

EXPLORING THE IMPACT OF DATA AND STATISTICAL METHODS FOR DEFINING SWEET SPOTS IN DEEP BRAIN STIMULATION

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Body: The precise location of the sweet spot (optimal target), for Deep Brain Stimulation (DBS) is still under investigation. Nevertheless, its identification holds significant importance in guiding algorithms for the automatic programming of DBS parameters. Previous studies have predominantly used t-tests and Wilcoxon tests to generate probabilistic stimulation maps. A comprehensive evaluation of both the dataset and the chosen statistical method's impact on the extracted sweet spot from group analysis is lacking. This study aims to compare the outcomes of these statistical tests applied to two DBS datasets with distinct compositions. The data used in this study was obtained from intra-operative stimulation tests on 6 Essential Tremor (ET) patients with implants in the ventral-intermediate nucleus (VIM). Stimulation parameters were used to generate patient-specific electric field simulations, subsequently transformed to a group-specific MRI template. Voxel-wise one-tailed one-sample t-tests and Wilcoxon signed-rank tests were performed to identify voxels significantly associated with tremor improvement exceeding 60% ($p < 0.05$). False Discovery Rate (FDR) correction was applied to mitigate false positives. The significant clusters obtained with the two methods were compared visually and by calculating their total volume, intersection volume, and Dice coefficient. Additionally, validation was conducted by correlating the overlap between the electric field and sweet spot with the improvement observed in the clinic. The same tests were

then repeated on a subset of the data, including only the 50 best configurations per patient weighted by amplitude. The statistical analyses on the complete dataset revealed sweet spots of varying sizes: 28.88 mm³ for the t-test and 58.25 mm³ for the Wilcoxon test. The Dice coefficient between the two was 66%. The significant volume obtained with the t-test was entirely enclosed in the volume extracted with the Wilcoxon test. For the best configurations sweet spot volumes were 567.63 mm³ for t-test and 560.88 mm³ for Wilcoxon, with a Dice coefficient of 99.3%. Stimulations activating the sweet spot were correlated to improvement with similar coefficients between methods but higher when using sweet spots derived from the complete dataset. Users should be conscious of the strong influence that the dataset and chosen statistical method exert on the extracted sweet spot in group analysis. Restricting analysis to optimal parameters leads to inflated volumes undermining the ability to identify high improvement areas. Despite the difference in extracted volumes between the methods, both provided a significant correlation with clinical improvement. Thus, further criteria to inform the method's selection are needed.

Keywords: Deep Brain Stimulation; Sweet Spot; Probabilistic Stimulation Maps.

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