It remains to be seen whether or not the activity in the reward network nodes can be used as a gauge to tune the efficacy of the NFB by adjusting the ergonomic parameters of the feedback signal.

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Нейрофизиологические корреляты эффективного обучения в парадигме нейронной обратной связи

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Аннотация. Широко известно, что группа структур в мозге, отвечающих за оперантное обусловливание, является частью системы вознаграждения, в то время как нейронная обратная связь рассматривается как процесс обучения с подкреплением. В зависимости от эргономических параметров сигнала обратной связи эффективность обучения и интенсивность пластических изменений в мозге может различаться. Можем ли мы определить корреляты эффективного обучения во время записи ЭЭГ и использовать их для того, чтобы настроить эргономические параметры обратной связи? Мы предъявляли испытуемым реальный и ложный сигнал обратной связи и сравнили ЭЭГ, записанную во время этих двух разных условий. Мы обнаружили статистически значимое различие в активации мозговых структур, причастных к процессу оперантного обусловливания.

Ключевые слова: альфа-ритм, обучение с подкреплением, сигнал обратной связи, ложная обратная связь, оптимизация эргономических параметров

TEST-RETEST RELIABILITY OF NTMS MULTI-MUSCLE MOTOR MAPPING

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Abstract. Despite being a routine technique for presurgical assessment, transcranial magnetic stimulation (TMS) mapping is underused for the probing of neuroplastic brain changes. We investigated the test-retest reproducibility of TMS cortical maps of several hand muscles using both standard and alternative parameters of the cortical representation in healthy volunteers. Pilot study results for four healthy right-handed male participants (19–33 y.o.) are presented. Two TMS mapping sessions with stimulation of the left motor cortex were performed within 5 to 10 days (Day1 and Day2). Day2 points repeated an exact order of the Day1 session. For quantitative comparison of the 3D profile similarities, earth mover's distance metrics was used. Analysis of nTMS maps was performed using the custom-made software TMSmap (http://tmsmap.ru). The between-days difference in the area of cortical representation for the four analyzed participants was 14.5–30.4% for one repetition and 3.9–11.2% for five repetitions of each cortical point. Considering the 3D profiles of cortical representation, higher similarity was shown for the same muscles' representations and their overlaps compared to the representations of the different muscles. The study is ongoing, and further analyzed results will be presented as they become available.

Keywords: motor cortex, transcranial magnetic stimulation, functional brain mapping

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Background

Navigated-TMS (nTMS) motor mapping has become a routine technique for presurgical cortical assessment (Picht et al., 2016; Tarapore et al., 2016). However, nTMS mapping to investigate cortical neuroplastic changes during rehabilitation, training or for any other longitudinal research is still limited both in clinical and basic research. This is largely due to the lack of any generally accepted methodology of nTMS mapping (Lüdemann-Podubecká, Nowak, 2016). Thus,

there is no agreement on how many stimulation points and how many repetitions for the each point are necessary and which parameters of TMS maps besides the area are useful for reliable mapping. Moreover, it is not clear to what extent motor maps are reproducible even in healthy participants, which seriously affects the interpretation of dynamic changes with an nTMS mapping approach. In this work, our aim was to investigate the test-retest reproducibility of the nTMS cortical maps of the upper-limb muscles in healthy volunteers using both standard and several new parameters such as the overlap between the cortical representation of different muscles (Nazarova, 2015) and 3D profiles of the cortical motor maps considering the motor evoked amplitudes (MEP) in each point (Raffin et al., 2015).

Method

Here we present the results of the pilot study performed on four healthy right-handed male volunteers (19–33 y.o.). Two TMS mapping sessions with stimulation of the left motor cortex were performed within 5 to 10 days (Day1 and Day2), with an investigation of the cortical representations of three upper limb muscles: the abductor pollicis brevis (APB), abductor digiti minimi (ADM), and extensor digitorum communis (EDC). Sessions consisted of 60–90 points stimulated in a pseudo-random order five times (see Fig. 1). Day 2 points were stimulated in the exact same order as on Day 1. Analysis was performed using the custom-made software TMSmap (http://tmsmap.ru/) (see Fig. 2). For quantitative comparison of the 3D profile similarities, we used earth mover's distance metrics (EMD), the so called Wasserstein metric.

Results

Below we present the initial results. The four analyzed participants demonstrated higher reproducibility of the maps in the case of five repetitions of each point compared to only one stimulation of each point. The difference in the area of cortical representation for Day1 and Day2 was 14.5–30.4% for one stimulation and only 3.9–11.2% for five repetitions, showing that the commonly used

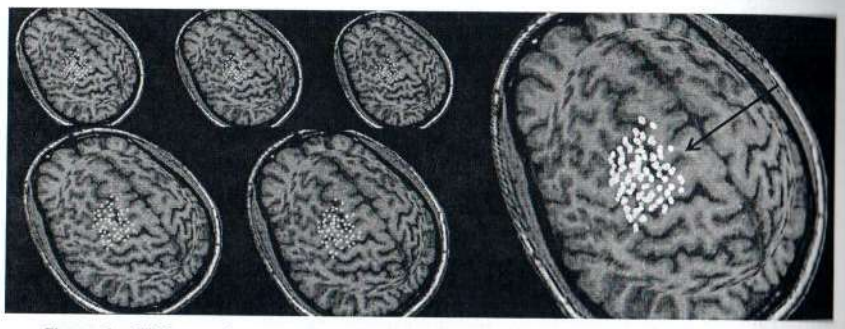

Figure 1. nTMS mapping procedure: 5 sub-sessions in the first mapping day (Day1) constitute the whole session. Five coordinates (x, y, z) and MEP-amplitudes in each target spot related to one node of the grid were averaged (black arrow)

