A new approach to the objective assessment of HPD performances in the field

Jeremie Voix, Jean Zeidan, Alexandra Cloutier

February 17, 2005

Presented at the NHCA 30th Annual Conference, February 24-26, 2005, in Tucson, AZ

Abstract

To objectively assess the real field performance of a new type of inflated custom earplugs, a measurement device and the corresponding predictive method have been developed. This objective measurement is performed a first time right after the earplug has been fitted ("Post-Curing Test") and a second time after the earplug has been removed and replaced by the user himself ("Subject-Fit Test"). The evolution -over time- of those Subject-Fit values has been studied carefully and it was found that this method not only allows the prediction of field performance but is also an effective training mechanisms to assist in fitting and insertion of the earplug.

1 Introduction

The NIOSH raised the need of the development of objective measurements devices to assess the real "field" performances of HPD. In this aim, a new objective measurement device has been developed to predict the attenuation experienced by the wearer from an objective Noise Reduction measurement(SoundPressure Level Difference) performed using a dual microphone probe placed in the HPD. The HPD is of a particular type: it is a custom inflated earplug (...). Therefore two objective measurements are performed: a so called "post-curing" test and a "subject fit" test. The first one is performed right after the earplug injection silicone has cured and usually leads to high values of attenuation since the earplug is optimally placed in the wearer's earcanal. The second one occurs once the curred earplug has been removed and replaced by the subject itself (a so called "subject-fit" method). The results obtained from both measuremts are compared to assess the validity of the subject-fit placement. This paper will present the results of a preliminary study on the evolution over time and usage of the "subject-fit" values achieved by a wearer in the field. It will show that the ideal "post-curing" value tends to be reached in a very short period of time, which validate also this objective measurement technique for field performance prediction as well as for.

2 Reinsertion Test Methodology

Five (5) subjects selected among the ÉTS employees and students were chosen for this study. These subjects have normal hearing for all the frequencies and inter-frequencies between 125 and 8000Hz which means that their hearing threshold are at 15dBHL maximum for the frequencies between 125Hz and 1500Hz and 25dBHL maximum for the frequencies between 2000Hz and 8000Hz. Their hearing thresholds were tested in the acoustic laboratory of the ÉTS, Montreal with an audiometer AC 40 (SN.).

The study was taken place in the Training room of the company Sonomax Hearing Healthcare in Montreal between July 28th and August 5th 2004. The subject had to complete the Implementation Questionnaire prior to his participation to the study. Afterwards, a visualization of their ear canals was done with a pocket otoscope to make sure that the otologic condition of the subject was conformed to the Sonomax implementation rejection criteria.

The subject was then fitted with a pair of SonoCustoms which are Sonomax intra-auricular hearing protectors. After the curing of the hearing protectors, SonoPass, a software provided by Sonomax, was used with an hardware composed of a speaker and a microphonic probe made of an external microphone (reference) and an internal microphone (measurement) to test the protectors. During the test, the speaker generated a pink noise at 84dBA and the microphonic probe inserted in the a hole crossing the protector measured the differences between the noise heard by the reference microphone and the noise heard by the measurement microphone close to the tympanic membrane. This test was done one ear at the time.

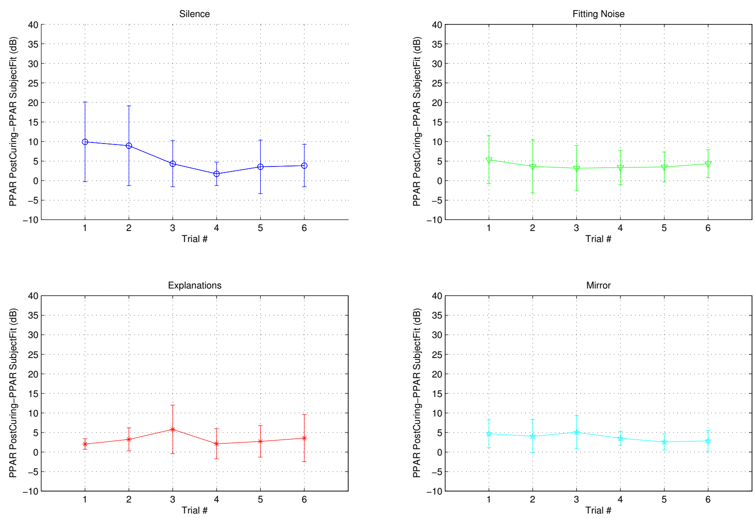
A first test at each ear was performed after the curing while the subject was still wearing his protectors. After this test, he was asked to remove his protectors and a visual inspection of them was made. If the test had given sufficient results and the confection of the protectors seemed to be correct, the subject was starting the protocol of the study.

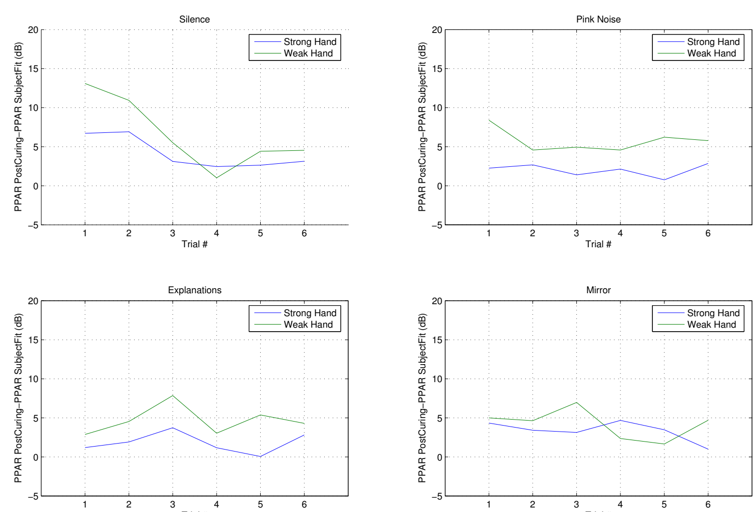
At first, the subject was asked to clean his ears and his protectors from the lubricant used during the fitting of the protectors with a tissue. The subject had to insert his protectors without any help or comments in a silent condition. Then the subject was asked if the reinsertion was easy or not. If not, another lubricant was offered to the subject. When he was done with the reinsertion, the test described above was performed. After the test, the results were written down and the subject was asked to remove his protectors. With the possibility to use the lubricant at any time, the subject was asked to reinsert his protectors in a silence condition and then the protectors were tested again. This part of the study was repeated 6 times for both ears.

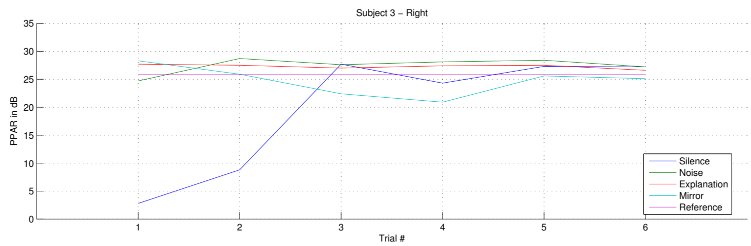
Afterwards, the subject was asked to reinsert his protectors while the noise used during the tests was on. Tests for each ear were performed after each reinsertion. This part of the study was repeated 6 times. The same procedure was performed in two other conditions which are: Reinsertion after a training on how to reinsert them and while the noise used during the tests was on. Reinsertion in front of a mirror while the noise used during the tests was on.

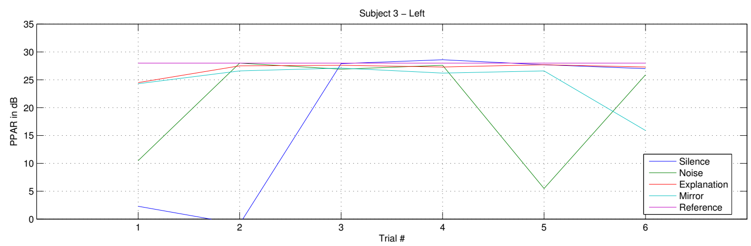
3 Results

The essential results are presented in the figure below.









4 About the authors

4.1 Jeremie Voix, P.Eng., M.A.Sc.

Jeremie Voix is an Acoustics Engineer with field experience in industrial noise reduction projects. He holds a Bachelor of Fundamental Physics from University of Lille (France) and a Master of Applied Sciences in Acoustics from Sherbrooke University (Canada). Jeremie is Director of Research and Chief Scientist of Sonomax Hearing Healthcare Inc (Montreal, Canada). He also is currently finishing his Ph.D. at the University of Quebec (Montreal, Canada).

4.2 Jean Zeidan, M.Sc.

Jean Zeidan holds a Master Degree in mathematics and statistics. He has 23 years of experience in the otologic field and contributed to various scientific publications and articles relating to hearing conservation programs in industry. Jean is in charge of the statistics of Sonomax Hearing Healthcare Inc (Montreal, Canada).

4.3 Alexandra Cloutier, MPA.

Alexandra Cloutier received a MPA in Audiology in 2004 from the University of Montreal. As a Master Degree candidate, Mrs. Cloutier conducted a research project entitled: Influence of Individual Hearing Protection on Voice Level Control with the use of the Sonomax Solution. In addition to her research work, Mrs. Cloutier worked into the Sonomax Implementation Department contributing to software development, product testing, documentation, training, and technical support exercises.

Educational Audiologist; Montreal Oral School for the Deaf; 5851, Chemin Upper Lachine;

