Establishing an EEG paradigm to track correlates of residual inhibition induced by patterned sounds

STSM REPORT

1. Purpose of your mission

The goal of the present STSM was to establish an EEG paradigm to test the effectiveness of different amplitude and frequency modulations on the residual inhibition. The additional goal was to generate and evaluate pilot data.

2. Description of the work carried out during a mission

Since the preliminary description of the paradigm was required prior the beginning of this mission, the efforts were concentrated mainly on the preparation of the following scripts/applications:

1) Tinnitus matching MAX7 application that enables the assessment of tinnitus pitch, loudness and perceived bandwidth.
2) MAX7 application that enables manual adjustment of the MMLs.
3) Matlab script for production of sounds modulated in amplitude.
4) Cogent 2000 (Matlab toolbox) EEG script for sound presentation and sending triggers.

and on the preparation of an equipment (adjustment box, custom midi controller, EEG ports).

We focused exclusively on the amplitude modulated sounds.

The success of the mission depended on the elaboration on experimental set up consisting of two parts, namely behavioral and neurophysiological.

A. Behavioral part

The psychoacoustical (behavioral) part described below was tested in two listeners with tinnitus.

Hearing thresholds (audiometer) were evaluated, dB HL converted to dB SPL and tinnitus matched (see point 2.1). The effectiveness of different frequencies of AM sounds (0 – no modulation, 4, 10, 23, 40, 90 and 250Hz) in obtaining the MMLs (Minimum Masking Levels) was evaluated (see point 2.2). Participants manually adjusted the level of each stimuli "just covering" their tinnitus. Maximal duration of each stimuli matching did not exceed 1min.

We provided some changes into the preliminary paradigm presented in the detailed work plan. Two kinds of stimuli instead of three were tested – tone of tinnitus frequency and white noise. We decided not to include the narrowband noise condition, which was justified by the need to

shorten the experimental session (further comments at the bottom of the "Description of the main results obtained" section).

All stimuli were presented in a random order.

Once the MML was determined, stimuli were prepared to be presented 12dB above the MML (see point 2.3).

B. Neurophysiological part:

Due to changes in the planned dates for this STSM we managed to find only one volunteer that agreed on the participation in the EEG session (potentially also due to holidays), moreover, only for the duration of one hour. Time needed to install the EEG cap (the amplifier BioSemi Active 2, 128 electrodes) reduced availability of this listener to one condition and single presentation of each stimuli (without repetitions). Due to strongly reduced number of trials (7 instead of 42) in the further part of text we refer to the recordings obtained from this participant as the "test EEG recording". The right developed EEG paradigm is described in the "Description of the main results obtained" section.

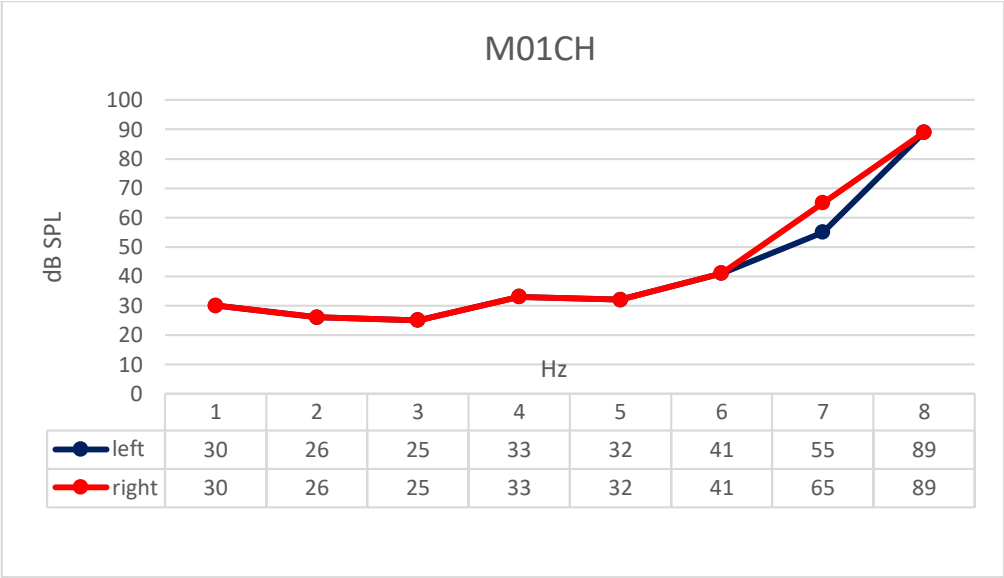
During the test EEG recording each white noise stimuli from the behavioral part was presented diotically (on the individual MML + 12dB) through headphones using custom Cogent 2000 script (see point 2.4). Each stimuli lasted 30s with 15s of silence interval (we reserved 5 last seconds of silence interval to a baseline). Stimuli were presented in a random order.

