```
% script for memory task anaysis
```

Parameter Setting

```
subject ='Group';
plot_window=[1 25 1920 1080];
home_dir = '/bigvault/Projects/seeg_pointing';
group_dir = '/bigvault/Projects/seeg_pointing/results/memory_group/';

% obj_pic = 51:165; % original [-2,3], save [-0.5,1.5], pic [0,1.15]
% seq_pic = 251:500;% original [-5,7], save [-2.5,5], pic [0,2.5]
% seq_pre = 1:200;  % original [-5,7], save [-2.5,5], pre interval [-2.5,-0.5]
% seq_after = 501:700;% original [-5,7], save [-2.5,5], pre interval [2.5,4.5]

index = [7,13,25,31,43,49];
bd_id = [index,index+18*6];
non_bd_id = [index+18*3,index+18*9];
```

RSA

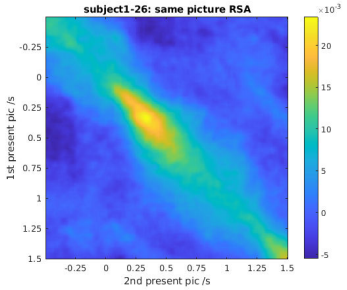
1. same VS different picture RSA
2. pre vs after RSA

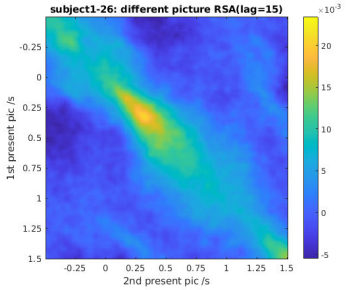
Neural Time Windows in Object Recognition Task

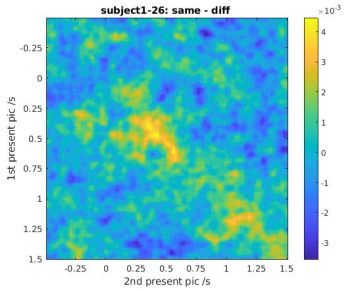
```
% load
load([group_dir,'rsa_obj_group.mat'], 'rsa_group')
disp(['subject: ',num2str(rsa_group.sub_id)])
```

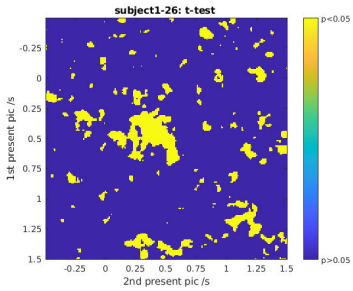
```
subject: 1   2   3   4   7  12  15  16  17  18  19  20  21  24  25  26
```

```
subject ='subject1-26';
rsa_same= rsa_group.same(:,:,1:end);
for lag = 15
    rsa_diff = rsa_group.diff{lag}(:,:,1:end);
    % 1. object same difff
    figure
    plt_rsa_obj_sd(rsa_same, rsa_diff, subject, lag, plot_window)
    % 2. object diag
    %plt_rsa_obj_diag(rsa_same,rsa_diff,subject,lag,plot_window)
end
```





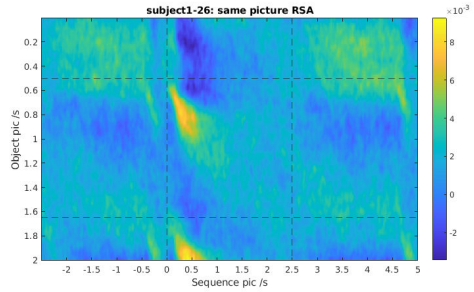


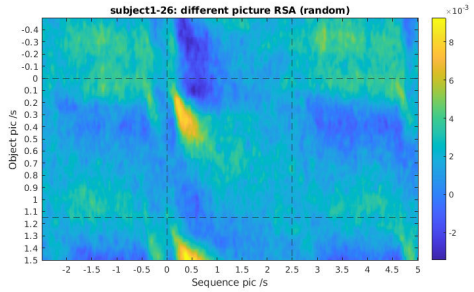


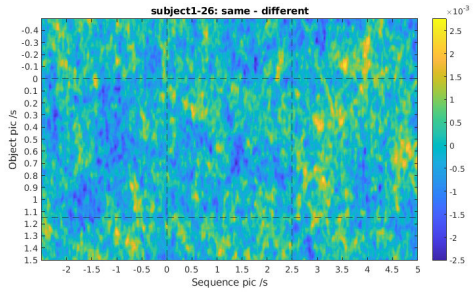
picture pair=16

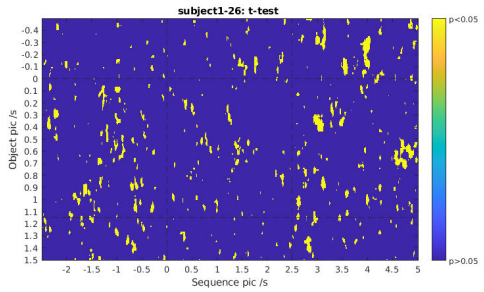
Consistency of neural activity across Object and Sequence

```
rsa_obj2seq_group = load_mat([group_dir,'rsa_obj2seq_group.mat']);
rsa_same = rsa_obj2seq_group.same;
rsa_diff = rsa_obj2seq_group.diff;
method = 'ttest';

% 4. obj2seq same difff
plt_rsa_obj2seq_sd(rsa_same,rsa_diff,subject,plot_window)
```

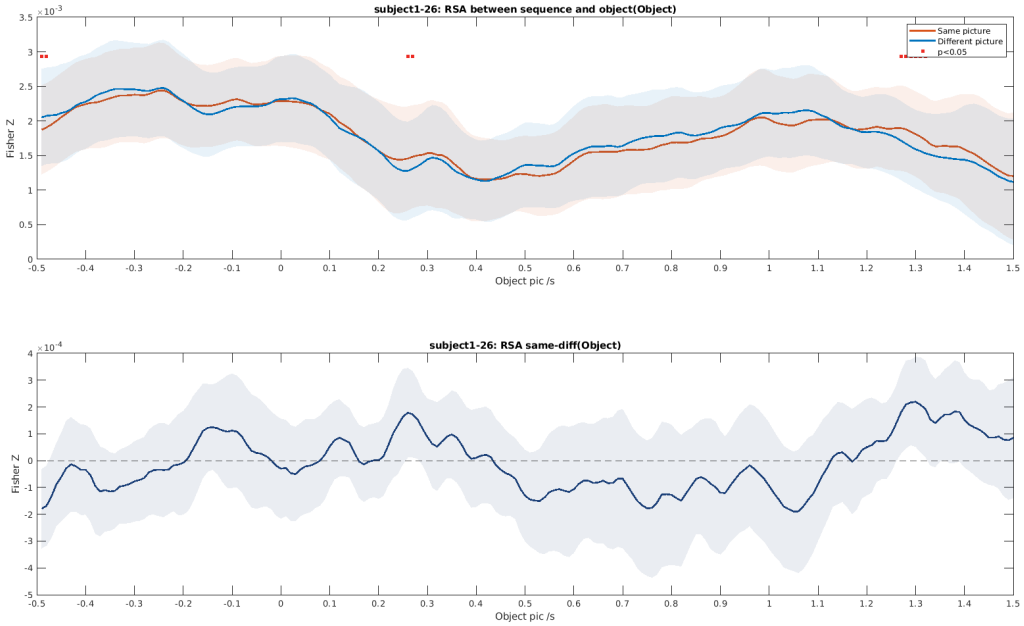




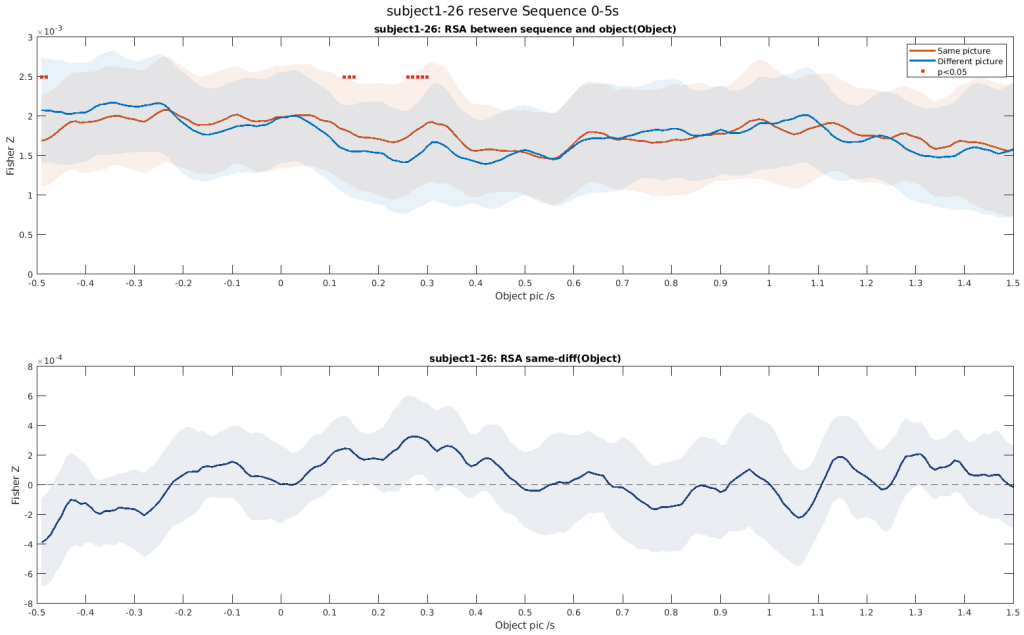




```
% 5. obj2seq flatten (to obj axis)
%plt_rsa_obj2seq_flatten(rsa_same, rsa_diff, 1, subject, plot_window)
plt_rsa_obj2seq_flatten(rsa_same, rsa_diff, 2, subject, plot_window)
```