Montreal, Qc; H4A 2B7; Canada

5 Appendix

5.1 Script used for analysis

```
%
% Programme de reinsertion
%
close all
clear all
clc
load reinsertion
%
% description de la matrice reinsertion
%
% la matrice reinsertion contient 6 matrices representant les sujets
% 1,2,3,4,5 et 6 . La matrice sujet contienne 6 lignes representant les
% repetitions des tests et 10 colonnes qui representent respectivements
% les criteres silence droite,noise droite, explication droite,mirror droite
% silence gauche,noise gauche,explication gauche, mirror gauche, reference
% droite ey reference gauche.
%
% La matrice reinsertion_var represente la variation des sujets par rapport
% a la reference selon les criteres selectionnees.
%
for i = 1: 6

%
% Sujet # 1
%
    subject_1_var(i,1) = subject_1(i,9) - subject_1(i,1); % variation ref. a droite
    subject_1_var(i,2) = subject_1(i,9) - subject_1(i,2); % variation ref. a droite
    subject_1_var(i,3) = subject_1(i,9) - subject_1(i,3); % variation ref. a droite
    subject_1_var(i,4) = subject_1(i,9) - subject_1(i,4); % variation ref. a droite
    subject_1_var(i,5) = subject_1(i,10) - subject_1(i,5); % variation ref. a gauche
    subject_1_var(i,6) = subject_1(i,10) - subject_1(i,6); % variation ref. a gauche
    subject_1_var(i,7) = subject_1(i,10) - subject_1(i,7); % variation ref. a gauche
    subject_1_var(i,8) = subject_1(i,10) - subject_1(i,8); % variation ref. a gauche
%
% calcul de la moyenne ds 2 oreilles (right & Left )
```

```
%
Msubject_1_var(i,1) = mean([subject_1_var(i,1);subject_1_var(i,5)]); % mean 2 variation Righ
Msubject_1_var(i,2) = mean([subject_1_var(i,2);subject_1_var(i,6)]); % mean 2 variation Righ
Msubject_1_var(i,3) = mean([subject_1_var(i,3);subject_1_var(i,7)]); % mean 2 variation Righ
Msubject_1_var(i,4) = mean([subject_1_var(i,4);subject_1_var(i,8)]); % mean 2 variation Righ

%
% Sujet # 2
%
    subject_2_var(i,1) = subject_2(i,9) - subject_2(i,1); % variation ref. a droite
    subject_2_var(i,2) = subject_2(i,9) - subject_2(i,2); % variation ref. a droite
    subject_2_var(i,3) = subject_2(i,9) - subject_2(i,3); % variation ref. a droite
    subject_2_var(i,4) = subject_2(i,9) - subject_2(i,4); % variation ref. a droite
    subject_2_var(i,5) = subject_2(i,10) - subject_2(i,5); % variation ref. a gauche
    subject_2_var(i,6) = subject_2(i,10) - subject_2(i,6); % variation ref. a gauche
    subject_2_var(i,7) = subject_2(i,10) - subject_2(i,7); % variation ref. a gauche
    subject_2_var(i,8) = subject_2(i,10) - subject_2(i,8); % variation ref. a gauche

%
% calcul de la moyenne ds 2 oreilles (right & Left )
%
Msubject_2_var(i,1) = mean([subject_2_var(i,1);subject_2_var(i,5)]); % mean 2 variation Righ
Msubject_2_var(i,2) = mean([subject_2_var(i,2);subject_2_var(i,6)]); % mean 2 variation Righ
Msubject_2_var(i,3) = mean([subject_2_var(i,3);subject_2_var(i,7)]); % mean 2 variation Righ
Msubject_2_var(i,4) = mean([subject_2_var(i,4);subject_2_var(i,8)]); % mean 2 variation Righ
%
% Sujet # 3
%
    subject_3_var(i,1) = subject_3(i,9) - subject_3(i,1); % variation ref. a droite
    subject_3_var(i,2) = subject_3(i,9) - subject_3(i,2); % variation ref. a droite
    subject_3_var(i,3) = subject_3(i,9) - subject_3(i,3); % variation ref. a droite
    subject_3_var(i,4) = subject_3(i,9) - subject_3(i,4); % variation ref. a droite
    subject_3_var(i,5) = subject_3(i,10) - subject_3(i,5); % variation ref. a gauche
    subject_3_var(i,6) = subject_3(i,10) - subject_3(i,6); % variation ref. a gauche
    subject_3_var(i,7) = subject_3(i,10) - subject_3(i,7); % variation ref. a gauche
    subject_3_var(i,8) = subject_3(i,10) - subject_3(i,8); % variation ref. a gauche
%
% calcul de la moyenne ds 2 oreilles (right & Left )
%
Msubject_3_var(i,1) = mean([subject_3_var(i,1);subject_3_var(i,5)]); % mean 2 variation Righ
Msubject_3_var(i,2) = mean([subject_3_var(i,2);subject_3_var(i,6)]); % mean 2 variation Righ
Msubject_3_var(i,3) = mean([subject_3_var(i,3);subject_3_var(i,7)]); % mean 2 variation Righ
Msubject_3_var(i,4) = mean([subject_3_var(i,4);subject_3_var(i,8)]); % mean 2 variation Righ
%
% Sujet # 4
%
```

```
    subject_4_var(i,1) = subject_4(i,9) - subject_4(i,1); % variation ref. a droite
    subject_4_var(i,2) = subject_4(i,9) - subject_4(i,2); % variation ref. a droite
    subject_4_var(i,3) = subject_4(i,9) - subject_4(i,3); % variation ref. a droite
    subject_4_var(i,4) = subject_4(i,9) - subject_4(i,4); % variation ref. a droite
    subject_4_var(i,5) = subject_4(i,10) - subject_4(i,5); % variation ref. a gauche
    subject_4_var(i,6) = subject_4(i,10) - subject_4(i,6); % variation ref. a gauche
    subject_4_var(i,7) = subject_4(i,10) - subject_4(i,7); % variation ref. a gauche
    subject_4_var(i,8) = subject_4(i,10) - subject_4(i,8); % variation ref. a gauche
%
% calcul de la moyenne ds 2 oreilles (right & Left )
%
Msubject_4_var(i,1) = mean([subject_4_var(i,1);subject_4_var(i,5)]); % mean 2 variation Righ
Msubject_4_var(i,2) = mean([subject_4_var(i,2);subject_4_var(i,6)]); % mean 2 variation Righ
Msubject_4_var(i,3) = mean([subject_4_var(i,3);subject_4_var(i,7)]); % mean 2 variation Righ
Msubject_4_var(i,4) = mean([subject_4_var(i,4);subject_4_var(i,8)]); % mean 2 variation Righ
%
% Sujet # 5
%
    subject_5_var(i,1) = subject_5(i,9) - subject_5(i,1); % variation ref. a droite
    subject_5_var(i,2) = subject_5(i,9) - subject_5(i,2); % variation ref. a droite
    subject_5_var(i,3) = subject_5(i,9) - subject_5(i,3); % variation ref. a droite
    subject_5_var(i,4) = subject_5(i,9) - subject_5(i,4); % variation ref. a droite
    subject_5_var(i,5) = subject_5(i,10) - subject_5(i,5); % variation ref. a gauche
    subject_5_var(i,6) = subject_5(i,10) - subject_5(i,6); % variation ref. a gauche
    subject_5_var(i,7) = subject_5(i,10) - subject_5(i,7); % variation ref. a gauche
    subject_5_var(i,8) = subject_5(i,10) - subject_5(i,8); % variation ref. a gauche
%
% calcul de la moyenne ds 2 oreilles (right & Left )
%
Msubject_5_var(i,1) = mean([subject_5_var(i,1);subject_5_var(i,5)]); % mean 2 variation Righ
Msubject_5_var(i,2) = mean([subject_5_var(i,2);subject_5_var(i,6)]); % mean 2 variation Righ
Msubject_5_var(i,3) = mean([subject_5_var(i,3);subject_5_var(i,7)]); % mean 2 variation Righ
Msubject_5_var(i,4) = mean([subject_5_var(i,4);subject_5_var(i,8)]); % mean 2 variation Righ
%
% Sujet # 6
%
    subject_6_var(i,1) = subject_6(i,9) - subject_6(i,1); % variation ref. a droite
    subject_6_var(i,2) = subject_6(i,9) - subject_6(i,2); % variation ref. a droite
    subject_6_var(i,3) = subject_6(i,9) - subject_6(i,3); % variation ref. a droite
    subject_6_var(i,4) = subject_6(i,9) - subject_6(i,4); % variation ref. a droite
    subject_6_var(i,5) = subject_6(i,10) - subject_6(i,5); % variation ref. a gauche
    subject_6_var(i,6) = subject_6(i,10) - subject_6(i,6); % variation ref. a gauche
    subject_6_var(i,7) = subject_6(i,10) - subject_6(i,7); % variation ref. a gauche
    subject_6_var(i,8) = subject_6(i,10) - subject_6(i,8); % variation ref. a gauche
%
% calcul de la moyenne ds 2 oreilles (right & Left )
```

```
%
Msubject_6_var(i,1) = mean([subject_6_var(i,1);subject_6_var(i,5)]); % mean 2 variation Righ
Msubject_6_var(i,2) = mean([subject_6_var(i,2);subject_6_var(i,6)]); % mean 2 variation Righ
Msubject_6_var(i,3) = mean([subject_6_var(i,3);subject_6_var(i,7)]); % mean 2 variation Righ
Msubject_6_var(i,4) = mean([subject_6_var(i,4);subject_6_var(i,8)]); % mean 2 variation Righ
end
%
% Sauvegarde du fichier variation par sujet(droite et gauche) selon les
% criteres silence,noise,explication et mirror
%
%save reinsertion_var subject_1_var subject_2_var subject_3_var subject_4_var subject_5_var
%
% Sauvegarde du fichier variation selon la  moyenne des 2 oreilles et selon
% les criteres silence,noise,explication et mirror.
%
%save mreinsertion_var Msubject_1_var Msubject_2_var Msubject_3_var Msubject_4_var Msubject_
%
% Sauvegarde les valeurs moyens des variations par critere. avec moyenne 2
% oreilles
%
%
% Criteres moyennes des 2 oreilles.
%
critere_silence = [Msubject_1_var(:,1),Msubject_2_var(:,1),Msubject_3_var(:,1),Msubject_5_va
critere_noise = [Msubject_1_var(:,2),Msubject_2_var(:,2),Msubject_3_var(:,2),Msubject_5_var(
critere_explication = [Msubject_1_var(:,3),Msubject_2_var(:,3),Msubject_3_var(:,3),Msubject_
critere_mirror = [Msubject_1_var(:,4),Msubject_2_var(:,4),Msubject_3_var(:,4),Msubject_5_var
%
%critere droite
%
critere_silence_droite = [subject_1_var(:,1),subject_2_var(:,1),subject_3_var(:,1),subject_5
critere_noise_droite = [subject_1_var(:,2),subject_2_var(:,2),subject_3_var(:,2),subject_5_v
critere_explication_droite = [subject_1_var(:,3),subject_2_var(:,3),subject_3_var(:,3),subje
critere_mirror_droite = [subject_1_var(:,4),subject_2_var(:,4),subject_3_var(:,4),subject_5_
%
%critere gauche
%
critere_silence_gauche = [subject_1_var(:,5),subject_2_var(:,5),subject_3_var(:,5),subject_5
critere_noise_gauche = [subject_1_var(:,6),subject_2_var(:,6),subject_3_var(:,6),subject_5_v
critere_explication_gauche = [subject_1_var(:,7),subject_2_var(:,7),subject_3_var(:,7),subje
critere_mirror_gauche = [subject_1_var(:,8),subject_2_var(:,8),subject_3_var(:,8),subject_5_

%
% Calcul du max et de min par repetition
%
for i=1:6
```

```
maximum_silence(i,:) = max([critere_silence_droite(i,1:5);critere_silence_gauche(i,1:5)]);
minimum_silence(i,:) = min([critere_silence_droite(i,1:5);critere_silence_gauche(i,1:5)]);
maximum_silence_av(i,:) = max(critere_silence(i,1:5));
minimum_silence_av(i,:) = min(critere_silence(i,1:5));

maximum_noise(i,:) = max([critere_noise_droite(i,1:5);critere_noise_gauche(i,1:5)]);
minimum_noise(i,:) = min([critere_noise_droite(i,1:5);critere_noise_gauche(i,1:5)]);
maximum_noise_av(i,:) = max(critere_noise(i,1:5));
minimum_noise_av(i,:) = min(critere_noise(i,1:5));

maximum_explication(i,:) = max([critere_explication_droite(i,1:5);critere_explication_gauche
minimum_explication(i,:) = min([critere_explication_droite(i,1:5);critere_explication_gauche
maximum_explication_av(i,:) = max(critere_explication(i,1:5));
minimum_explication_av(i,:) = min(critere_explication(i,1:5));

maximum_mirror(i,:) = max([critere_mirror_droite(i,1:5);critere_mirror_gauche(i,1:5)]);
minimum_mirror(i,:) = min([critere_mirror_droite(i,1:5);critere_mirror_gauche(i,1:5)]);
maximum_mirror_av(i,:) = max(critere_mirror(i,1:5));
minimum_mirror_av(i,:) = min(critere_mirror(i,1:5));


end
%
% calcul de l'ecart type de 10 tests
%
for j=1:6
ecart_silence_10tests_1(j,:) = [critere_silence_droite(j,1),critere_silence_gauche(j,1)]; %
ecart_noise_10tests_1(j,:) = [critere_noise_droite(j,1),critere_noise_gauche(j,1)];     % bo
ecart_explica_10tests_1(j,:) = [critere_explication_droite(j,1),critere_explication_gauche(j
ecart_mirror_10tests_1(j,:) = [critere_mirror_droite(j,1),critere_mirror_gauche(j,1)];     %
end
for j=1:6
ecart_silence_10tests_2(j,:) = [critere_silence_droite(j,2),critere_silence_gauche(j,2)]; %
ecart_noise_10tests_2(j,:) = [critere_noise_droite(j,2),critere_noise_gauche(j,2)];     % bo
ecart_explica_10tests_2(j,:) = [critere_explication_droite(j,2),critere_explication_gauche(j
ecart_mirror_10tests_2(j,:) = [critere_mirror_droite(j,2),critere_mirror_gauche(j,2)];     %
end
for j=1:6
ecart_silence_10tests_3(j,:) = [critere_silence_droite(j,3),critere_silence_gauche(j,3)]; %
ecart_noise_10tests_3(j,:) = [critere_noise_droite(j,3),critere_noise_gauche(j,3)];     % bo
ecart_explica_10tests_3(j,:) = [critere_explication_droite(j,3),critere_explication_gauche(j
ecart_mirror_10tests_3(j,:) = [critere_mirror_droite(j,3),critere_mirror_gauche(j,3)];     %
end
for j=1:6
ecart_silence_10tests_4(j,:) = [critere_silence_droite(j,4),critere_silence_gauche(j,4)]; %
ecart_noise_10tests_4(j,:) = [critere_noise_droite(j,4),critere_noise_gauche(j,4)];     % bo
```

```
ecart_explica_10tests_4(j,:) = [critere_explication_droite(j,4),critere_explication_gauche(j
ecart_mirror_10tests_4(j,:) = [critere_mirror_droite(j,4),critere_mirror_gauche(j,4)];     %
end
for j=1:6
ecart_silence_10tests_5(j,:) = [critere_silence_droite(j,5),critere_silence_gauche(j,5)]; %
ecart_noise_10tests_5(j,:) = [critere_noise_droite(j,5),critere_noise_gauche(j,5)];     % bo
ecart_explica_10tests_5(j,:) = [critere_explication_droite(j,5),critere_explication_gauche(j
ecart_mirror_10tests_5(j,:) = [critere_mirror_droite(j,5),critere_mirror_gauche(j,5)];     %
end


for i=1:6
 sd_silence_10tests(i,1:10) = [ecart_silence_10tests_1(i,1:2),ecart_silence_10tests_2(i,1:2)
 sd_noise_10tests(i,1:10) = [ecart_noise_10tests_1(i,1:2),ecart_noise_10tests_2(i,1:2),ecart
 sd_explica_10tests(i,1:10) = [ecart_explica_10tests_1(i,1:2),ecart_explica_10tests_2(i,1:2)
 sd_mirror_10tests(i,1:10) = [ecart_mirror_10tests_1(i,1:2),ecart_mirror_10tests_2(i,1:2),ec
end

scritere_silence_10tests =std(sd_silence_10tests');
scritere_noise_10tests =std(sd_noise_10tests');
scritere_explica_10tests =std(sd_explica_10tests');
scritere_mirror_10tests =std(sd_mirror_10tests');

%
% fin de calcul de l'ecart type des 10 tests
%


for i=1:6
max_silence(i)=max(maximum_silence(i,1:5)) ;
min_silence(i)=min(minimum_silence(i,1:5));

max_noise(i)=max(maximum_noise(i,1:5));
min_noise(i)=min(minimum_noise(i,1:5));

max_explication(i)=max(maximum_explication(i,1:5));
min_explication(i)=min(minimum_explication(i,1:5));

max_mirror(i)=max(maximum_mirror(i,1:5));
min_mirror(i)=min(minimum_mirror(i,1:5));
end

%
% Average for all subject by criteria and trial
%
for i=1:6
```

```
mcritere_silence(i) = mean(critere_silence(i,1:5)); % both ear
mcritere_noise(i) = mean(critere_noise(i,1:5));     % both ear
mcritere_explica(i) = mean(critere_explication(i,1:5)); % both Ear
mcritere_mirror(i) = mean(critere_mirror(i,1:5));       % both ear

scritere_silence(i) = std(critere_silence(i,1:5)); % both ear
scritere_noise(i) = std(critere_noise(i,1:5));     % both ear
scritere_explica(i) = std(critere_explication(i,1:5)); % both Ear
scritere_mirror(i) = std(critere_mirror(i,1:5));       % both ear

mcritere_silence_gauche(i) = mean( critere_silence_gauche(i,1:5)); % left ear
mcritere_noise_gauche(i) = mean( critere_noise_gauche(i,1:5));     % Left ear
mcritere_explication_gauche(i) = mean( critere_explication_gauche(i,1:5)); % Left ear
mcritere_mirror_gauche(i) = mean(critere_mirror_gauche(i,1:5));    % Left Ear

mcritere_silence_droite(i) = mean( critere_silence_droite(i,1:5)); % Right ear
mcritere_noise_droite(i) = mean( critere_noise_droite(i,1:5));    % Right Ear
mcritere_explication_droite(i) = mean( critere_explication_droite(i,1:5)); % Right Ear
mcritere_mirror_droite(i) = mean( critere_mirror_droite(i,1:5));  % Right ear

scritere_silence_gauche(i) = std( critere_silence_gauche(i,1:5)); % left ear
scritere_noise_gauche(i) = std( critere_noise_gauche(i,1:5));     % Left ear
scritere_explication_gauche(i) = std( critere_explication_gauche(i,1:5)); % Left ear
scritere_mirror_gauche(i) = std(critere_mirror_gauche(i,1:5));    % Left Ear

scritere_silence_droite(i) = std( critere_silence_droite(i,1:5)); % Right ear
scritere_noise_droite(i) = std( critere_noise_droite(i,1:5));    % Right Ear
scritere_explication_droite(i) = std( critere_explication_droite(i,1:5)); % Right Ear
scritere_mirror_droite(i) = std( critere_mirror_droite(i,1:5));  % Right ear
end

%
% inverse des matrices
%
mcritere_silence_gauche =  mcritere_silence_gauche';
mcritere_noise_gauche =    mcritere_noise_gauche';
mcritere_explica_gauche = mcritere_explication_gauche';
mcritere_mirror_gauche = mcritere_mirror_gauche';

mcritere_silence_droite = mcritere_silence_droite';
mcritere_noise_droite = mcritere_noise_droite';
mcritere_explica_droite = mcritere_explication_droite';
mcritere_mirror_droite = mcritere_mirror_droite';

scritere_silence_gauche =  scritere_silence_gauche';
scritere_noise_gauche =    scritere_noise_gauche';
```

```
scritere_explica_gauche = scritere_explication_gauche';
scritere_mirror_gauche = scritere_mirror_gauche';

scritere_silence_droite = scritere_silence_droite';
scritere_noise_droite = scritere_noise_droite';
scritere_explica_droite = scritere_explication_droite';
scritere_mirror_droite = scritere_mirror_droite';

%
% both ears
%
mcritere_silence = mcritere_silence';
mcritere_noise = mcritere_noise';
mcritere_explica = mcritere_explica';
mcritere_mirror = mcritere_mirror';

scritere_silence = scritere_silence';
scritere_noise = scritere_noise';
scritere_explica = scritere_explica';
scritere_mirror = scritere_mirror';


critere_silence = [Msubject_1_var(:,1),Msubject_2_var(:,1),Msubject_3_var(:,1),Msubject_5_va
critere_noise = [Msubject_1_var(:,2),Msubject_2_var(:,2),Msubject_3_var(:,2),Msubject_5_var(
critere_explication = [Msubject_1_var(:,3),Msubject_2_var(:,3),Msubject_3_var(:,3),Msubject_
critere_mirror = [Msubject_1_var(:,4),Msubject_2_var(:,4),Msubject_3_var(:,4),Msubject_5_var

%
% GRaph des 4 conditions moyenne de tous les sujets.
%
hold on
plot(mcritere_silence,'bo-')
plot(mcritere_noise,'gv-')
plot(mcritere_explica,'r*-')
plot(mcritere_mirror,'cp-')

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence','Average Noise','Average Explication','Average Mirror',1)
  title('Average of all subjects - Both Ears');
  axis([0 7 0 10])
  grid

%
```

```
% graph doite
%
figure;
hold on
plot(mcritere_silence_droite,'bo-')
plot(mcritere_noise_droite,'gv-')
plot(mcritere_explica_droite,'r*-')
