Lab Report: It is only necessary to turn in a report on Sections that require you to make graphs and to give short explanations. You are asked to label the axes of your plots and include a title for every plot. If you are unsure about what is expected, ask the instructor.

1 Sound localization Lab.

1.1 Goal and Background

The specific aim of this lab is (1) to analyze the sound spectrally by use of FFT; (2) to create stimulus/response plots as to analyze how well the subject was able to localize the sounds. In this way, it should be possible to attribute which parts of the frequency domain are relevant for sound localization and for with dimension (azimuth vs. elevation).

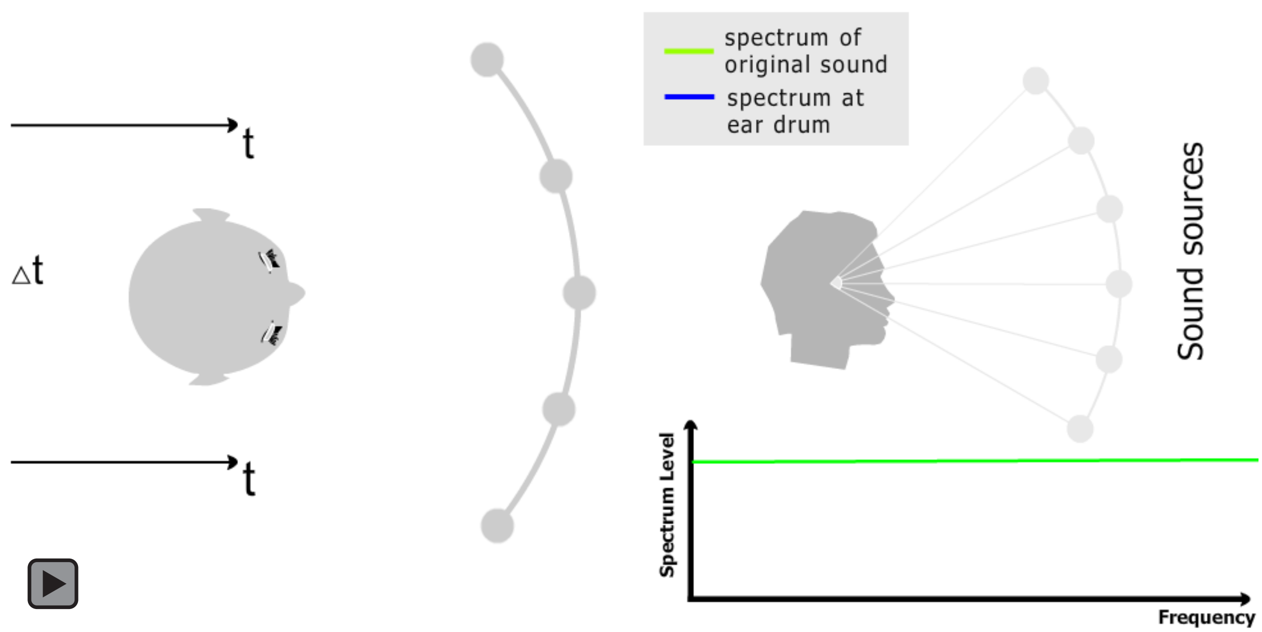


Fig. 1: Three acoustic cues contribute to our ability to localize sounds in space: interaural (between-ear) differences in sound arrival time and level (left) and spectral notches (right). Move your mouse over the panels to see how these cues change with sound direction. A goal of the laboratory is to investigate how these cues are represented within the auditory system. Source: http://www.urmc.rochester.edu/labs/Davis-Lab/projects/auditory_processing_of_sound_localization_cues

Sound localization experiments in humans have revealed that there are three main physical cues o the location of a sound in external space; these are illustrated in the figure to the right. The first two cues arise as a result of the separation of the two ears in space, i.e., sound from one side of the head arrives at the farther ear delayed in time and attenuated in level with respect to that arriving at the nearer ear (Fig. 1, left). These binaural cues are important for left-right (azimuthal) localization. The third cue, spectral information, is created by the filtering properties of the head and outer ear as auditory stimuli propagate to the eardrum (Fig. 1, right). Spectral cues contribute to the resolution of front/back confusions when different sound sources create the same interaural cues, and are critical for accurate localization of elevation in the midline where interaural cues are presumed to reduce to zero.