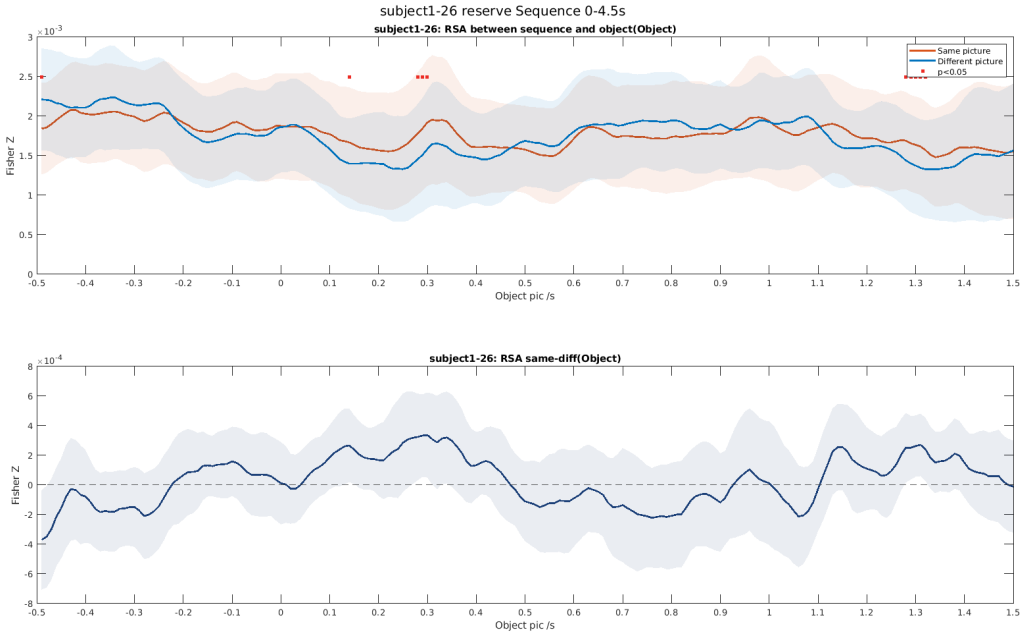



```
% sequence 0-5s
plt_rsa_obj2seq_flatten(rsa_same(:,251:750,:), rsa_diff(:,251:750,:), 2, subject, plot_
sgtitle([subject,' reserve Sequence 0-5s'])
```




```
% sequence 0-4.5s
plt_rsa_obj2seq_flatten(rsa_same(:,251:700,:), rsa_diff(:,251:700,:), 2, subject, plot_
```

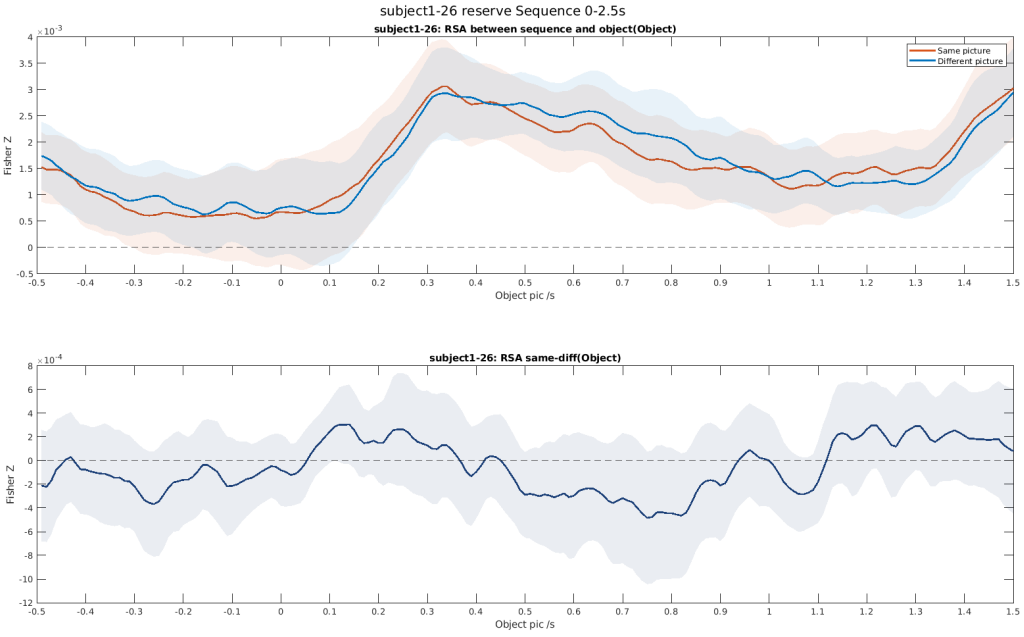
```
sgtitle([subject,' reserve Sequence 0-4.5s'])
```




```
% sequence 0-2.5s
plt_rsa_obj2seq_flatten(rsa_same(:,251:500,:), rsa_diff(:,251:500,:), 2, subject, plot_
```

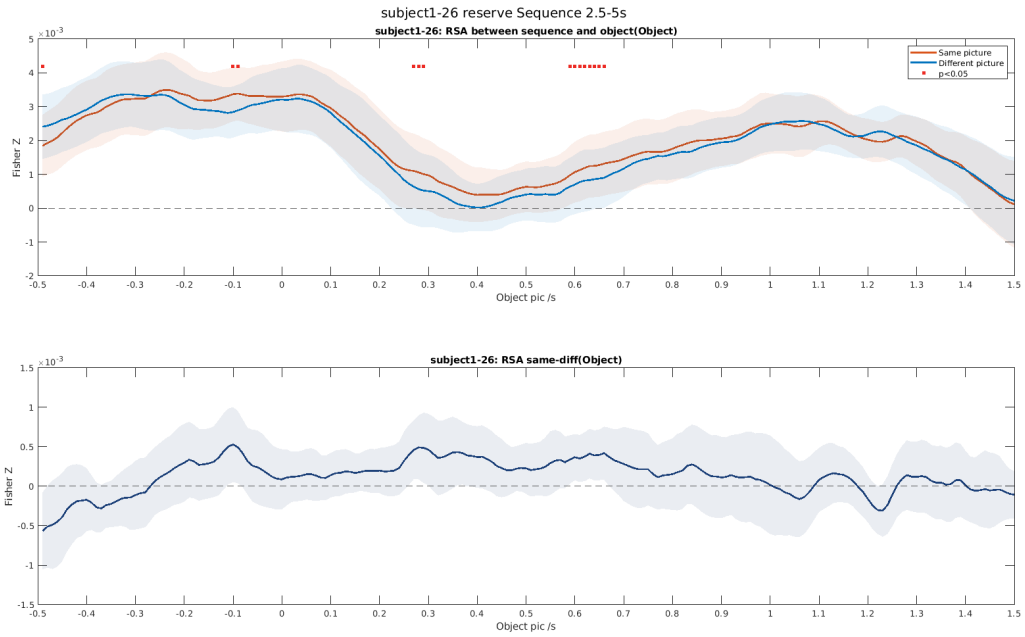
```
Warning: Ignoring extra legend entries.
```

```
sgtitle([subject,' reserve Sequence 0-2.5s'])
```