3. Description of the main results obtained

Two listeners (M01CH and M02CH) took part in the behavioral part of testing. They both had noise-like tinnitus localized "inside the head". Results of tinnitus matching are presented in the Table 1, hearing thresholds in the Figure 1 and the MMLs in the Figure 2.

Table 1
Tinnitus matching – results

ID	TI freq (Hz)	TI level (dB SPL)	TI bandwidth (Hz)
M01CH	3684	49	64
M02CH	15349	73	25



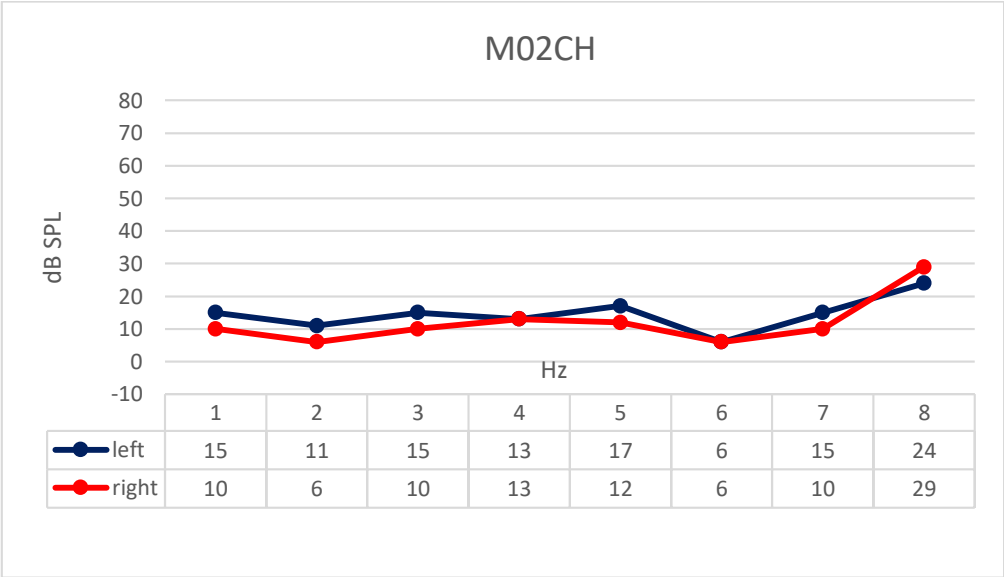


Figure 1. Hearing thresholds for tinnitus listeners (M01CH, tinnitus frequency 3684Hz and M02CH, 15349Hz).