1.2 Sound localization Experimental Protocol

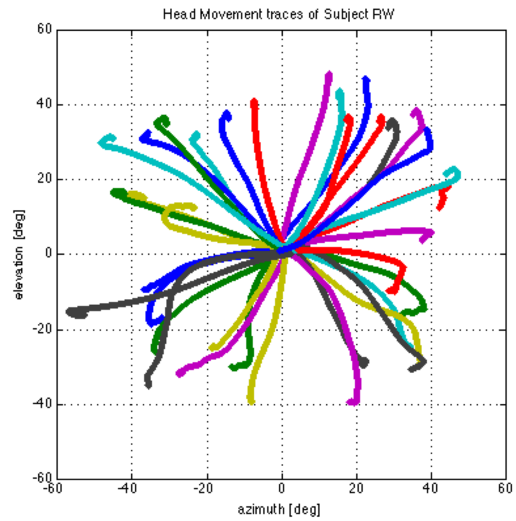
Below you find the enrollment of the experiment as it was performed along with additional information such as the type of sound that was used. Write down in your own words how the experiment was conducted. See for example:
http://www.mbfys.ru.nl/~robvdw/DGCN22/PRACTICUM_2011/LABS_2011/LAB_ASSIGNMENTS/LAB05_CN05/FRENS1995.pdf

```
#################################################################
#
CALIBRATION:
RW-GWN_EYE_CAL.exp
EX_SS-2008-08-14-000.dat   %%%% DATA AQUISITION 500 MSEC


##############################################################
EXPERIMENT:  WHITE NOISE BROADBAND
RW-GWN_111_BB.exp
EX_SS-2008-08-14-001.dat   %%%% DATA AQUISITION 2500 MSEC

EXPERIMENT:  LOW PASS
RW-GWN_110_LP.exp
EX_SS-2008-08-14-002.dat   %%%% DATA AQUISITION 2500 MSEC

EXPERIMENT:  1kHz TONE
RW-GWN_100_1kHz.exp
EX_SS-2008-08-14-003.dat   %%%% DATA AQUISITION 2500 MSEC

EXPERIMENT:  HIGH PASS
RW-GWN_011_HP.exp
EX_SS-2008-08-14-004.dat   %%%% DATA AQUISITION 2500 MSEC
##############################################################
```

Note that EX stands for the initials of the experimenter and SS are the initials of the subject proper.

1.3 Example data

To give you some idea of how to visualize the collected Head movement traces, data of subject RW is shown in response to BB sounds.



1.4 Getting Started:

The Auditory Tool Box

First go to the following web-side:
http://www.mbfys.ru.nl/staff/m.vanwanrooij/doku.php?id=tutorial:saccade_calibration
(see also the auditory toolbox manual (Start at chapter 4 p.20 up to p30).
It is your job to determine the steps that you need to undertake as to analyze the Head movement data that was collect previously. For example, one important aspect is calibration of the raw head trace data along with the subsequent detection of the onset and offset of the specific head movements. Subsequently, the headmovents (head saccades) have to be detected. Finaly head movement data (end point positions) should be related to the Targets that have been presented.

As a starting point you should take the experimental protocol (above). Four different types of sound were used:
snd001BB.wav
snd001HP.wav
snd001LP.wav
snd1kHz.wav

You can find them at:
http://www.mbfys.ru.nl/~robvdw/DGCN22/PRACTICUM_2011/LABS_2011/LAB_ASSIGNMENTS/LAB05_CN05/

After reading the auditory toolbox manual you should be able to recreate these sounds. Write Matlab scriptsthat create these sounds and test them by plotting their Fourier transform.