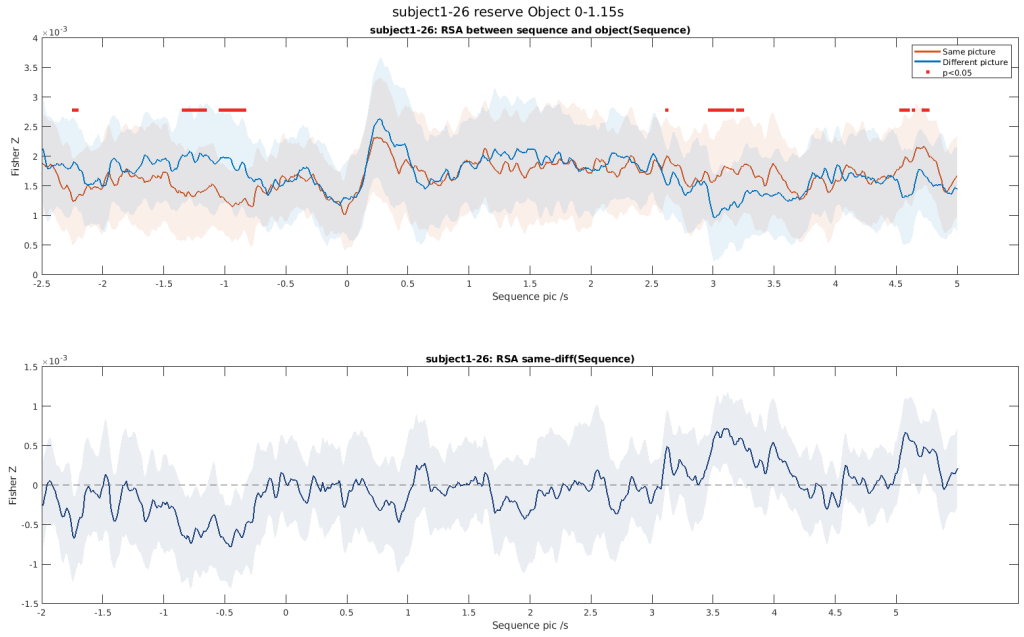



```
% sequence 2.5-4.5s
```

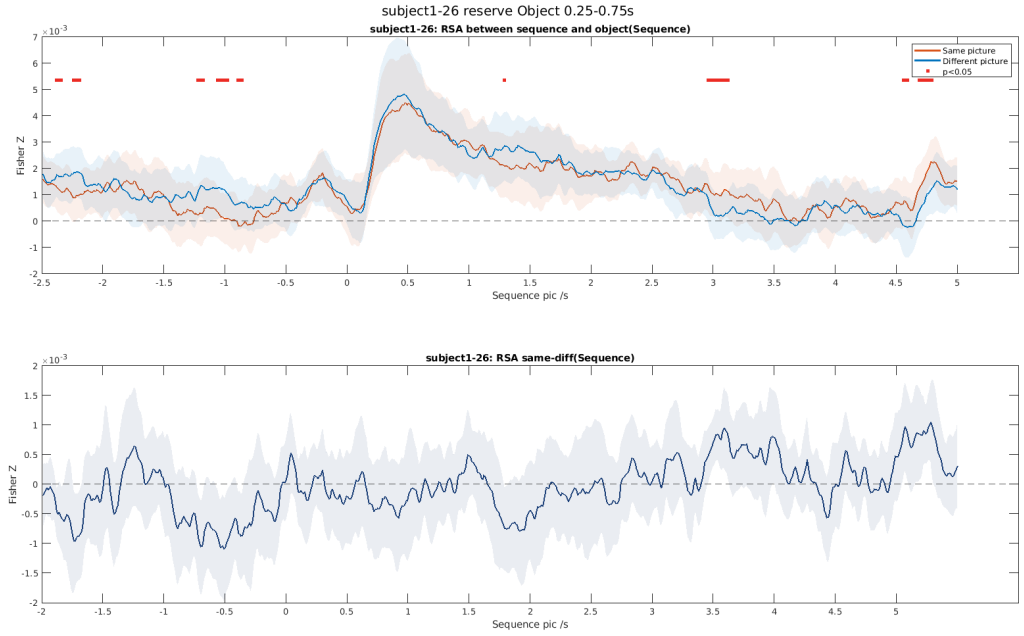
```
plt_rsa_obj2seq_flatten(rsa_same(:,501:750,:), rsa_diff(:,501:750,:), 2, subject, plot_
sgtitle([subject,' reserve Sequence 2.5-5s'])
```



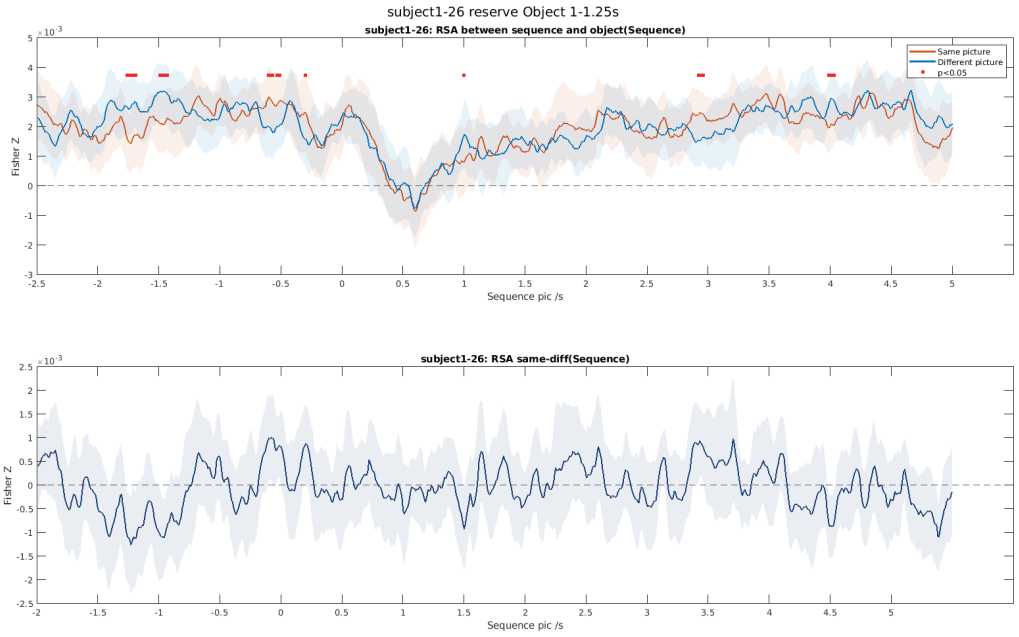

```
% sequence 2.5-4.5s/5s
%plt_rsa_obj2seq_flatten(rsa_same(:,251:750,:), rsa_diff(:,251:750,:), 2, subject, plot
%sgtitle([subject,' reserve Sequence 0-5s'])

% 5. obj2seq flatten (to seq axis)
% Object 0-1.15s
plt_rsa_obj2seq_flatten(rsa_same(51:165,:,:), rsa_diff(51:165,:,:), 1, subject, plot_wi
sgtitle([subject,' reserve Object 0-1.15s'])
```




```
% Object 0.25-0.75s
plt_rsa_obj2seq_flatten(rsa_same(76:125,:,:), rsa_diff(76:125,:,:), 1, subject, plot_wi
sgtitle([subject,' reserve Object 0.25-0.75s'])
```

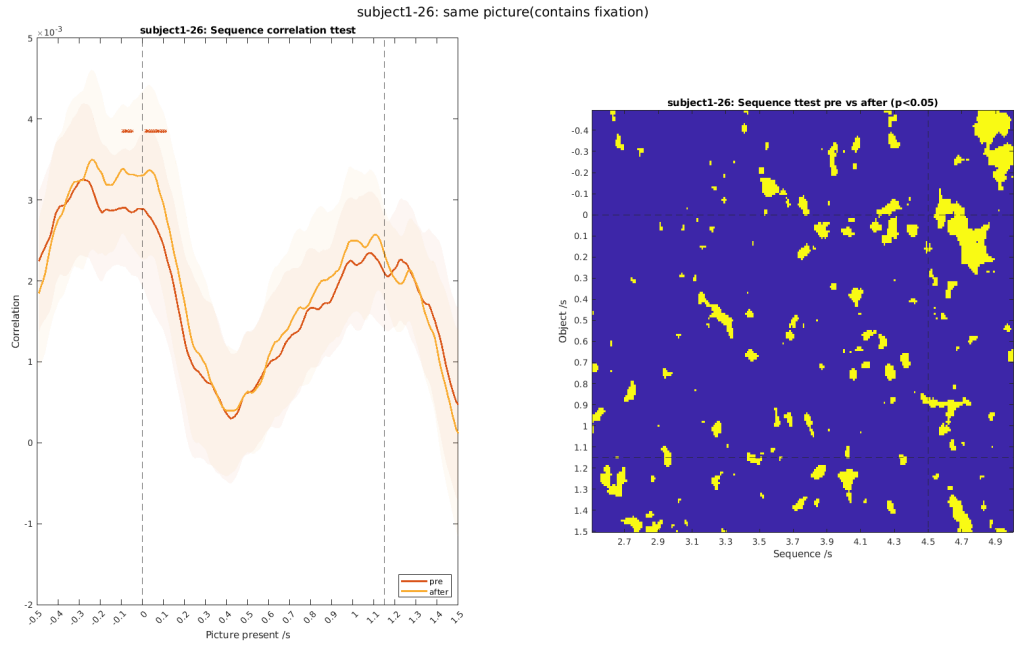



```
% Object 1-1.25s
plt_rsa_obj2seq_flatten(rsa_same(151:175,:,:), rsa_diff(151:175,:,:), 1, subject, plot_
sgtitle([subject,' reserve Object 1-1.25s'])
```