plot(mcritere_mirror_droite,'cp-')

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence','Average Noise','Average Explication','Average Mirror',1)
  title('Average of all subjects - Right Ear');
  axis([0 7 0 10])
  grid

%
% Left Ear
%
figure;
hold on
plot(mcritere_silence_gauche,'bo-')
plot(mcritere_noise_gauche,'gv-')
plot(mcritere_explica_gauche,'r*-')
plot(mcritere_mirror_gauche,'cp-')

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence','Average Noise','Average Explication','Average Mirror',1)
  title('Average of all subjects - Left Ear');
  axis([0 7 0 10])

  grid

%
% Graph de la condition silence moyenne de tous les sujets.
%
x=[1,2,3,4,5,6];

figure;subplot(2,2,1)
hold on
plot(mcritere_silence,'bo-')
```

```
errorbar(x,mcritere_silence,min_silence-mcritere_silence',max_silence-mcritere_silence','bo-

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(mcritere_noise,'gv-')
  errorbar(x,mcritere_noise,min_noise-mcritere_noise',max_noise-mcritere_noise','gv-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica,'r*-')
  errorbar(x,mcritere_explica,min_explication-mcritere_explica',max_explication-mcritere_exp

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot(mcritere_mirror,'cp-')
```

```
  errorbar(x,mcritere_mirror,min_mirror-mcritere_mirror',max_mirror-mcritere_mirror','cp-');
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid

% Graph   avec la moyenne droite et gauche

figure;SUBPLOT(2,2,1)
hold on
plot(mcritere_silence,'bo-')
errorbar(x,mcritere_silence,minimum_silence_av-mcritere_silence,maximum_silence_av-mcritere_

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(mcritere_noise,'gv-')
  errorbar(x,mcritere_noise,minimum_noise_av-mcritere_noise,maximum_noise_av-mcritere_noise,

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica,'r*-')
  errorbar(x,mcritere_explica,minimum_explication_av-mcritere_explica,maximum_explication_av
```

```
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot(mcritere_mirror,'cp-')

  errorbar(x,mcritere_mirror,minimum_mirror_av-mcritere_mirror,maximum_mirror_av-mcritere_mi
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid



%
%
% graph right ear
%
figure;SUBPLOT(2,2,1)
hold on
plot(mcritere_silence_droite,'bo-')
errorbar(x,mcritere_silence_droite,min_silence',max_silence','bo-');
set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Right Ear');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
```

```
  subplot(2,2,2)
  plot(mcritere_noise_droite,'gv-')
  errorbar(x,mcritere_noise_droite,min_noise',max_noise','gv-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects _ Right Ear');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica_droite,'r*-')
  errorbar(x,mcritere_explication_droite,min_explication',max_explication','r*-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Right Ear');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot(mcritere_mirror_droite,'cp-')
 errorbar(x,mcritere_mirror_droite,min_mirror',max_mirror','cp-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
  title('Average of all subjects - Right Ear');
  axis([0 7 -10 40])
  grid
%
% GRaph Gauche

figure;SUBPLOT(2,2,1)
```

```
hold on
plot(mcritere_silence_gauche,'bo-')
set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Left Ear');
  axis([0 7 0 10])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(mcritere_noise_gauche,'gv-')
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects - Left Ear');
  axis([0 7 0 10])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica_gauche,'r*-')
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Left Ear');
  axis([0 7 0 10])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot(mcritere_mirror_gauche,'cp-')
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
```

```
  title('Average of all subjects - Left Ear');
  axis([0 7 0 10])
  grid



%save mcriteres mcritere_silence mcritere_noise mcritere_explica mcritere_mirror -v4

%save criteres_moy_var critere_silence critere_noise critere_explication critere_mirror  -v4
%
% Graph debppar aindi que la reference droite et gauche.
%
% Subject_1
%
figure;subplot(2,1,1)
hold on
y=[subject_1(:,1:4),subject_1(:,9)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 1 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_1(:,5:8),subject_1(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 1 - Left');
  axis([0 7 0 35])
  grid
%
% Subject_2
%
figure;subplot(2,1,1)
hold on
y=[subject_2(:,1:4),subject_2(:,9)];
```

```
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 2 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_2(:,5:8),subject_2(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 2 - Left');
  axis([0 7 0 35])
  grid
  %
% Subject_3
%
figure;subplot(2,1,1)
hold on
y=[subject_3(:,1:4),subject_3(:,9)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 3 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_3(:,5:8),subject_3(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
```

```
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 3 - Left');
  axis([0 7 0 35])
  grid
%
% Subject_4
%
figure;subplot(2,1,1)
hold on
y=[subject_4(:,1:4),subject_4(:,9)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 4 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_4(:,5:8),subject_4(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 4 - Left');
  axis([0 7 0 35])
  grid
%
% Subject_5
%
figure;subplot(2,1,1)
hold on
y=[subject_5(:,1:4),subject_5(:,9)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
```

```
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 5 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_5(:,5:8),subject_5(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 5 - Left');
  axis([0 7 0 35])
  grid

  %
% Subject_6
%
figure;subplot(2,1,1)
hold on
y=[subject_6(:,1:4),subject_6(:,9)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 6 - Right');
  axis([0 7 0 35])
  grid
%
% Gauche
%
subplot(2,1,2)
y=[subject_6(:,5:8),subject_6(:,10)];
plot(y)
set(gca,'xtick',(1:6))
set(gca,'xticklabel',[1 2 3 4 5 6])
xlabel('Trial #');
  ylabel('PPAR in dB');
  legend('Silence','Noise','Explanation','Mirror','Reference',4)
  title('Subject 6 - Left');
```

```
  axis([0 7 0 35])
  grid



  x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot(mcritere_silence,'bo-')
errorbar(x,mcritere_silence,scritere_silence_10tests','bo-');

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(mcritere_noise,'gv-')
  errorbar(x,mcritere_noise,scritere_noise_10tests','gv-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica,'r*-')
  errorbar(x,mcritere_explica,scritere_explica_10tests','r*-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
```

```
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)

  plot(mcritere_mirror,'cp-')

  errorbar(x,mcritere_mirror,scritere_mirror_10tests','cp-');
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
  title('Average of all subjects - Both Ears - 10 tests');
  axis([0 7 -10 40])
  grid


   x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot(mcritere_silence,'bo-')
errorbar(x,mcritere_silence,scritere_silence,'bo-');

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(mcritere_noise,'gv-')
  errorbar(x,mcritere_noise,scritere_noise,'gv-');

  set(gca,'xtick',(1:6))
```

```
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(mcritere_explica,'r*-')
  errorbar(x,mcritere_explica,scritere_explica,'r*-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)

  plot(mcritere_mirror,'cp-')

  errorbar(x,mcritere_mirror,scritere_mirror,'cp-');
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror',1)
  title('Average of all subjects - Both Ears - 5*2 tests');
  axis([0 7 -10 40])
  grid

  %
  % Droitier et gaucher tous les sujets sont des droitiers sauf le sujet #2
  % qui est gaucher
  %
  % Main dominant
  %
  dominant_silence_1 = [critere_silence_droite(1,1),critere_silence_gauche(1,2),critere_sile
```

```
dominant_silence_2 = [critere_silence_droite(2,1),critere_silence_gauche(2,2),critere_sile
dominant_silence_3 = [critere_silence_droite(3,1),critere_silence_gauche(3,2),critere_sile
dominant_silence_4 = [critere_silence_droite(4,1),critere_silence_gauche(4,2),critere_sile
dominant_silence_5 = [critere_silence_droite(5,1),critere_silence_gauche(5,2),critere_sile
dominant_silence_6 = [critere_silence_droite(6,1),critere_silence_gauche(6,2),critere_sile
sujets_silence_dominant = [dominant_silence_1;dominant_silence_2;dominant_silence_3;domina

for i=1:6
    average_dominant_silence(i) = mean(sujets_silence_dominant(i,1:5));
    ecart_dominant_silence(i) = std(sujets_silence_dominant(i,1:5));
    max_dominant_silence(i) = max(sujets_silence_dominant(i,1:5));
    min_dominant_silence(i) = min(sujets_silence_dominant(i,1:5));
end

dominant_noise_1 = [critere_noise_droite(1,1),critere_noise_gauche(1,2),critere_noise_droi
dominant_noise_2 = [critere_noise_droite(2,1),critere_noise_gauche(2,2),critere_noise_droi
dominant_noise_3 = [critere_noise_droite(3,1),critere_noise_gauche(3,2),critere_noise_droi
dominant_noise_4 = [critere_noise_droite(4,1),critere_noise_gauche(4,2),critere_noise_droi
dominant_noise_5 = [critere_noise_droite(5,1),critere_noise_gauche(5,2),critere_noise_droi
dominant_noise_6 = [critere_noise_droite(6,1),critere_noise_gauche(6,2),critere_noise_droi
sujets_noise_dominant = [dominant_noise_1;dominant_noise_2;dominant_noise_3;dominant_noise

for i=1:6
    average_dominant_noise(i) = mean(sujets_noise_dominant(i,1:5));
    ecart_dominant_noise(i) = std(sujets_noise_dominant(i,1:5));
    max_dominant_noise(i) = max(sujets_noise_dominant(i,1:5));
    min_dominant_noise(i) = min(sujets_noise_dominant(i,1:5));
end

dominant_explication_1 = [critere_explication_droite(1,1),critere_explication_gauche(1,2),
dominant_explication_2 = [critere_explication_droite(2,1),critere_explication_gauche(2,2),
dominant_explication_3 = [critere_explication_droite(3,1),critere_explication_gauche(3,2),
dominant_explication_4 = [critere_explication_droite(4,1),critere_explication_gauche(4,2),
dominant_explication_5 = [critere_explication_droite(5,1),critere_explication_gauche(5,2),
dominant_explication_6 = [critere_explication_droite(6,1),critere_explication_gauche(6,2),
sujets_explication_dominant = [dominant_explication_1;dominant_explication_2;dominant_expl

for i=1:6
    average_dominant_explication(i) = mean(sujets_explication_dominant(i,1:5));
    ecart_dominant_explication(i) = std(sujets_explication_dominant(i,1:5));
    max_dominant_explication(i) = max(sujets_explication_dominant(i,1:5));
    min_dominant_explication(i) = min(sujets_explication_dominant(i,1:5));
end

dominant_mirror_1 = [critere_mirror_droite(1,1),critere_mirror_gauche(1,2),critere_mirror_
dominant_mirror_2 = [critere_mirror_droite(2,1),critere_mirror_gauche(2,2),critere_mirror_
```

```
dominant_mirror_3 = [critere_mirror_droite(3,1),critere_mirror_gauche(3,2),critere_mirror_
dominant_mirror_4 = [critere_mirror_droite(4,1),critere_mirror_gauche(4,2),critere_mirror_
dominant_mirror_5 = [critere_mirror_droite(5,1),critere_mirror_gauche(5,2),critere_mirror_
dominant_mirror_6 = [critere_mirror_droite(6,1),critere_mirror_gauche(6,2),critere_mirror_
sujets_mirror_dominant = [dominant_mirror_1;dominant_mirror_2;dominant_mirror_3;dominant_m

for i=1:6
    average_dominant_mirror(i) = mean(sujets_mirror_dominant(i,1:5));
    ecart_dominant_mirror(i) = std(sujets_mirror_dominant(i,1:5));
    max_dominant_mirror(i) = max(sujets_mirror_dominant(i,1:5));
    min_dominant_mirror(i) = min(sujets_mirror_dominant(i,1:5));
end



%
% Main esclave
%
esclave_silence_1 = [critere_silence_gauche(1,1),critere_silence_droite(1,2),critere_siler
esclave_silence_2 = [critere_silence_gauche(2,1),critere_silence_droite(2,2),critere_siler
esclave_silence_3 = [critere_silence_gauche(3,1),critere_silence_droite(3,2),critere_siler
esclave_silence_4 = [critere_silence_gauche(4,1),critere_silence_droite(4,2),critere_siler
esclave_silence_5 = [critere_silence_gauche(5,1),critere_silence_droite(5,2),critere_siler
esclave_silence_6 = [critere_silence_gauche(6,1),critere_silence_droite(6,2),critere_siler
sujets_silence_esclave = [esclave_silence_1;esclave_silence_2;esclave_silence_3;esclave_si

for i=1:6
    average_esclave_silence(i) = mean(sujets_silence_esclave(i,1:5));
    ecart_esclave_silence(i) = std(sujets_silence_esclave(i,1:5));
    max_esclave_silence(i) = max(sujets_silence_esclave(i,1:5));
    min_esclave_silence(i) = min(sujets_silence_esclave(i,1:5));
end

esclave_noise_1 = [critere_noise_gauche(1,1),critere_noise_droite(1,2),critere_noise_gauch
esclave_noise_2 = [critere_noise_gauche(2,1),critere_noise_droite(2,2),critere_noise_gauch
esclave_noise_3 = [critere_noise_gauche(3,1),critere_noise_droite(3,2),critere_noise_gauch
esclave_noise_4 = [critere_noise_gauche(4,1),critere_noise_droite(4,2),critere_noise_gauch
esclave_noise_5 = [critere_noise_gauche(5,1),critere_noise_droite(5,2),critere_noise_gauch
esclave_noise_6 = [critere_noise_gauche(6,1),critere_noise_droite(6,2),critere_noise_gauch
sujets_noise_esclave = [esclave_noise_1;esclave_noise_2;esclave_noise_3;esclave_noise_4;es

for i=1:6
    average_esclave_noise(i) = mean(sujets_noise_esclave(i,1:5));
    ecart_esclave_noise(i) = std(sujets_noise_esclave(i,1:5));
    max_esclave_noise(i) = max(sujets_noise_esclave(i,1:5));
    min_esclave_noise(i) = min(sujets_noise_esclave(i,1:5));
```

```
  end

  esclave_explication_1 = [critere_explication_gauche(1,1),critere_explication_droite(1,2),c
  esclave_explication_2 = [critere_explication_gauche(2,1),critere_explication_droite(2,2),c
  esclave_explication_3 = [critere_explication_gauche(3,1),critere_explication_droite(3,2),c
  esclave_explication_4 = [critere_explication_gauche(4,1),critere_explication_droite(4,2),c
  esclave_explication_5 = [critere_explication_gauche(5,1),critere_explication_droite(5,2),c
  esclave_explication_6 = [critere_explication_gauche(6,1),critere_explication_droite(6,2),c
  sujets_explication_esclave = [esclave_explication_1;esclave_explication_2;esclave_explicat

  for i=1:6
      average_esclave_explication(i) = mean(sujets_explication_esclave(i,1:5));
      ecart_esclave_explication(i) = std(sujets_explication_esclave(i,1:5));
      max_esclave_explication(i) = max(sujets_explication_esclave(i,1:5));
      min_esclave_explication(i) = min(sujets_explication_esclave(i,1:5));
  end

  esclave_mirror_1 = [critere_mirror_gauche(1,1),critere_mirror_droite(1,2),critere_mirror_g
  esclave_mirror_2 = [critere_mirror_gauche(2,1),critere_mirror_droite(2,2),critere_mirror_g
  esclave_mirror_3 = [critere_mirror_gauche(3,1),critere_mirror_droite(3,2),critere_mirror_g
  esclave_mirror_4 = [critere_mirror_gauche(4,1),critere_mirror_droite(4,2),critere_mirror_g
  esclave_mirror_5 = [critere_mirror_gauche(5,1),critere_mirror_droite(5,2),critere_mirror_g
  esclave_mirror_6 = [critere_mirror_gauche(6,1),critere_mirror_droite(6,2),critere_mirror_g
  sujets_mirror_esclave = [esclave_mirror_1;esclave_mirror_2;esclave_mirror_3;esclave_mirror

  for i=1:6
      average_esclave_mirror(i) = mean(sujets_mirror_esclave(i,1:5));
      ecart_esclave_mirror(i) = std(sujets_mirror_esclave(i,1:5));
      max_esclave_mirror(i) = max(sujets_mirror_esclave(i,1:5));
      min_esclave_mirror(i) = min(sujets_mirror_esclave(i,1:5));
  end


   x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot(average_dominant_silence,'bo-')
errorbar(x,average_dominant_silence,ecart_dominant_silence,'bo-');

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Silence - Dominant',1)
  title('Average of all subjects - Dominant Hand - STD');
```

```
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(average_dominant_noise,'gv-')
  errorbar(x,average_dominant_noise,ecart_dominant_noise,'gv-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise - Dominant',1)
  title('Average of all subjects - Dominant Hand - STD');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(average_dominant_explication,'r*-')
  errorbar(x,average_dominant_explication,ecart_dominant_explication,'r*-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication - Dominant',1)
  title('Average of all subjects - Dominant Hand - STD');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)

  plot(average_dominant_mirror,'cp-')

  errorbar(x,average_dominant_mirror,ecart_dominant_mirror,'cp-');
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror - Dominant',1)
  title('Average of all subjects - Dominant Hand - STD');
```

```
  axis([0 7 -10 40])
  grid

  %
  % Main esclave
  %

     x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot(average_esclave_silence,'bo-')
errorbar(x,average_esclave_silence,ecart_esclave_silence,'bo-');

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('PPARDifference in (dB)');
  legend('Average Silence - esclave',1)
  title('Average of all subjects - esclave Hand - STD');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot(average_dominant_noise,'gv-')
  errorbar(x,average_esclave_noise,ecart_esclave_noise,'gv-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Noise - esclave',1)
  title('Average of all subjects - esclave Hand - STD');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(average_esclave_explication,'r*-')
  errorbar(x,average_esclave_explication,ecart_esclave_explication,'r*-');

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
```