2 Analyzing the data with the Auditory Toolbox

2.1 Installation

All of the `.m` files and directories in the zip file of the Auditory Toolbox http://www.mbfys.ru.nl/staff/r.vanderwilligen/CNP04/LAB_ASSIGMENTS/LAB05_CN05/auditory_toolbox.rar should be copied into a single directory whose name is then added to the MATLAB path. For this you should write something like:

```
disp('Startup from auditory toolbox');
addpath( ...
    genpath(fullfile('/','MICELENEOUS/LOCALIZATION_LAB_2011/auditory_toolbox/')), ...
    genpath(fullfile('/','MICELENEOUS/LOCALIZATION_LAB_2011/PRATICUM_2008/')));
```

The name of the directory does not matter "**auditory_toolbox**" will suffice. The location of the directory is also immaterial: the only requirement is that it can be accessed by MATLAB. Also notice that you should add the data directory (i.e., the .log / .dat and .csv files). The data can be found at:

http://www.mbfys.ru.nl/staff/r.vanderwilligen/CNP04/LAB_ASSIGMENTS/LAB05_CN05/PRATICUM_2008/DAT/

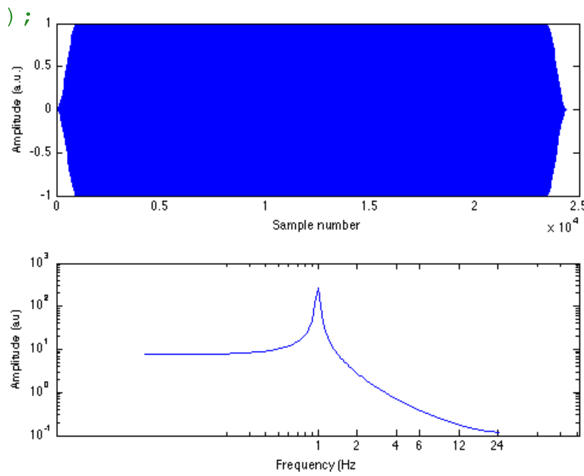
or

http://www.mbfys.ru.nl/~robvdw/DGCN22/PRACTICUM_2011/LABS_2011/LAB_ASSIGNMENTS/LAB05_CN05/PRACTICUM_2011/DAT/

2.2 Creating and Analyzing the Sound stimuli

Write your own Matlab scripts that create the sound used in the experimental protocol. Below an example script is given with aid of the `gentone` function of the auditory toolbox.
Note: verify with FFT that the frequency spectrum is correct.

```
%%  GENTONE   GENTONE GENTONE

% GenerateTtone Stimulus
%
% STM = GENTONE (<N>, <Freq>, <NEnvelope>, <Fs>, <grph>)
%
% Generate a sine-shaped tone, with
% N         - number of samples                [7500]      samples
% Freq      - Frequency of tone                [2000]      Hz
% NEnvelope - number of samples in envelope    [250]       samples
%              (head and tail are both 'NEnvelope')
% Fs        - Sample frequency                 [48828.125] Hz
% grph      - set to 1 to display stuff        [0]

dur=500; %%%[msec]
%%%NUMBER OF SAMPLES
%%%%%length(Sine3000)*((1/48828.125)*1000)
Fs=48828.125;
N=dur/((1/Fs)*1000);
Fsig=1000;  %%% SIGNAL FREQUENCY
Ramp_duration= 20; %% in [msec]
N_Ramp=ceil(Ramp_duration/((1/Fs)*1000));
Sine1000 = gentone(N,Fsig,N_Ramp,Fs,0.99);
Nzero = zeros(1,978);        %20 msec / ((1/Fs)*1000) %This will create a
vector with 978 zeros
Sine1000 = [Nzero Sine1000]; %This ?prepends? the zerovector to the Noise

%%wavplay(Sine1000,50000); %%%% WINDOWS ONLY
sound(Sine1000,50000);
%writewav(Sine1000,'snd001kHz.wav');
```



2.3 Calibration and Data Plotting

In this lab you have to use a script that allows you to display the raw or calibrated head movement traces.