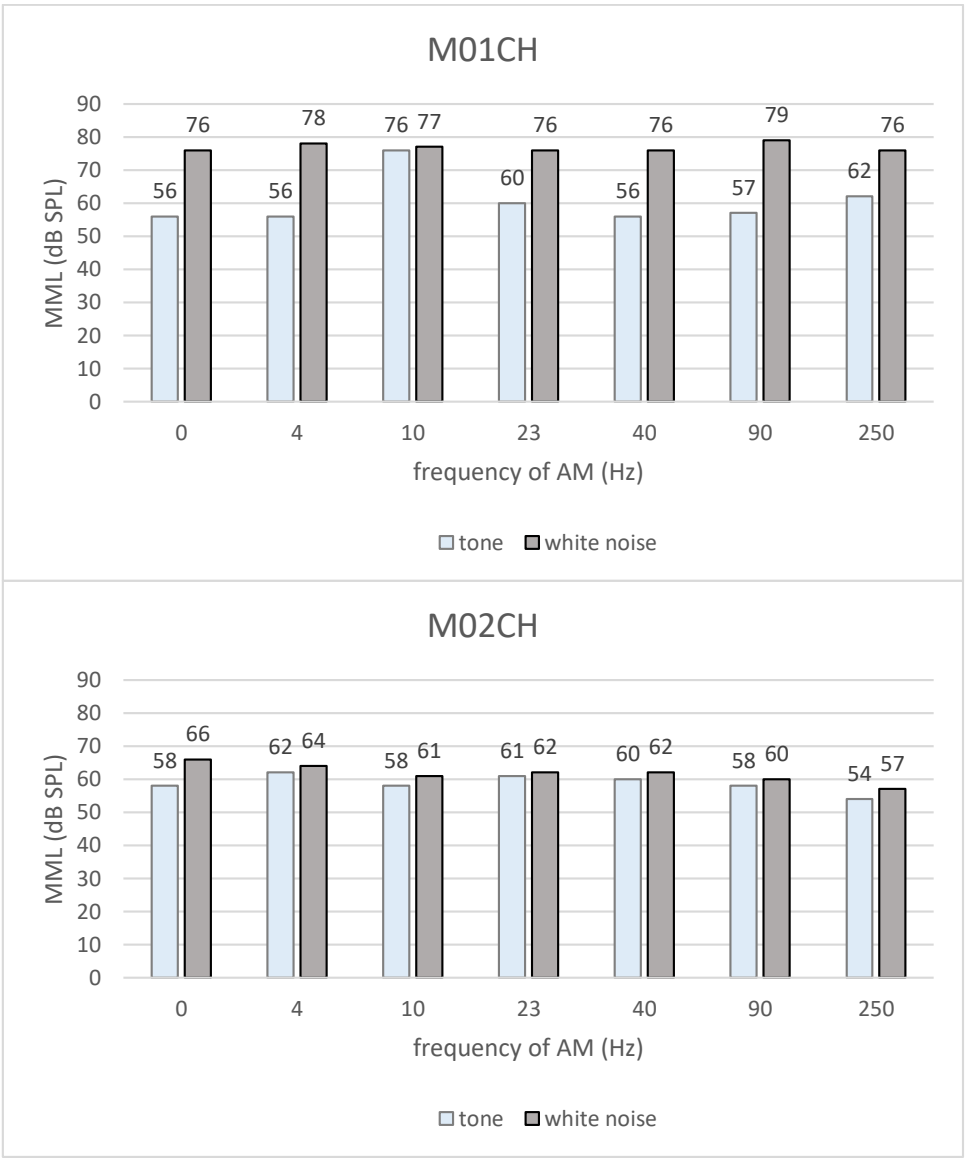


Figure 2. Minimum Masking Levels obtained by two listeners for different types of stimuli and frequencies of amplitude modulation.

The analysis of data obtained only from two listeners does not seem to enable appropriate statistical reasoning. However, visual inspection suggests that:

1) MMLs are not influenced by changes in the frequency of AM.
2) In some cases lower level of tones compared to white noise may be required to obtain MML.

Both observations require further verification on a bigger sample.

During the duration of the mission we managed to collect only one "test EEG recording" (listener M01CH). These data will be analyzed altogether with results of the forthcoming pilot study[1].

MAIN RESULT

The main result of this mission is a paradigm that may potentially enable tracking of the neurophysiological changes following residual inhibition induced by amplitude modulated sounds. It consists of two parts – behavioral and neurophysiological. For the pilot study carried in interested centers we suggest the following:

A. Behavioral part:
   1) Determination of the hearing thresholds (in case of the use of audiometer with respective conversion of the dB HL to dB SPL).
   2) Tinnitus matching (by the means of the MAX7 software and adjustment box).
   3) Determination of MMLs (MAX7) for 14 stimuli (2 types X 7 frequencies of AM).
   4) Generation of amplitude modulated sound files on the MML+12dB (Matlab).

   Time: ~30min.

B. Neurophysiological part:
   1) Recording baseline – 5 minutes with no stimulation (BioSemi Active 2, 64 electrodes).
   2) Presentation in one block 14 types of stimuli (2 types X 7 frequencies of AM, presented 12dB above the MMLs). Block repeated 3 times with small break between repetitions (3-5min). Stimuli duration – 30s, silence interval – 15s (BioSemi Active 2, 64 electrodes, Cogent 2000, Matlab). Participant is focused on the fixation point.
   3) Duration of residual inhibition as a measure of the effectiveness of AM stimuli (space bar press indicating recovery of tinnitus, Cogent 2000, Matlab).

   Time: ~70min (cap preparation + recordings ~45min)

We decided not to include a narrowband noise condition proposed in the detailed work plan, owing to the fact that prolonged stimulation with the stimuli eliciting residual inhibition always holds the risk to abolish/alternate tinnitus perception. Already with 2 types of stimuli we have 32min of presentation. We would prefer to avoid further increment in the duration of experimental session.

On the bigger sample we propose the following analysis:

[1] Recently the applicant obtained a grant from the Institute of Psychology, Adam Mickiewicz University in Poznań to test the proposed paradigm in a form of a pilot study in collaboration with the University and University Hospital of Zurich (CH) and potentially the University Hospital in Regensburg (DE). Comments on the paradigm presented on this and next page are very welcome and will be considered.

1) The dependence of the MML on different frequencies of AM and types of stimuli.
2) The EEG power changes in the standard frequency bands.
3) Comparison of 1) and 2).
4) Facultatively, the EEG analysis in power and connectivity on the sensor (electrode) and source level.

4. Future collaboration with the host institution (if applicable)

We would be more than happy to continue our collaboration. Present STSM is going to find its continuation in the form of a pilot study potentially conducted parallelly in Poznań, Zurich and Regensburg.

5. Foreseen publications/articles resulting from a mission (if applicable)

We hope to prepare a publication based on results from the possible pilot study at the Action and Cognition Lab, Adam Mickiewicz University in Poznań (PL), the University and University Hospital of Zurich (CH) and the University Hospital in Regensburg (DE). Potential enthusiastic results will be presented and the paradigm recommended for the future research.

6. Confirmation by the host institution of the successful execution of your mission

Attached to the email.

7. And other comments (if any).

We would like to truly thank the TINNET Action for the possibility to work together on this project.

Małgorzata Wrzosek