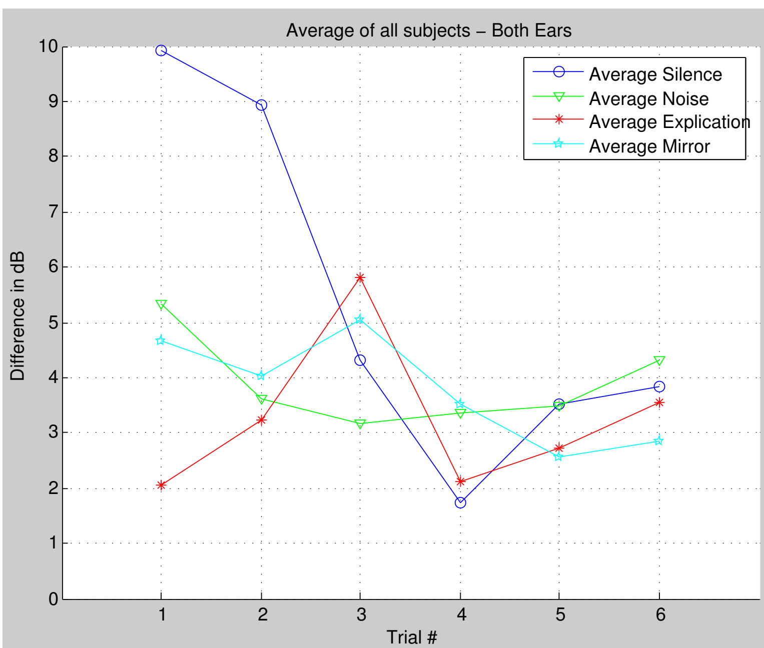
```
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Explication - esclave',1)
  title('Average of all subjects - esclave Hand - STD');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)

  plot(average_esclave_mirror,'cp-')

  errorbar(x,average_esclave_mirror,ecart_esclave_mirror,'cp-');
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('Difference in dB');
  legend('Average Mirror - esclave',1)
  title('Average of all subjects - esclave Hand - STD');
  axis([0 7 -10 40])
  grid

%
% Graph avec min et max  main dominant et esclave
%
x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot(average_dominant_silence,'bo-')
errorbar(x,average_dominant_silence,min_dominant_silence-average_dominant_silence,max_domina

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Average Silence - Dominant',1)
  title('Average of all subjects - Dominant Hand - Min&MAx');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
```