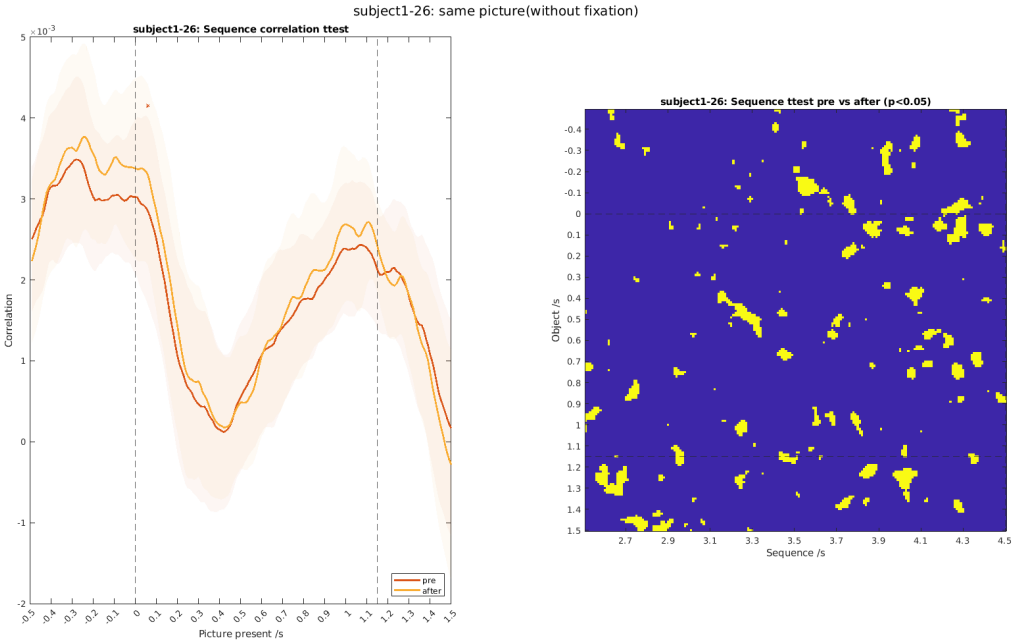
Consistency of neural activity across pre and after in Obj2Seq

```
% 6. obj2seq region123 (same picture: pre vs after)
% contains fixation
plt_rsa_obj2seq_pre_after(rsa_same,subject,plot_window,method,'contains_fixation')
sgtitle([subject,': same picture(contains fixation)'])
```




```
% without fixation
plt_rsa_obj2seq_pre_after(rsa_same,subject,plot_window,method,'without_fixation')
```

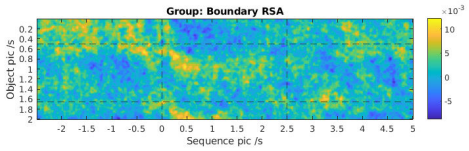
```
sgtitle([subject,': same picture(without fixation)'])
```

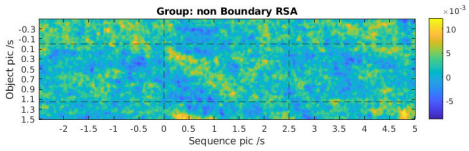


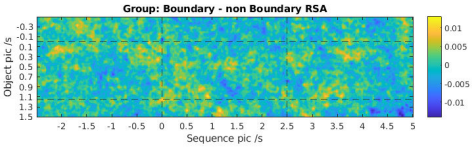
Boundary effect RSA?

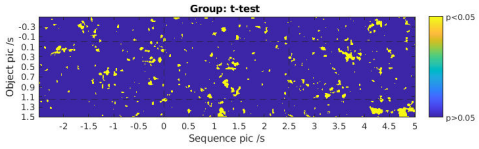
obj2sequence: boundary vs boundary

```
load(([group_dir,'rsa_obj2seq_bd.mat']))
obj2seq_bd = cell2matrix(rsa_group.bd);
obj2seq_non_bd = cell2matrix(rsa_group.non_bd);
plt_rsa_obj2seq_sd(obj2seq_bd,obj2seq_non_bd,'Group',plot_window)
subplot(2,2,1);title([subject,': Boundary RSA'])
subplot(2,2,2);title([subject,': non Boundary RSA'])
subplot(2,2,3);title([subject,': Boundary - non Boundary RSA'])
```