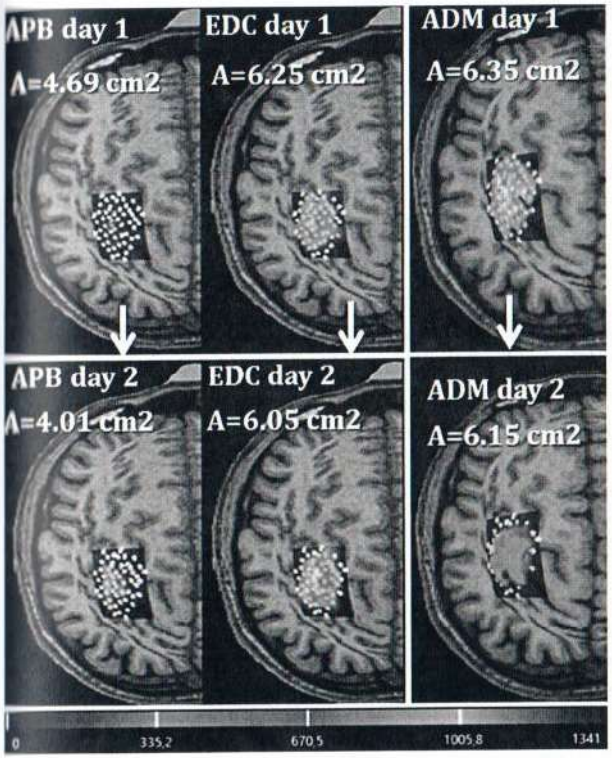

Figure 2. Muscle cortical representations stability from Day1 to Day2 (Subj. 2).

approach for presurgical mapping (one stimulation per site) may be less applicable for longitudinal studies. Considering the 3D profiles of the cortical representations, higher similarity was shown for the same muscles' representations and their overlaps compared to the representations of different muscles based on the EMD metric, reflecting that the 3D profiles of the cortical representation considering MEP amplitudes in each point may be functionally meaningful and not just noise as it was regarded before. The obtained results provide further evidence for the usefulness of the more elaborate metrics such as 3D profiles and the overlaps between muscle cortical representations when estimating the stability of motor TMS maps. More detailed results will be presented in the future.

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Стабильность двигательных корковых репрезентаций при навигационной ТМС моторной коры

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Аннотация. Предхирургическое картирование моторных зон коры с помощью навигационной транскраниальной магнитной стимуляции (нТМС) является на настоящий момент достаточно распространенным клиническим подходом. В данной работе мы исследовали стабильность различных параметров нТМС корковых репрезентаций нескольких мышц руки, включая такие новые параметры как 3D профили ТМС карт и их наложение. Представлены результаты пилотного исследования четырех здоровых добровольцев (19–33 года). Исследование включало две повторные ТМС сессии левой двигательной коры, проведенные с разницей в 5–10 дней (День1 и День2). Анализ проводился с использованием разработанной программы TMSmap (http://tmsmap.ru/). Для количественной оценки 3D профилей использовалась метрика Вассерштейна (earth mover's distance). Предварительные результаты для четырех добровольцев показали большую стабильность стандартных показателей карт при пяти повторениях стимуляции каждой точки по сравнению с единичной стимуляцией. Так, разница площадей корковых репрезентаций для сессий первого и второго дня составила 14.5–30.4% в случае единичного повторения и 3.9–11.2% в случае пяти повторений. Относительно 3D профилей корковых репрезентаций большая схожесть карт День1–День2 (меньшее значение EMD) было показано для репрезентаций одних и тех же мышц и их наложений по сравнению с корковыми картами различных мышц. Полученные результаты подчеркивают важность использования дополнительных параметров для оценки стабильности двигательных ТМС карт.

Ключевые слова: двигательная кора, навигационная транскраниальная магнитная стимуляция, функциональное картирование мозга

VISUAL WORD RECOGNITION DIFFERS IN SILENT READING AND VERB GENERATION TASKS: AN MEG STUDY

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Abstract. Previous studies showed that the brain response to a written word depends on whether the word is a target of a lexico-semantic task or is only read. Here we aimed to examine whether the task that uses the presented word not as the target but a cue to produce another word still modifies its recognition process. Using MEG and magnetic source imaging, we compared the spatio-temporal pattern of the brain responses elicited by a noun cue when it was read silently, either without an additional task (SR) or with a requirement to produce an associated verb (VG). We found that the task demands penetrated into early (200–300 ms) and late (500–800 ms) stages of written word processing by enhancing the brain response under the VG versus SR condition. The cortical sources of the early differential response were localized to the bilateral inferior occipito-temporal and anterior temporal cortices, suggesting elaborate orthographic and lexico-semantic analysis in the VG task. A late effect was observed in the middle and superior temporal gyri and the motor representation of articulators bilaterally and can be associated with enhanced sensorimotor transformations under the VG condition. Overall, our results suggest that written word processing depends on the task goal while intensified linguistic processing recruits bilaterally lateralized networks.

Keywords: visual word recognition, top-down modulations, sensorimotor transformation, speech lateralization, magnetoencephalography (MEG)

Visual word recognition is incorporated in various tasks, from covert reading to overt association production. Previous studies showed that a task's goal modulates the word recognition process. The brain's electrical or magnetic response to a written word differs from around 200 ms after word onset in reading and semantic categorization tasks (Strijkers et al., 2011), in reading and semantic decision