The script PRACTICUM_ANALYSIS_LOCALIZATION_LAB_V2.pdf contains Matlab code that allows you to calibrated the head movement data and perform subsequent analysis. Several important stages within in this [raw-data to calibrated and sorted-data] process are highlighted.

Provide a list of all the necessary steps needed to the [raw-data to calibrated and sorted-data] process. You can find them in the script: PRACTICUM_ANALYSIS_LOCALIZATION_LAB_V2.pdf. Or see Appendix A below.

Loading & Displaying Headmovement traces from .mat files:
Make a time trace or off-set plot, i.e., similar as the trace plot (above) but now as function of time. Show the target positions in the figure plot of the sounds in terms of azimuth and elevation.

```
%%%%% loadraw ENABLES TO PLOT CALIBRATED DATA (.hv files)
cd '/MICELENEOUS/LOCALIZATION_LAB_2008/PRATICUM_2008/DAT/';
[filename,pathname]   = uigetfile('*.csv','Calibrationfile');

    csvfile                     =   fcheckext(filename,'csv');
    [expinfo,chaninfo,mLog]     =   readcsv(filename);

    Nsamples                    = chaninfo(1,6);
    Fsample                     = chaninfo(1,5);
    Ntrial                      = max(mLog(:,1));
    StimType                    = mLog(:,5);
    StimOnset                   = mLog(:,8);
    Stim                        = log2stim(mLog);
    NChan                       = expinfo(1,8);

cd '/MICELENEOUS/LOCALIZATION_LAB_2008/PRATICUM_2008/DAT/'
[h,v]=loadraw('AF_RW-2008-17-11-001.hv',2,Nsamples);
```

2.4 Determination of Localization Ability of the Subject

Your final task for this lab is, after calibrating the .dat files to write a script that produces plots like these:

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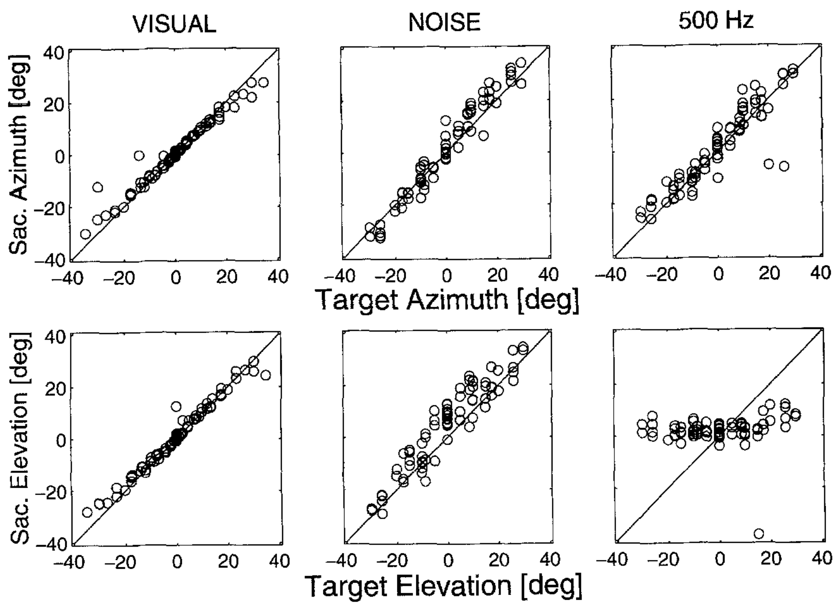
Fig. 2 Accuracy of primary saccades. End-point azimuth (*top*) and elevation (*bottom*) of primary saccades to targets in the two-dimensional frontal plane (see Materials and methods) are shown as a function of target azimuth and elevation, respectively. Data are from subject M.F. *Left* Visually directed saccades, *centre* saccades towards broad-band noise targets (500 ms), *right* saccades towards a 500-Hz tone. The latter data are typical for all tone responses, apart from the mean value of the saccade elevation components (see also Fig. 3)



For this you need the Matlab code as shown on the opposite page. Also provide a valid statistical analysis with which you objectively can test these stimulus/response plots. Remember this analysis is about correlating end point positions (offset) of the head orienting responses (trace) with the stimulus positions of the sounds in terms of azimuth and elevation.

