Preparation for EEG measurements

The EEG measurements for an auditory attention decoding (AAD) experiment are carried out using the Smarting mobile EEG amplifier by mBrainTrain and a Windows 10 laptop (provided at the experiment). The software (OpenVibe) has already been setup on the laptop and the protocol given below will already be programmed in it. Your task is only to prepare the audio files required for the experiment.

The raw audio files, given as left and right tracks in table 2, are provided. The final *mixed* audio files which serve as the audio tracks ('stimuli') during the experiment have to be generated by the students.

In each session, we will be recording data for two purposes:

- Data to train/test the AAD in phase 2: these are sequences where the subject is consistently listening to the left or right speaker
- Data for the integration in phase 3: here, the subject switches his/her attention a few times during the recording.

Generation of stimuli

The audio stimuli listened to by the subject are generated by mixing the *left* and *right* audio tracks after filtering them using head-related transfer functions (HRTFs). A HRTF allows to filter an audio signal to create a stereo signal such that –when listening to it through head phones- the signal is perceived to be located ϑ degrees to the left or right of the subject (depending on the ϑ). For more info: see wikipedia.

The HRTFs are provided in a MAT file called **deadroom_ite_hrtfs.mat**. They were measured on a dummy head in an anechoic room using in-the-ear microphones for various angles. Each angle results in two HRTFs: one for the left ear and one for the right ear. This is provided in the MAT file in the columns of the variables **hrtfL** and **hrtfR,** corresponding to the left and right ear respectively. Another variable **source_angles** contains the angles at which the HRTFs were estimated corresponding to each column of **hrtfL** and **hrtfR.**

It is your task to mix the two speech tracks according to the angle of arrival by referring to Table 1. This should result in 4 new stereo .wav-files. **The filenames given to these mixed-signal wav files have to match the names given in Table 1.** The angles mentioned in the table are with respect to 0 degree being the line-of-sight of the subject when (s)he looks straight ahead. Clockwise from this line-of-sight are the positive angles.

While the true angle of arrival is important in the beamforming design in phase 1, here the actual angle of the HRTF does not play a big role as long as one speech signal is perceived to come from the left, and the other from the right[1]. Therefore, to simplify the design and the experiment protocol, the 'left' speaker is positioned at -90 degrees in all cases, and the 'right' speaker is positioned at +90 degrees in all cases, i.e., we do not re-do the experiment for different speaker locations. The main reason why we use HRTFs instead of simply playing the two speakers in different ears, is merely to emulate a realistic sound perception (with crosstalk between both ears) as this has an influence on the brain responses.

[1] You can test this yourself: if you use the HRTFs to create a set-up A with the two speakers at -60/+90 degrees, and a set-up B with the two speakers at -60/+90 or -90/+60 degrees, the perceived difference is hardly noticable.

NOTE: For audio files 3 and 4, the final audio file has to be made by concatenating 2 audio tracks on the left and 2 audio tracks on the right (in the order in which the .wav files appear in the table).

NOTE: While both speakers are perceived to come from different directions (left and right), each stereo channel should still contain a mixture of **both** speakers.

The following table (Table 1) has the details of which tracks were mixed (after HRTF filtering) to make the final audio listened to by the subject.

	Stimulus file name (don't use another name!)	**Left speaker**	**Angle of left track (in deg.)**	**Right speaker**	**Angle of right track (in deg.)**
1	Experiment1_2.wav	part1_track1_dry.wav	-90	part1_track2_dry.wav	90
2	Experiment3_4.wav	part2_track1_dry.wav	-90	part2_track2_dry.wav	90
3	Experiment5.wav	part3_track1_dry.wav & part4_track1_dry.wav	-90	part3_track2_dry.wav & part4_track2_dry.wav	90
4	Experiment6.wav	Part5_track1.wav --concatenate— part6_track1.wav	-90	Part5_track2.wav --concatenate— part6_track2.wav	90

Table 1

EEG-based AAD Protocol

The following table (Table 2) has the details of the EEG experiment during the recording sessions. The experiment is divided in 6 sessions. Each recording session is followed by a small break where the subject has to answer a questionnaire to assess whether the subject attended to the whole of the story (only the first 4 recording sessions). During this break, the audio file and setup configurations have to be modified for the next session.

Recording Session	**Stimuli (Audio listened to by the subject)** Mixing details of these files are in table below.	**Attention**
1	Experiment1_2.wav	L
2	Experiment1_2.wav	R
3	Experiment3_4.wav	R
4	Experiment3_4.wav	L
5	Experiment5.wav	Switching
6	Experiment6.wav	Switching

Table 2