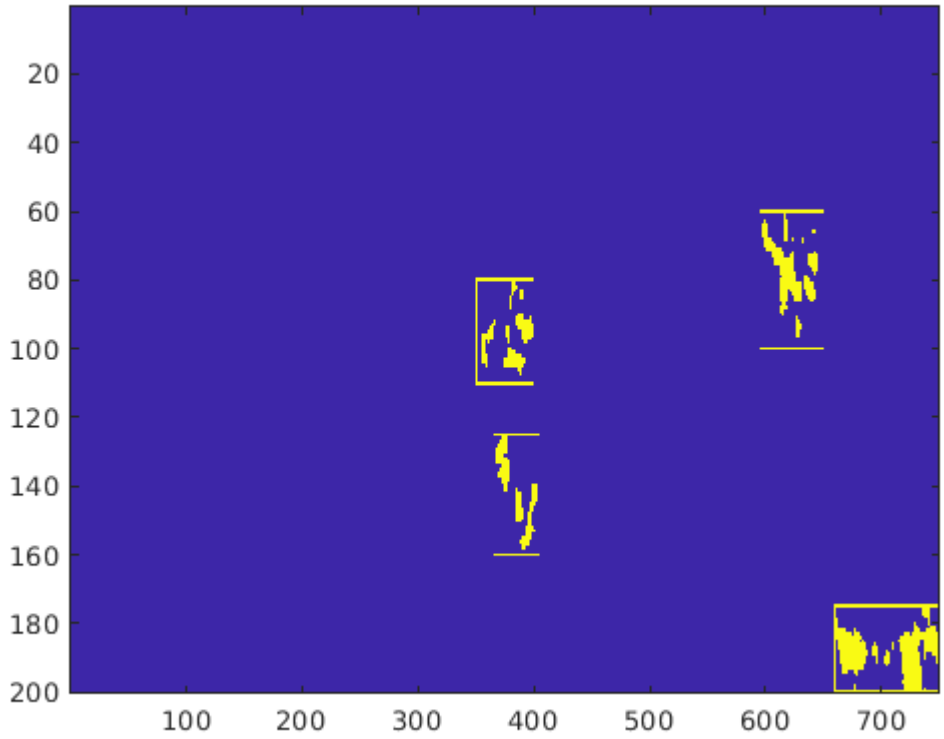




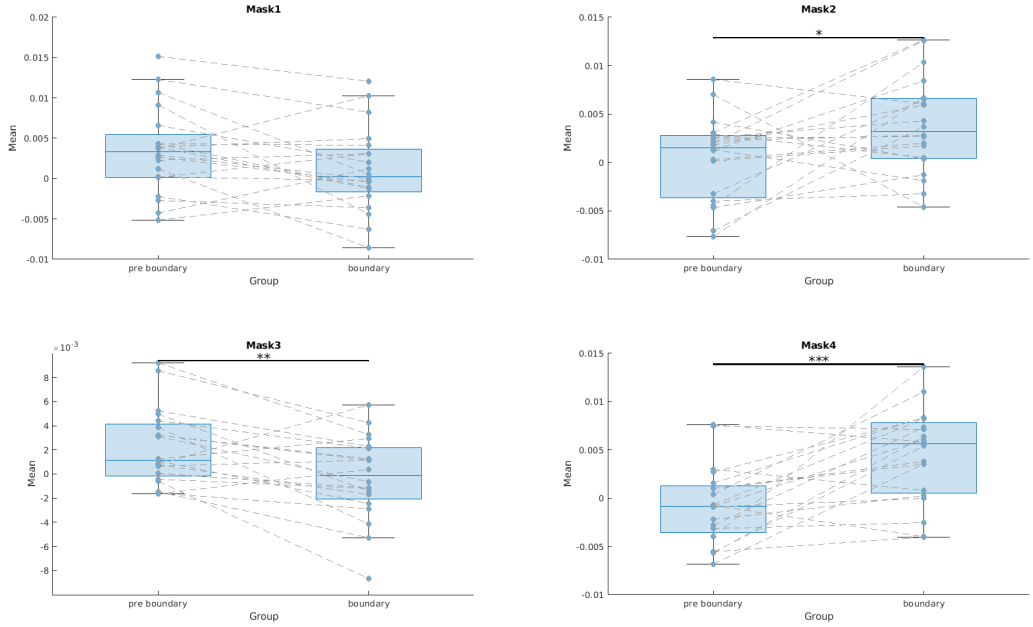


subjects number=20

```
% calculate pic_coor_h
pic_corr_h=[];
for i=1:size(obj2seq_bd,1)
    for j=1:size(obj2seq_bd,2)
        [pic_corr_h(i,j),~]=ttest(squeeze(obj2seq_bd(i,j,:)),squeeze(obj2seq_non_bd(i,j
    end
end

% set mask
mask_temp{1,1} = [80:110];mask_temp{1,2} = [350:400];
mask_temp{2,1} = [125:160];mask_temp{2,2} = [365:405];
mask_temp{3,1} = [60:100];mask_temp{3,2} = [595:650];
mask_temp{4,1} = [175:200];mask_temp{4,2} = [660:750];

% plot mask
mask = zeros(200,750);
for i = 1:4
    mask(mask_temp{i,1},mask_temp{i,2})=1;
end
BW2 = bwperim(mask, 4);
figure;imagesc(mask.*pic_corr_h|BW2)
```

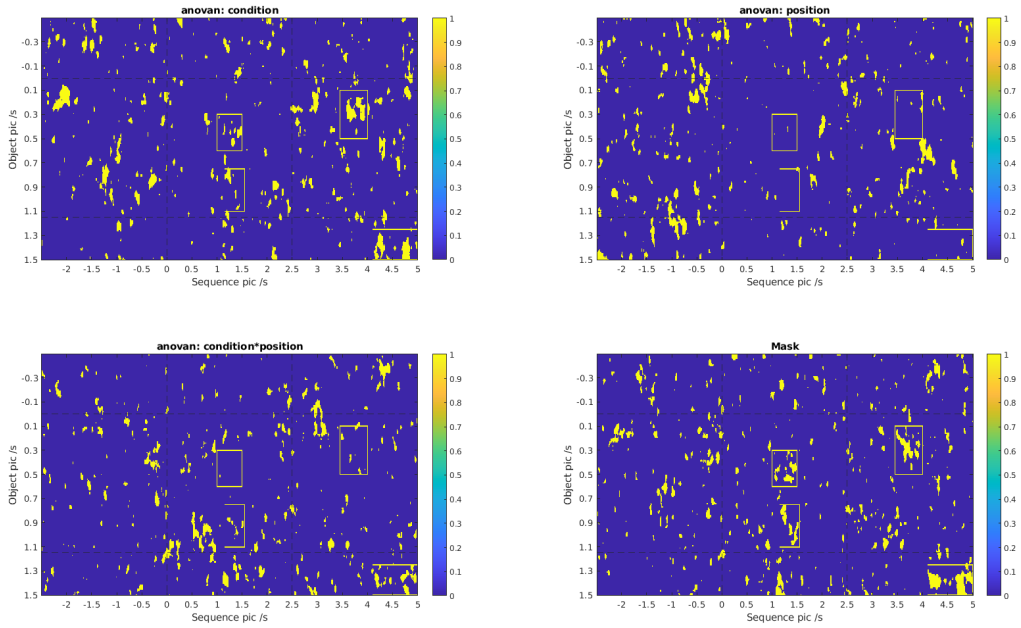



```
% plot mean value in each mask

obj2seq1 = cell2matrix(rsa_group.bd);
obj2seq2 = cell2matrix(rsa_group.non_bd);
obj2seq = cat(3, cell2matrix(rsa_group.bd),cell2matrix(rsa_group.bd_pre),cell2matrix(rs
condition  = reshape(repmat([1,1,2,2], 20, 1),[],1);
position  = reshape(repmat([1,2,1,2], 20, 1),[],1);
figure
for i=1:4
    subplot(2,2,i)
    mask_bd = squeeze(mean(mean(obj2seq1(mask_temp{i,1},mask_temp{i,2},:),1),2));
    mask_non_bd = squeeze(mean(mean(obj2seq2(mask_temp{i,1},mask_temp{i,2},:),1),2));
    plt_bar_line([mask_bd ,mask_non_bd],{'pre boundary','boundary'})
    title(['Mask',num2str(i)])
end
```




```
% anova
p=[];
for i = 1:size(obj2seq,1)
    for j=1:size(obj2seq,2)
        p(i,j,:) = anovan(squeeze(obj2seq(i,j,:)),{condition position},'model','interac
    end
end

a = p; a(a<0.05)=-1; a(a>=0.05)=0; a=abs(a);
anovan_name = {'condition','position','condition*position'};
figure
for i= 1:4
    subplot(2,2,i)
    if i<4
        imagesc(a(:,:,i)|BW2)
        title(['anovan: ',anovan_name{i}])
    else
        imagesc(pic_corr_h|BW2)
        title('Mask')
    end
    yticks(0:20:200);
    yticklabels([-50:20:150]/100);
    ylabel('Object pic /s')
    yline(50,'--')
    yline(165,'--')
    xticks(0:50:750);
    xticklabels([-250:50:500]/100);
    xlabel('Sequence pic /s')
    xline(250,'--')
    xline(500,'--')
    colorbar()
```

```
end
set(gcf, 'Position', [1 25 1920 1080]);
```

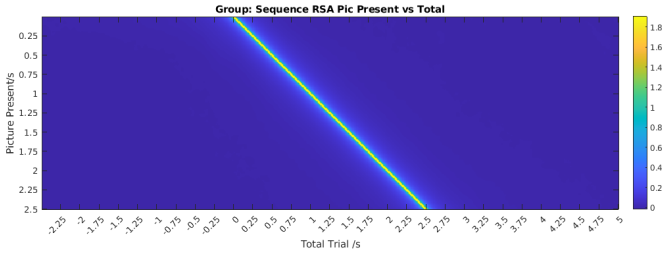


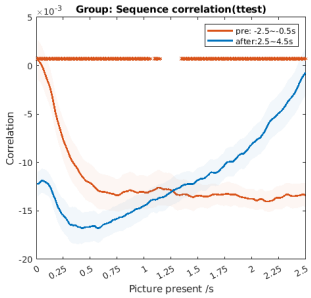
sequence2sequence: boundary vs boundary

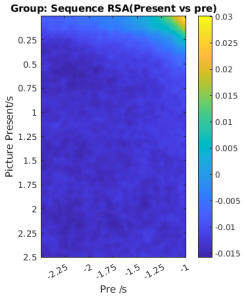
```
% Atantion!!! the mean corr in this part is negtive
load(([group_dir,'rsa_seq_group.mat']))
```

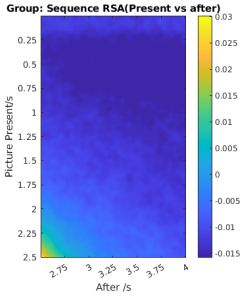
pic vs total

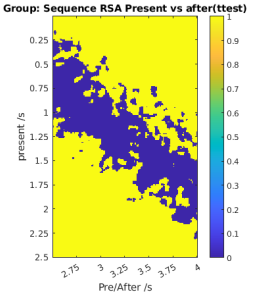
```
% plot seq_pic_total
plt_rsa_seq_pic_total(rsa_group.pic_total, subject, plot_window)
```