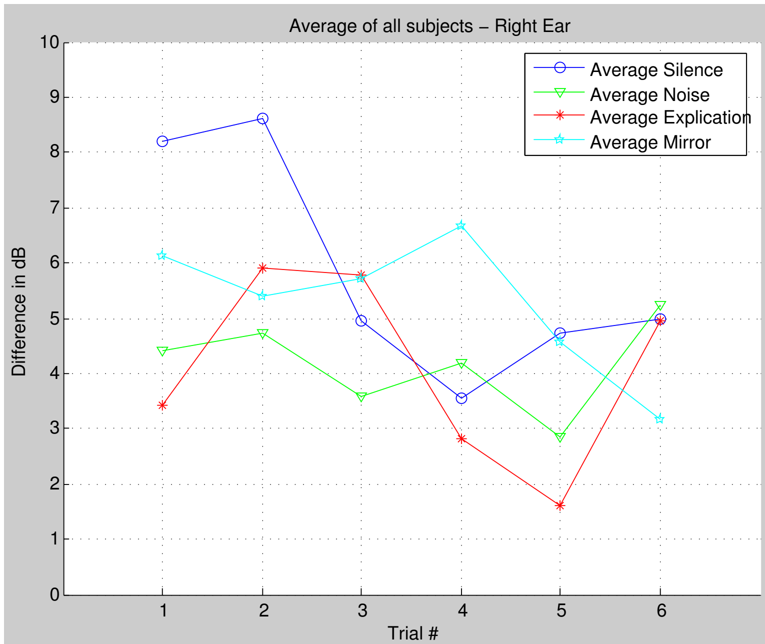
```
  plot(average_dominant_noise,'gv-')
  errorbar(x,average_dominant_noise,min_dominant_noise-average_dominant_noise,max_dominant_n

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Average Noise - Dominant',1)
  title('Average of all subjects - Dominant Hand - Min&Max');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot(average_dominant_explication,'r*-')
  errorbar(x,average_dominant_explication,min_dominant_explication-average_dominant_explicat

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Average Explication - Dominant',1)
  title('Average of all subjects - Dominant Hand - Min&Max');
  axis([0 7 -10 40])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot(average_dominant_mirror,'cp-')

  errorbar(x,average_dominant_mirror,min_dominant_mirror-average_dominant_mirror,max_dominar
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Average Mirror - Dominant',1)
  title('Average of all subjects - Dominant Hand - Min&Max');
  axis([0 7 -10 40])
  grid

 %
```