Examine the following code:

```
%% Load the matfile(s)
clear all
close all
[filename,pathname]   = uigetfile('*.mat','Choose a matfile','MultiSelect','on');
if ~ischar(filename) && ~iscell(filename)
    error('No data to read')
end
Fsample = 1000;
Mod = 1;    % Modality (0 = LED, 1 = Sound,4 = Sky)

if ischar(filename)
    load ([pathname filename])
    SupSac = supersac(Sac,Stim,Mod,1,Fsample);
    Windowheader = [filename(4) filename(5)];
else
    Sachuge = [];
    for i = 1:size(filename,2)
        load ([pathname filename{i}])
        SupSac = supersac(Sac,Stim,Mod,1,Fsample);
        Sachuge(size(Sachuge,1)+1:size(Sachuge,1)+size(SupSac,1),:)     = SupSac;
    end
    SupSac = Sachuge; clear Sachuge;
    Windowheader = cell2mat(filename(1));
    Windowheader = [Windowheader(4) Windowheader(5)];
end



SupSac(:,5) = SupSac(:,5)-20;   % Correct for 20 ms header in sound files
ind = find(SupSac(:,5) < 150);  % Find and remove responses which are to fast to
prevent dynamic information.
SupSac = removerows(SupSac,ind);
```

This should allow you to create plots similar to the ones shown on the previous page.

APPENDIX A.