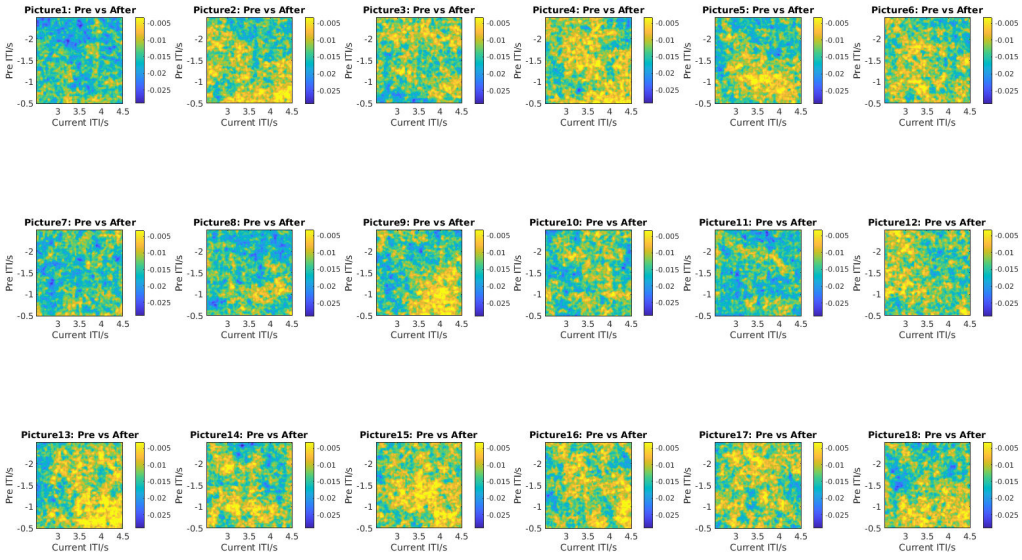




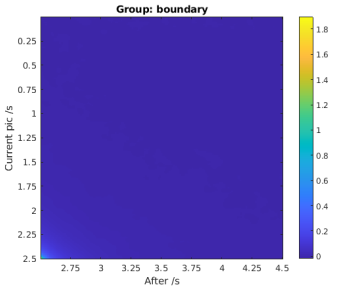


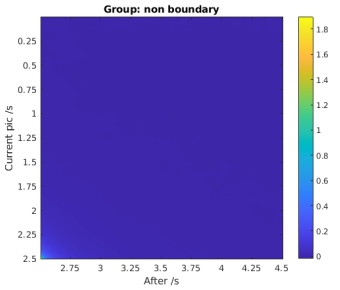


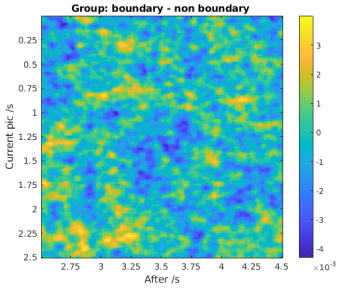
Boundary: pre_after

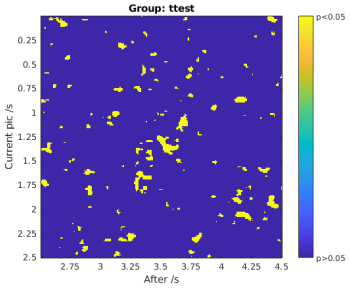



```
% current vs after
pic_total_bd = squeeze(mean(rsa_group.position.pic_total.bd,3));
pic_total_non_bd = squeeze(mean(rsa_group.position.pic_total.non_bd,3));
plt_rsa_seq_sd(pic_total_bd(:,501:700,:), pic_total_non_bd(:,501:700,:), subject, plot_
```

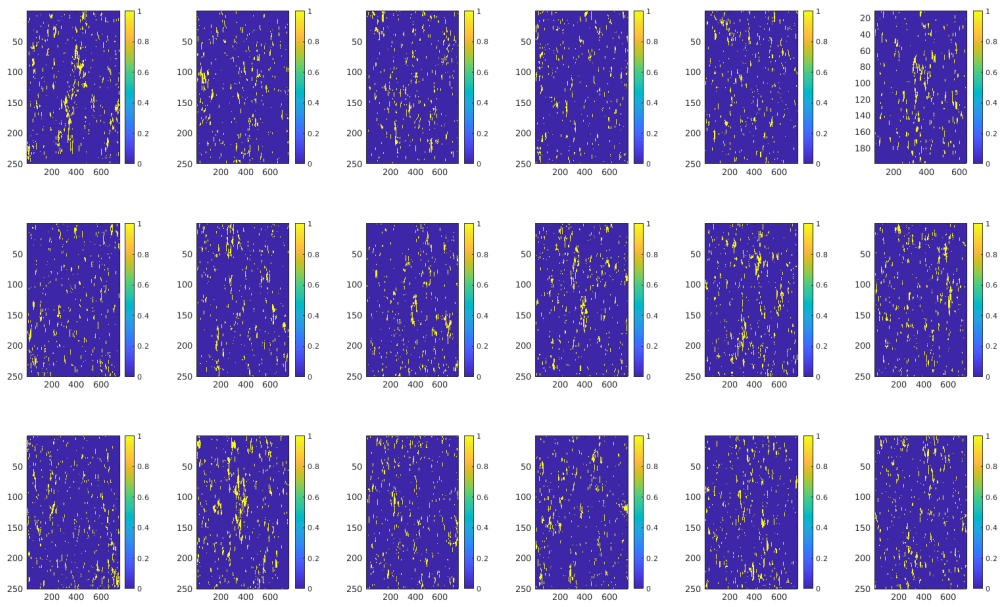








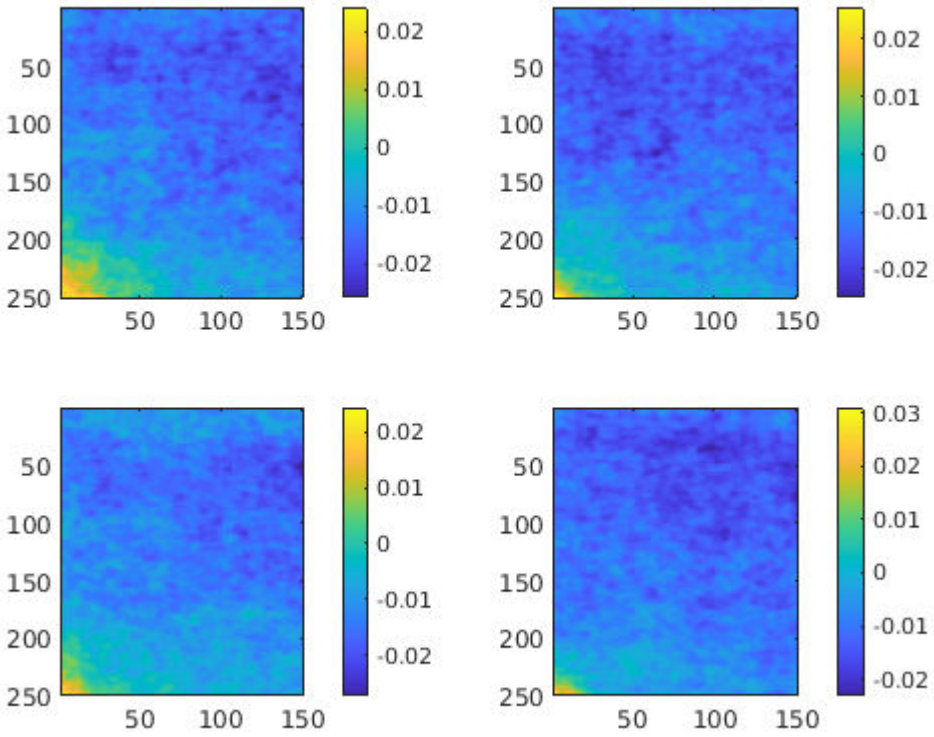

```
% boundary vs non bounday
pic_total_bd18 = rsa_group.position.pic_total.bd;
pic_total_non_bd18 = rsa_group.position.pic_total.non_bd;
ttest_h = [];
for pici =1:18
    for i =1:size(pic_total_bd,1)
        for j=1:size(pic_total_bd,2)
            ttest_h(i,j,pici)=ttest(pic_total_bd18(i,j,pici,:),pic_total_non_bd18(i,j,p
        end
    end
end
plt_pic18(ttest_h,'pic_total')
```



```
% boundary-6-before vs non_boundary-6-before (after-after)
plt_rsa_seq_sd(rsa_group.isnr.boundary, rsa_group.isnr.non_boundary, subject, plot_windo

% position
position_name ={'pic_total_bd','pic_total_pre_bd','pic_total_non_bd','pic_total_pre_non
```

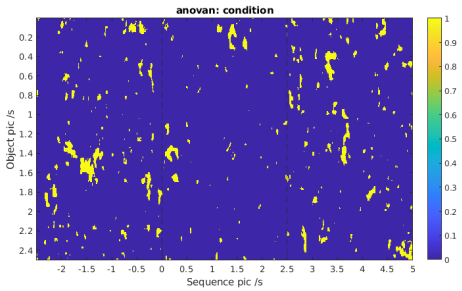
```
position_name = 1×4 cell
'pic_total_bd'    'pic_total_pre_bd'    'pic_total_non_bd'    'pic_total_pre_non ···
```

