – 67000 Strasbourg - France*Jack.foucher@laposte.net*