Code required to perform the [raw-data to calibrated and sorted-data] process:

```
%% Cleaning Up / Make sure that Matlab is mounted to the auditory toolbox files.
%% see example below.
clear all
clc;
close all
home;
disp('>>MWs Version<<');

disp('Startup from auditory toolbox');
addpath( ...

genpath(fullfile('\\','Plus.science.ru.nl\mbaudit1\MATLAB_STUFF\auditory_toolbox\')),
...

genpath(fullfile('E:\','PROJECTS2008\COLLEGE_PRAC_2008_2009\LOCALIZATION_LAB_2008\PRATIC
UM_2008\')));

cd 'E:\PROJECTS2008\COLLEGE_PRAC_2008_2009\LOCALIZATION_LAB_2008\PRATICUM_2008\DAT'
%%%path
```

```
%%
%%%% READING EXP PARAMETERS FROM CSV FILE (IN DAT DIRECTORY) with readcsv
% cd 'E:\PROJECTS2008\COLLEGE_PRAC_2008_2009\LOCALIZATION_LAB_2008\PRATICUM_2008\DAT\';
% [filename,pathname]   = uigetfile('*.csv','Calibrationfile');

files=dir('AF_RW*-000.csv');

    csvfile                         =   fcheckext(files(1).name,'csv');
    [expinfo,chaninfo,mLog]         =   readcsv(files(1).name);
    Nsamples                        = chaninfo(1,6);
    Fsample                         = chaninfo(1,5);
    Ntrial                          = max(mLog(:,1));
    StimType                        = mLog(:,5);
    StimOnset                       = mLog(:,8);
    Stim                            = log2stim(mLog);
    NChan                           = expinfo(1,8);
```

```
%%
%%%% LOAD RAWDATA from DAT file
files=dir('AF_RW*-000.dat');

        datfile=files(1).name
        data = loaddat(datfile,NChan,Nsamples);

        horE = data(:,:,1);
        verE = data(:,:,2);
        froE = data(:,:,3);
        trig=data(:,:,4);
        horH = data(:,:,5);
        verH = data(:,:,2);
        froH = data(:,:,3);

        mhorE=mean(horE);
        mverE=mean(verE);
        mfroE=mean(froE);
        mhorH=mean(horH);
        mverH=mean(verH);
        mfroH=mean(froH);


        figure(3)
        plot(mhorE,mverE,'x')








%%
```

```
%%%% CALIBRATION WITH TRAINCALtraincal('AF_RW-2008-17-11-000')


%%
%%%% calibrate USES WEIGHT SETTINGS OF TRAINED NNET TO CALIBRATE .DAT FILE DATA
% % % % % % % USE .net file to calibrate RAW DATA
% % % % % % %
% % % % % % % calibrate('LH_RW-2008-01-21-003.dat','LH_RW-2008-01-21-000.net')
% % % % % % %

calibrate('AF_RW-2008-17-11-001.dat','AF_RW-2008-17-11-000.net')


%%
%%%%%% hvfilt LOW_PASS FILTERING
% % % % % % % USE hvfilt to low_pass filter de Calibrated HV data
% % % % % % %
% % % % % % % hvfilt('LH_RW-2008-01-21-001.dat';'LH_RW-2008-01-21-002.net';'LH_RW-2008-01-21-003.dat';'LH_RW-2008-01-21-004.net';'LH_RW-2008-01-21-005.dat')
% % % % % % %



%hvfilt(['LH_RW-2008-01-21-001';'LH_RW-2008-01-21-002';'LH_RW-2008-01-21-003';'LH_RW-2008-01-21-004';'LH_RW-2008-01-21-005'])


%%
%%% DETERMINE EXPERIMENTAL PARAMETERS e.g., onset/offset sacccade; reactiontime etc
ultradet('AF_RW-2008-17-11-001.hv');


%%
%%%%% loadraw ENABLES TO PLOT CALIBRATED DATA (.hv files)
cd 'E:\PROJECTS2008\COLLEGE_PRAC_2008_2009\LOCALIZATION_LAB_2008\PRATICUM_2008\DAT\';
[filename,pathname]   = uigetfile('*.csv','Calibrationfile');

    csvfile                    =   fcheckext(filename,'csv');
    [expinfo,chaninfo,mLog]    =   readcsv(filename);

    Nsamples                   = chaninfo(1,6);
    Fsample                    = chaninfo(1,5);
```

```
    Ntrial                            = max(mLog(:,1));
    StimType                          = mLog(:,5);
    StimOnset                         = mLog(:,8);
    Stim                              = log2stim(mLog);
    NChan                             = expinfo(1,8);

cd 'E:\PROJECTS2008\COLLEGE_PRAC_2008_2009\LOCALIZATION_LAB_2008\PRATICUM_2008\DAT\'
[h,v]=loadraw('AF_RW-2008-17-11-001.hv',2,Nsamples);

figure(10)
plot(h,v,'.')
%plot(h(end-100:end,:),v(end-100:end,:),'x')

hr=[];
for i=1:1:61
    dd=h(i);
hr(i)=sqrt(     1/61*sum(dd'.^2)              )
end
mean(hr)



%% use sactomat to CREATE .MAT FILES
sactomat('AF_CM-2008-08-14-002.hv','AF_CM-2008-08-14-002.log','AF_CM-2008-08-14-
002.sac')

%% Load the matfile(s)
clear all
close all
[filename,pathname]   = uigetfile('*.mat','Choose a matfile','MultiSelect','on');
if ~ischar(filename) && ~iscell(filename)
    error('No data to read')
end
Fsample = 1000;
Mod = 1;    % Modality (0 = LED, 1 = Sound,4 = Sky)

if ischar(filename)
```

```
    load ([pathname filename])
    SupSac = supersac(Sac,Stim,Mod,1,Fsample);
    Windowheader = [filename(4) filename(5)];
else
    Sachuge = [];
    for i = 1:size(filename,2)
        load ([pathname filename{i}])
        SupSac = supersac(Sac,Stim,Mod,1,Fsample);
        Sachuge(size(Sachuge,1)+1:size(Sachuge,1)+size(SupSac,1),:)     = SupSac;
    end
    SupSac = Sachuge; clear Sachuge;
    Windowheader = cell2mat(filename(1));
    Windowheader = [Windowheader(4) Windowheader(5)];
end



SupSac(:,5) = SupSac(:,5)-20;   % Correct for 20 ms header in sound files
ind = find(SupSac(:,5) < 150);  % Find and remove responses which are to fast to prevent
dynamic information.
SupSac = removerows(SupSac,ind);
```