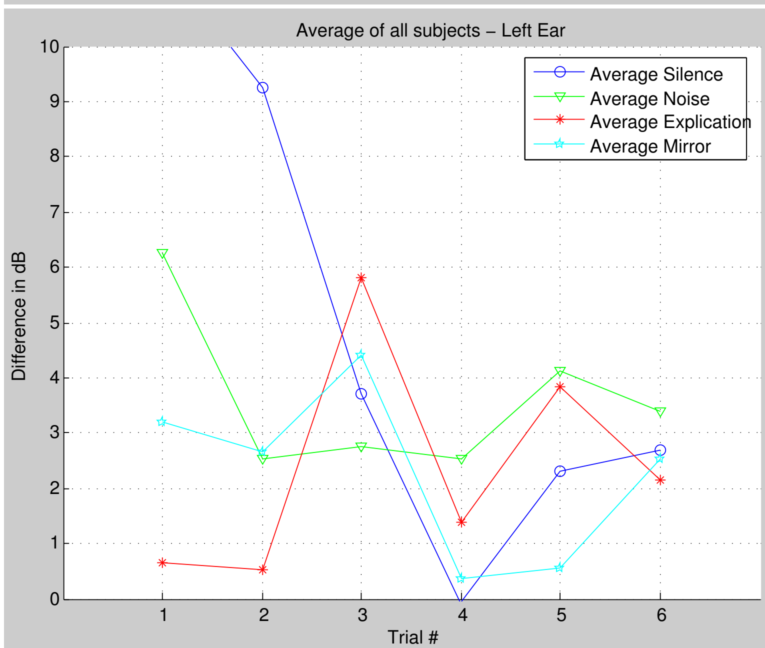
```
 % esclave Min et Max
 %

 x=[1,2,3,4,5,6];

figure;SUBPLOT(2,2,1)
hold on
plot([average_dominant_silence; average_esclave_silence]')
% errorbar(x,average_esclave_silence,min_esclave_silence-average_esclave_silence,max_esclave

set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Strong Hand','Weak Hand')
  title('Silence');
  axis([0 7 -5 20])
  grid
%
% Graph de la condition noise moyenne de tous les sujets
%
  subplot(2,2,2)
  plot([average_dominant_noise;average_esclave_noise]')
%   errorbar(x,average_esclave_noise,min_esclave_noise-average_esclave_noise,max_esclave_noi

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Strong Hand','Weak Hand')
  title('Pink Noise');
  axis([0 7 -5 20])
  grid
%
% Graph de la condition explication moyenne de tous les sujets.
%
  subplot(2,2,3)
  plot([average_dominant_explication;average_esclave_explication]')
%   errorbar(x,average_esclave_explication,min_esclave_explication-average_esclave_explicati

  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
    ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
```

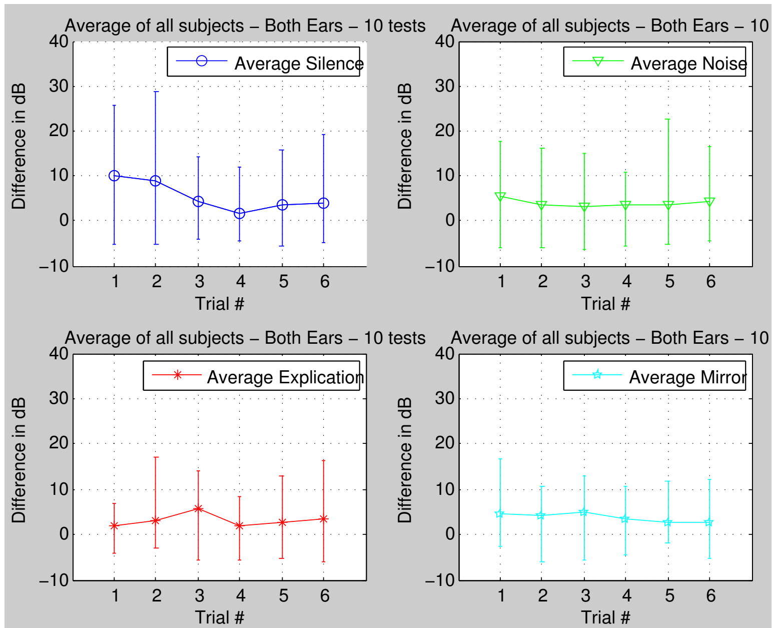
```
  legend('Strong Hand','Weak Hand')
  title('Explanations');
  axis([0 7 -5 20])
  grid
%
% Graph de la condition Mirror moyenne de tous les sujets.
%
  subplot(2,2,4)
  plot([average_dominant_mirror;average_esclave_mirror]')

  %errorbar(x,average_esclave_mirror,min_esclave_mirror-average_esclave_mirror,max_esclave_m
  set(gca,'xtick',(1:6))
  set(gca,'xticklabel',[1 2 3 4 5 6])
  xlabel('Trial #');
%   ylabel('Difference in dB');
  ylabel('PPAR PostCuring-PPAR SubjectFit (dB)');
  legend('Strong Hand','Weak Hand')
  title('Mirror');
  axis([0 7 -5 20])
  grid
```

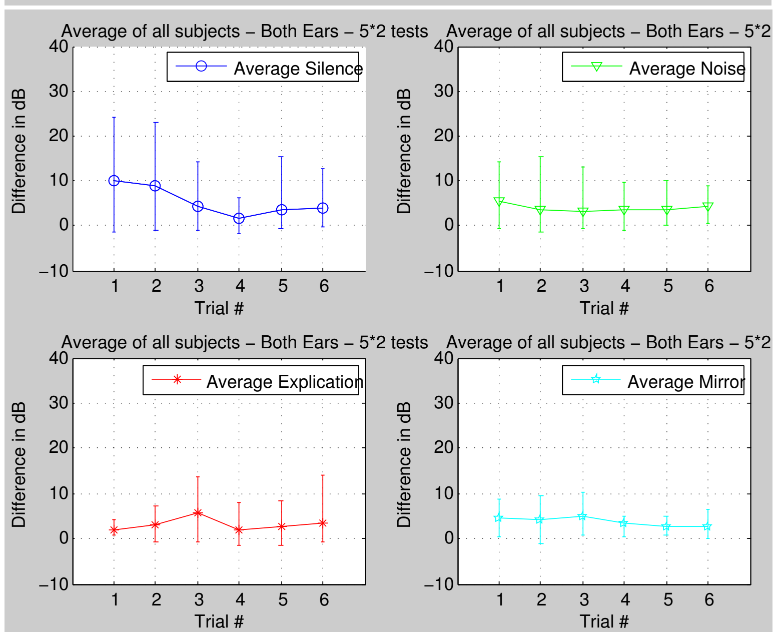
5.2 Other Graphics

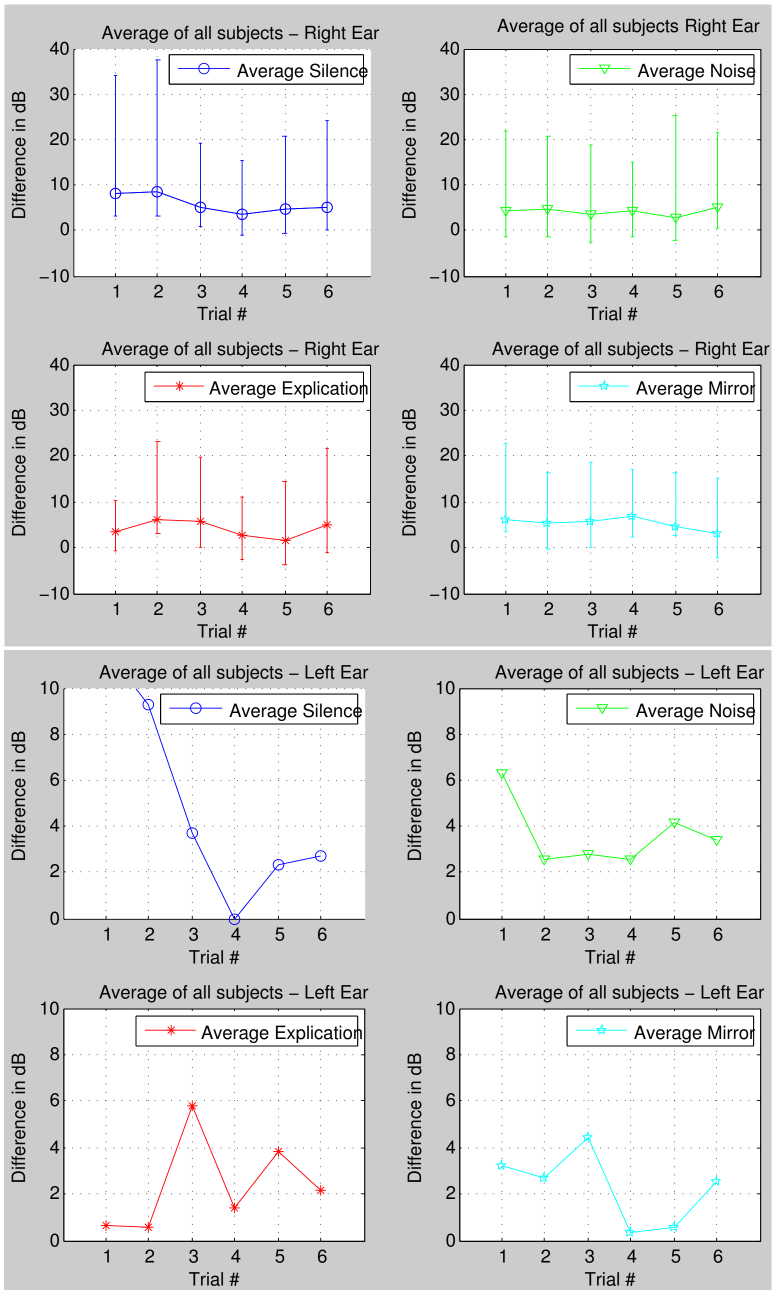


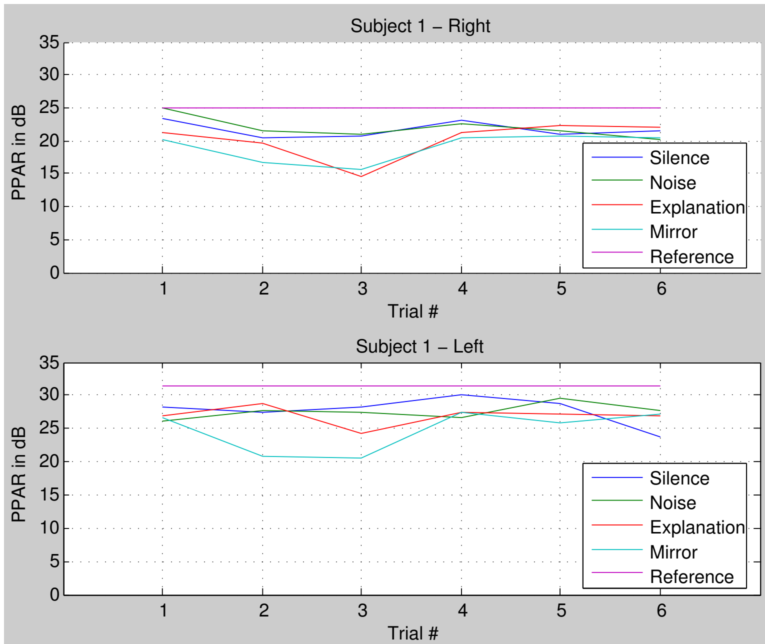

Average of all subjects – Right Ear
Average Silence
Average Noise
Average Explication
Average Mirror
Difference in dB
Trial #
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6