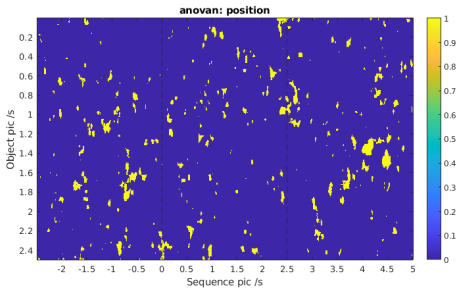
```
data_position.pic_total_bd = squeeze(mean(rsa_group.position.pic_total.bd(:,:,[7,13],:)
data_position.pic_total_pre_bd = squeeze(mean(rsa_group.position.pic_total.bd(:,:,[6,12
data_position.pic_total_non_bd = squeeze(mean(rsa_group.position.pic_total.non_bd(:,:,[
data_position.pic_total_pre_non_bd = squeeze(mean(rsa_group.position.pic_total.non_bd(:

seq = [];
figure
for i = 1:4
    subplot(2,2,i)
    imagesc(mean(data_position.(position_name{i})(:,551:700,:),3))
    seq = cat(3,seq,data_position.(position_name{i}));
    colorbar()
end
```

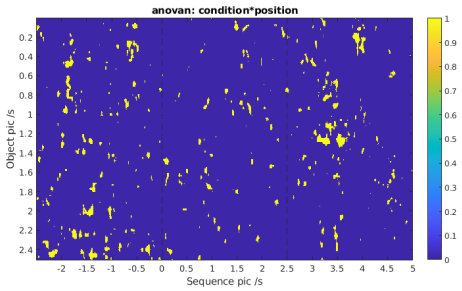



```
condition  = reshape(repmat([1,1,2,2], 20, 1),[],1);
position  = reshape(repmat([1,2,1,2], 20, 1),[],1);
p=[];
for i = 1:size(seq,1)
    for j=1:size(seq,2)
        p(i,j,:) = anovan(squeeze(seq(i,j,:)),{condition position},'model','interaction
    end
end

% anova: condition * position
a = p; a(a<0.05)=-1; a(a>=0.05)=0; a=abs(a);
anovan_name = {'condition','position','condition*position'};
figure
for i= 1:3
    subplot(2,2,i)
    if i<4
        imagesc(a(:,:,i))
        title(['anovan: ',anovan_name{i}])
    else
        imagesc(pic_corr_h)
        title('Mask')
    end
    yticks(0:20:250);
    yticklabels([0:20:250]/100);
    ylabel('Object pic /s')
    xticks(0:50:750);
    xticklabels([-250:50:500]/100);
```

```
    xlabel('Sequence pic /s')
    xline(250,'--')
    xline(500,'--')
    colorbar()
end
set(gcf, 'Position', [1 25 1920 1080]);
```

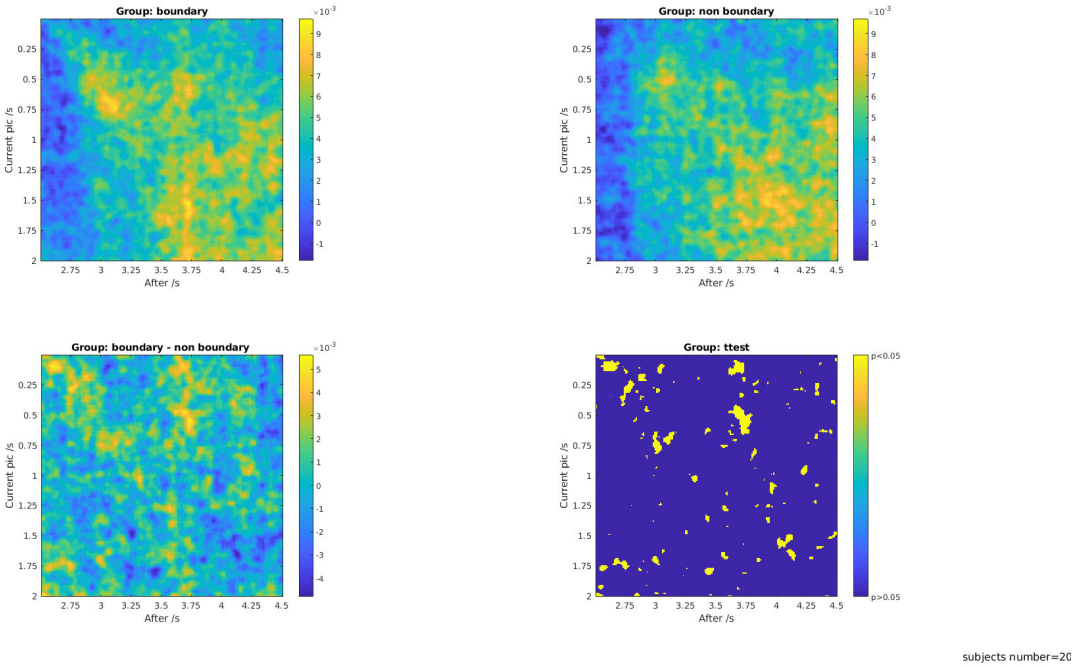






pre vs after

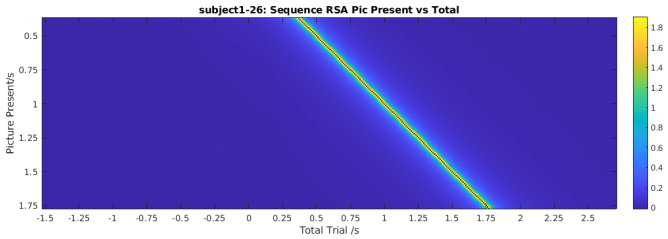
```
% 1-18 picture (pre vs after)
plt_pic18(mean(rsa_group.position.pre_after.bd,4),'pre_after')
sgtitle('Boundary: pre_after')

seq_pre = rsa_group.pic_total(:,1:200,:);
seq_after = rsa_group.pic_total(:,501:700,:);
```

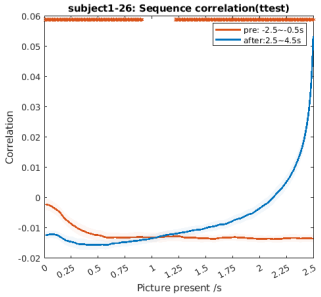


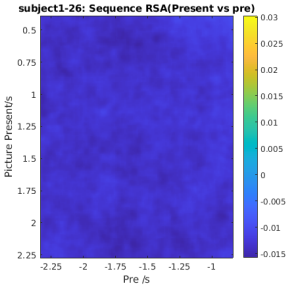
Item Specific Representation

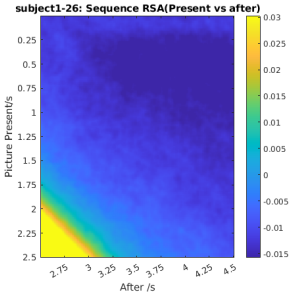
Pre/After vs current stimulus

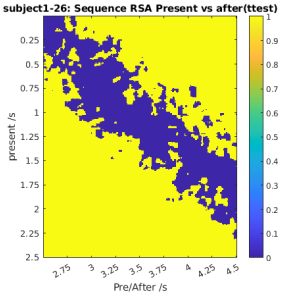
```
% sequence2sequence
load([group_dir,'rsa_seq_pic_total_group.mat']);
rsa_seq = tanh(rsa_seq_pic_total_group.same);
%rsa_seq(rsa_seq==inf)= nan;

% pic vs total
plt_rsa_seq_pic_total(tanh(rsa_seq), subject, plot_window)
```