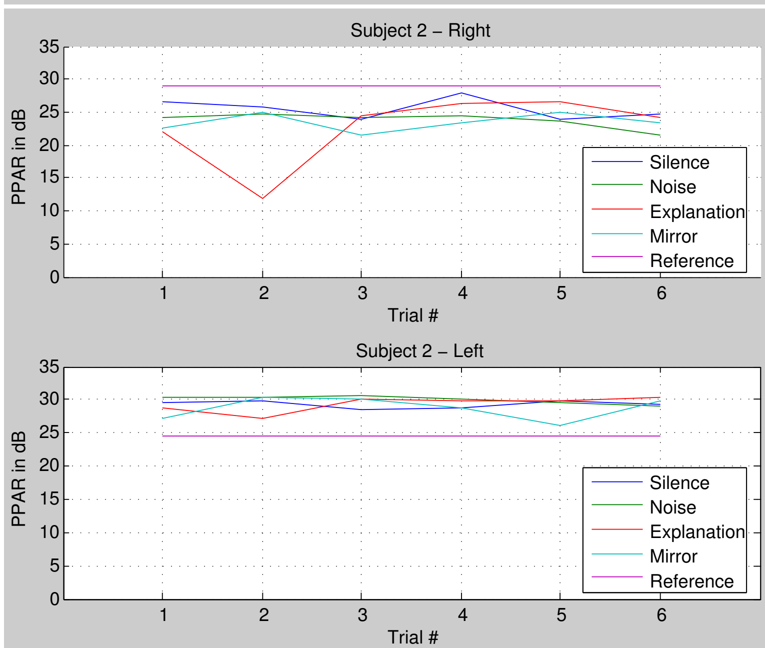

Average of all subjects – Left Ear
Average Silence
Average Noise
Average Explication
Average Mirror
Difference in dB
Trial #
0
1
2
3
4
5
6
7
8
9
10
1
2
3
4
5
6

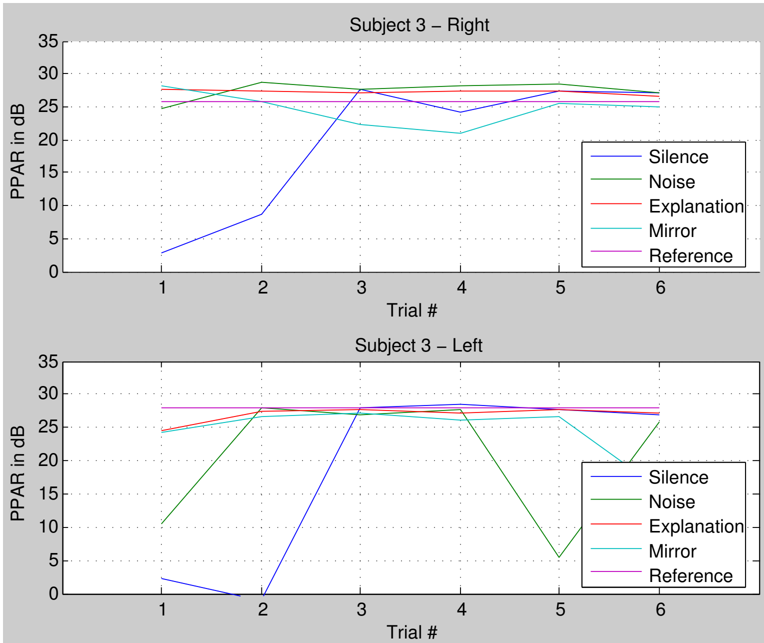

Average of all subjects – Both Ears – 10 tests
Average Silence
Average of all subjects – Both Ears – 10
Average Noise
Average of all subjects – Both Ears – 10 tests
Average Explication
Average of all subjects – Both Ears – 10
Average Mirror
Difference in dB
Trial #
40
30
20
10
0
−10
1
2
3
4
5
6

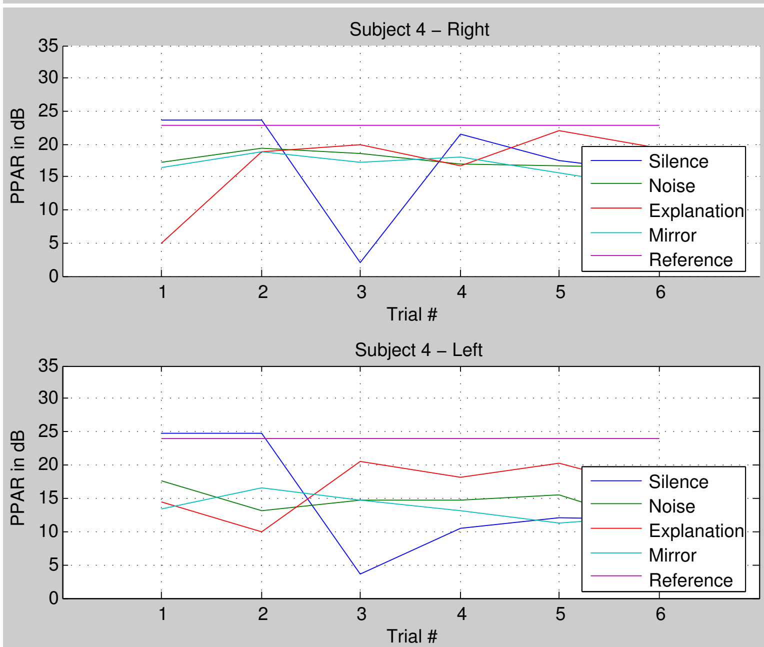

Average of all subjects – Both Ears – 5*2 tests
Average Silence
Average of all subjects – Both Ears – 5*2
Average Noise
Average of all subjects – Both Ears – 5*2 tests
Average Explication
Average of all subjects – Both Ears – 5*2
Average Mirror
Difference in dB
Trial #
40
30
20
10
0
−10
1
2
3
4
5
6

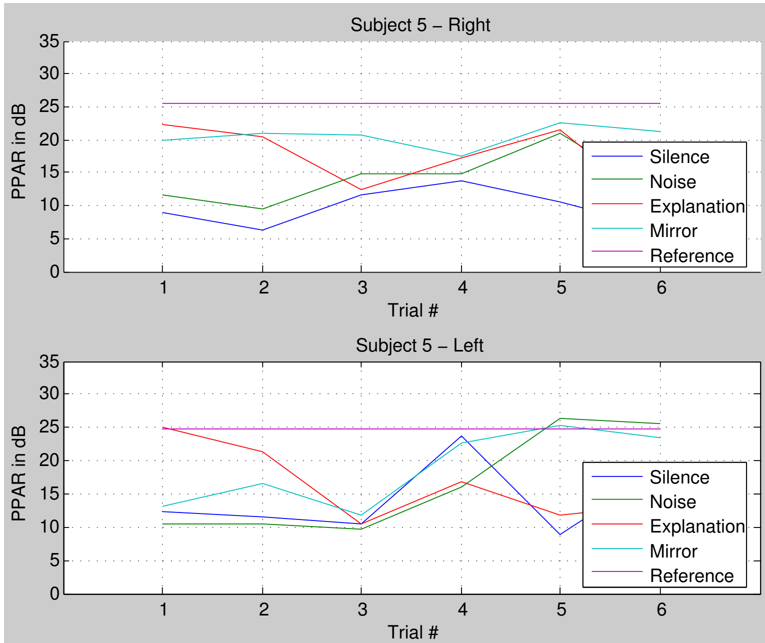

Average of all subjects – Right Ear
Average Silence
Average of all subjects Right Ear
Average Noise
Average of all subjects – Right Ear
Average Explication
Average of all subjects – Right Ear
Average Mirror
Average of all subjects – Left Ear
Average Silence
Average of all subjects – Left Ear
Average Noise
Average of all subjects – Left Ear
Average Explication
Average of all subjects – Left Ear
Average Mirror
Difference in dB
Trial #

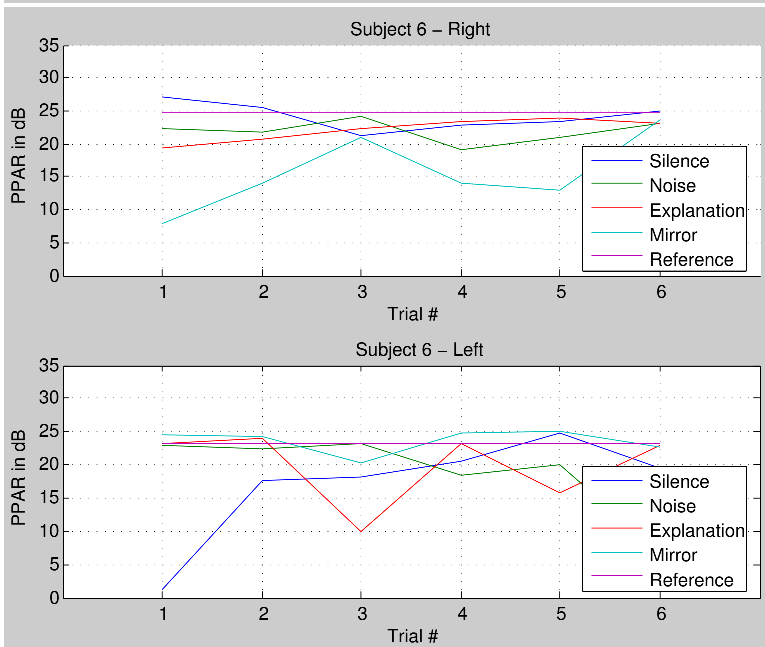

Subject 1 – Right
PPAR in dB
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 1 – Left
PPAR in dB
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Trial #
Silence
Noise
Explanation
Mirror
Reference

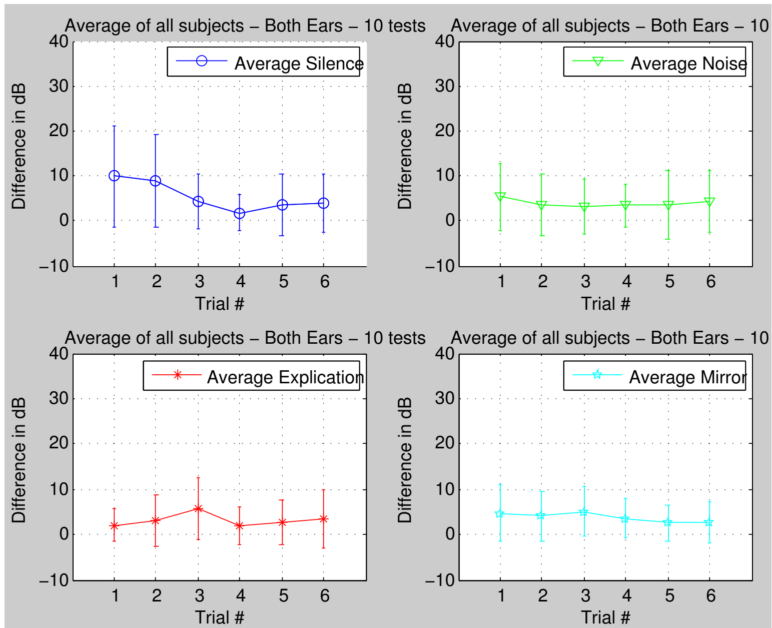

Subject 2 – Right
PPAR in dB
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 2 – Left
PPAR in dB
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Trial #
Silence
Noise
Explanation
Mirror
Reference


Subject 3 – Right
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 3 – Left
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference

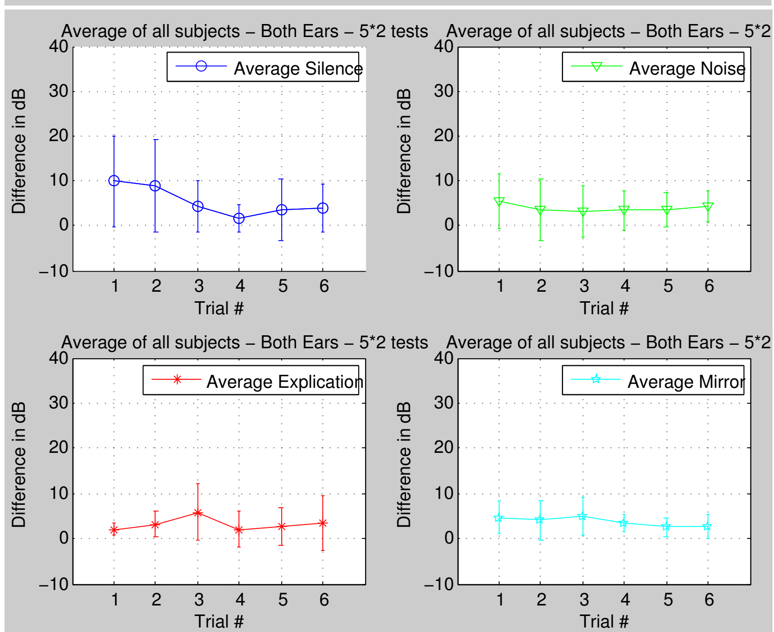

Subject 4 – Right
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 4 – Left
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference


Subject 5 – Right
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 5 – Left
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference

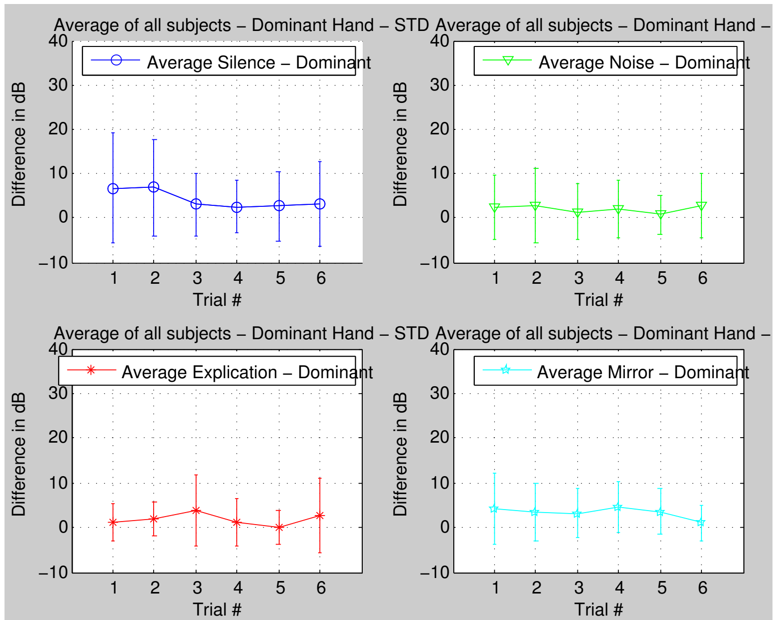

Subject 6 – Right
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference
Subject 6 – Left
PPAR in dB
Trial #
Silence
Noise
Explanation
Mirror
Reference



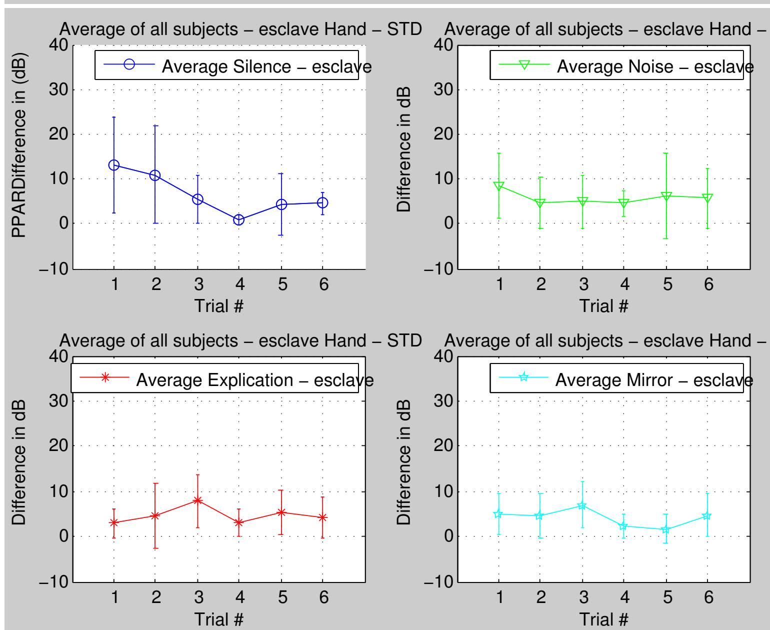
Average of all subjects – Both Ears – 10 tests
Average Silence
Difference in dB
Trial #
40
30
20
10
0
−10
1
2
3
4
5
6
Average of all subjects – Both Ears – 10
Average Noise
Difference in dB
Trial #
Average of all subjects – Both Ears – 10 tests
Average Explication
Difference in dB
Trial #
Average of all subjects – Both Ears – 10
Average Mirror
Difference in dB
Trial #



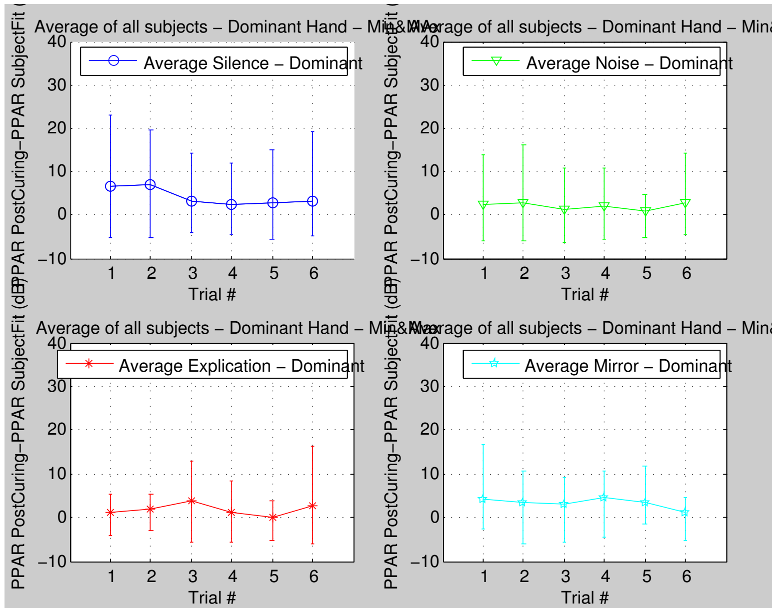
Average of all subjects – Both Ears – 5*2 tests
Average Silence
Difference in dB
Trial #
40
30
20
10
0
−10
1
2
3
4
5
6
Average of all subjects – Both Ears – 5*2
Average Noise
Difference in dB
Trial #
Average of all subjects – Both Ears – 5*2 tests
Average Explication
Difference in dB
Trial #
Average of all subjects – Both Ears – 5*2
Average Mirror
Difference in dB
Trial #

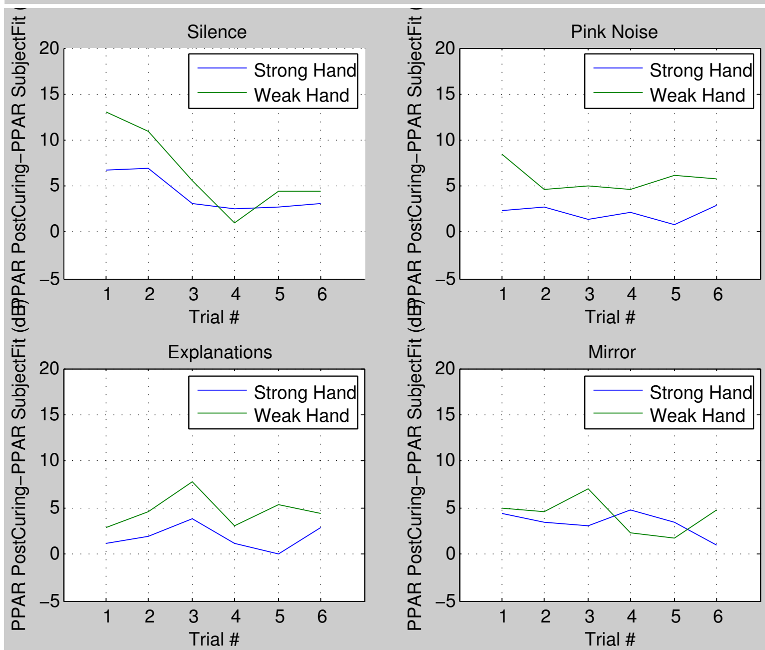


Average of all subjects – Dominant Hand – STD
Average Silence – Dominant
Difference in dB
Trial #
Average of all subjects – Dominant Hand –
Average Noise – Dominant
Difference in dB
Trial #
Average of all subjects – Dominant Hand – STD
Average Explication – Dominant
Difference in dB
Trial #
Average of all subjects – Dominant Hand –
Average Mirror – Dominant
Difference in dB
Trial #



Average of all subjects – esclave Hand – STD
Average Silence – esclave
PPARDifference in (dB)
Trial #
Average of all subjects – esclave Hand –
Average Noise – esclave
Difference in dB
Trial #
Average of all subjects – esclave Hand – STD
Average Explication – esclave
Difference in dB
Trial #
Average of all subjects – esclave Hand –
Average Mirror – esclave
Difference in dB
Trial #


Average of all subjects – Dominant Hand – Min&Max
Average Silence – Dominant
Average Noise – Dominant
Average Explication – Dominant
Average Mirror – Dominant
PPAR PostCuring–PPAR SubjectFit (dB)
Trial #


Silence
Pink Noise
Explanations
Mirror
Strong Hand
Weak Hand
PPAR PostCuring–PPAR SubjectFit (dB)
Trial #