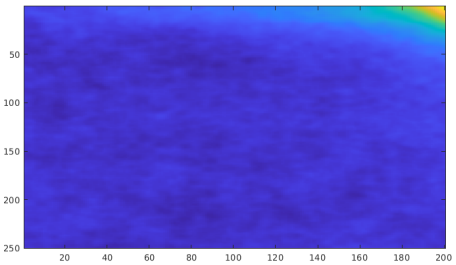


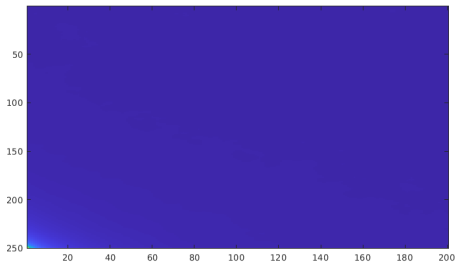


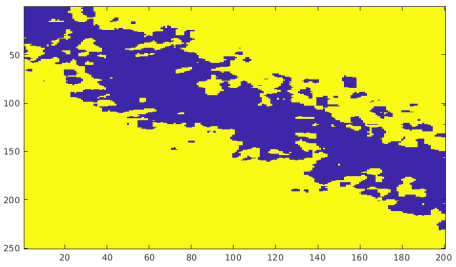


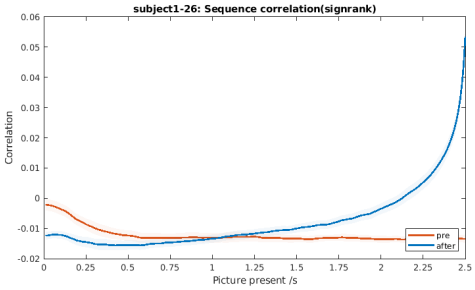












Hippocampus

Neural Time Windows in Object Recognition Task

Consistency of neural activity across Object and Sequence

Consistency of neural activity across pre and after in Sequence

Pre/After vs current stimulus

Power change in Boundary and Nonboundary

channel 2 subject

```
wavelet_subject = load_mat([group_dir,'Hippocampus_subject.mat']);

wavelet_subject = [];

subjects =unique(wavelet_group.info(:,1))
for j = 1:length(subjects)
    subject=subjects(j);
    ids = find(wavelet_group.info(:,1)==subject);
    for i=1:18
        wavelet_subject.data_bd{subject,i} = mean(cell2matrix(wavelet_group.data_bd(ids
        wavelet_subject.data_non_bd{subject,i} = mean(cell2matrix(wavelet_group.data_no
    end
end
wavelet_subject.info = wavelet_group.info;
wavelet_subject.subjects =subjects;
```

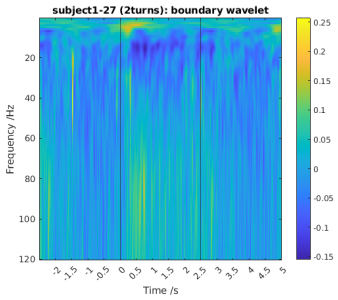
```
% load wavlet data for subject
load([group_dir,'Hippocampus_wavelet_subject.mat']);
```

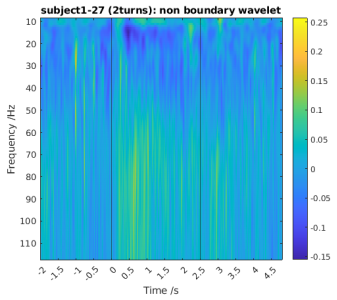
Boundary turns vs nonBoundary turns

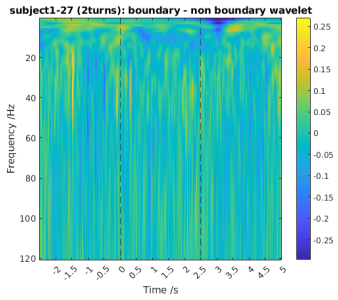
total

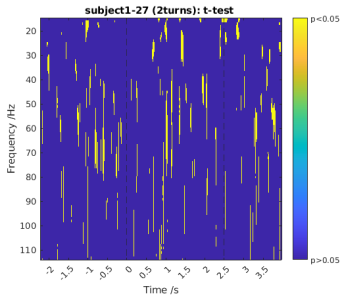
```
subject='subject1-27 (2turns)';
data_bd = [];
data_non_bd = [];
subjects =wavelet_subject.subjects;
for subi=1:length(subjects)
    data_bd(:,:,subi) = mean(cell2matrix(wavelet_subject.data_bd(subjects(subi),7:18)),
    data_non_bd(:,:,subi) = mean(cell2matrix(wavelet_subject.data_non_bd(subjects(subi)
end
wavelet_porr_h = [];
for i = 1:size(data_bd,1)
    for j = 1:size(data_bd,2)
         [wavelet_porr_h(i,j),~] = ttest(squeeze(data_bd(i,j,:)),squeeze(data_non_bd(i,
    end
```

```
end
plt_wavelet_region_bd(data_bd, data_non_bd, subject, plot_window)
```







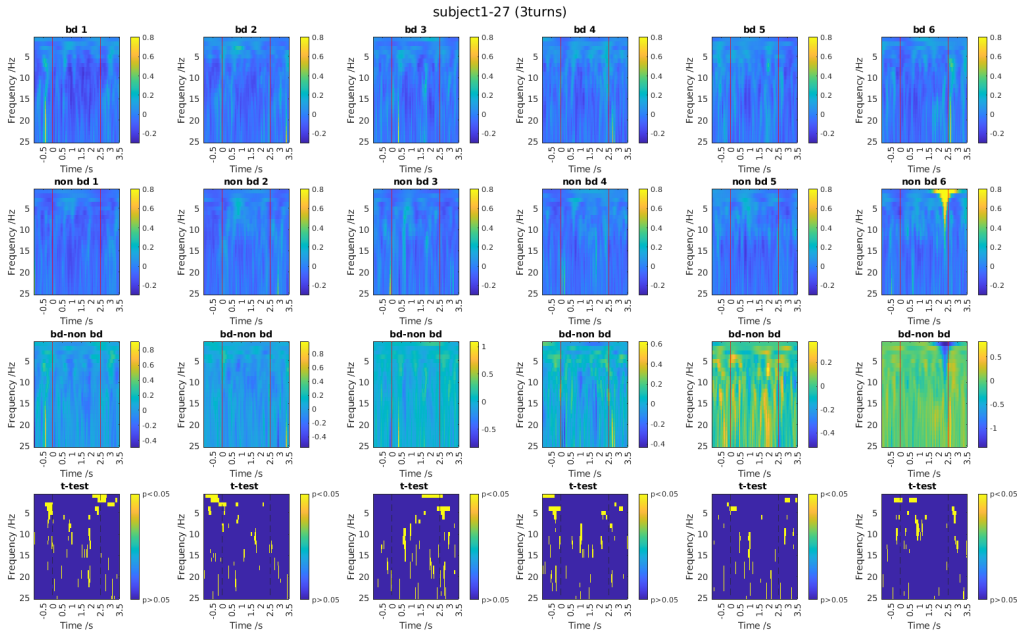


3 turns

```
subject='subject1-27 (3turns)'
```

```
subject =
'subject1-27 (3turns)'
```

```
data_bd = [];
data_non_bd = [];
subjects =wavelet_subject.subjects;
for subi=1:length(subjects)
    for seqi=1:6
    data_bd{subi,seqi} = mean(cell2matrix(wavelet_subject.data_bd(subjects(subi),seqi:6
    data_non_bd{subi,seqi} = mean(cell2matrix(wavelet_subject.data_non_bd(subjects(subi
    end
end
plt_wavelet_sd(data_bd, data_non_bd, subject, plot_window)
```

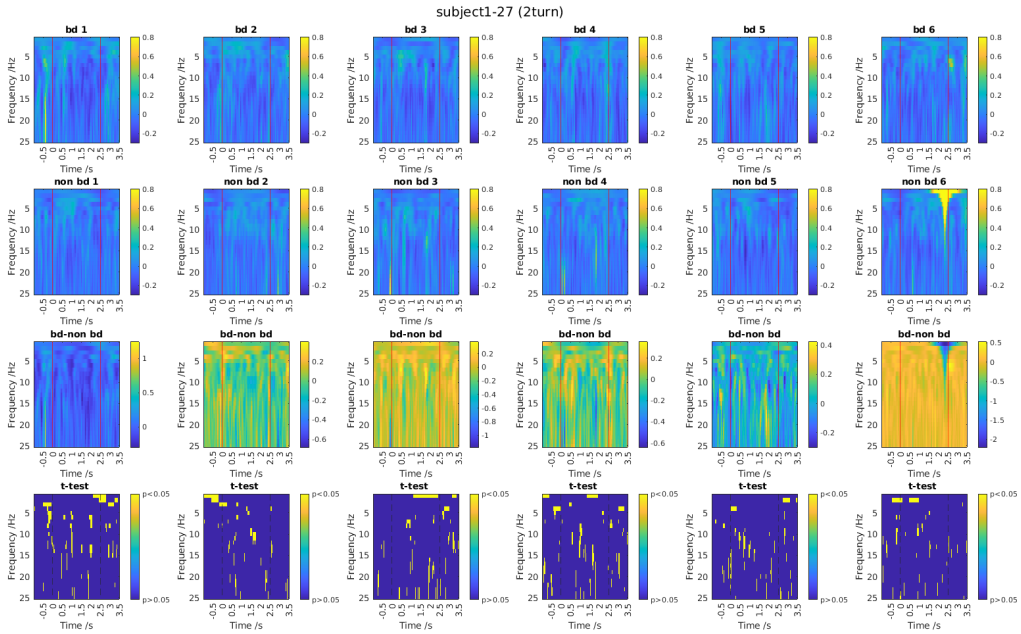


2 turns

```
% zoom in 1-25Hz
subject='subject1-27 (2turn)'
```

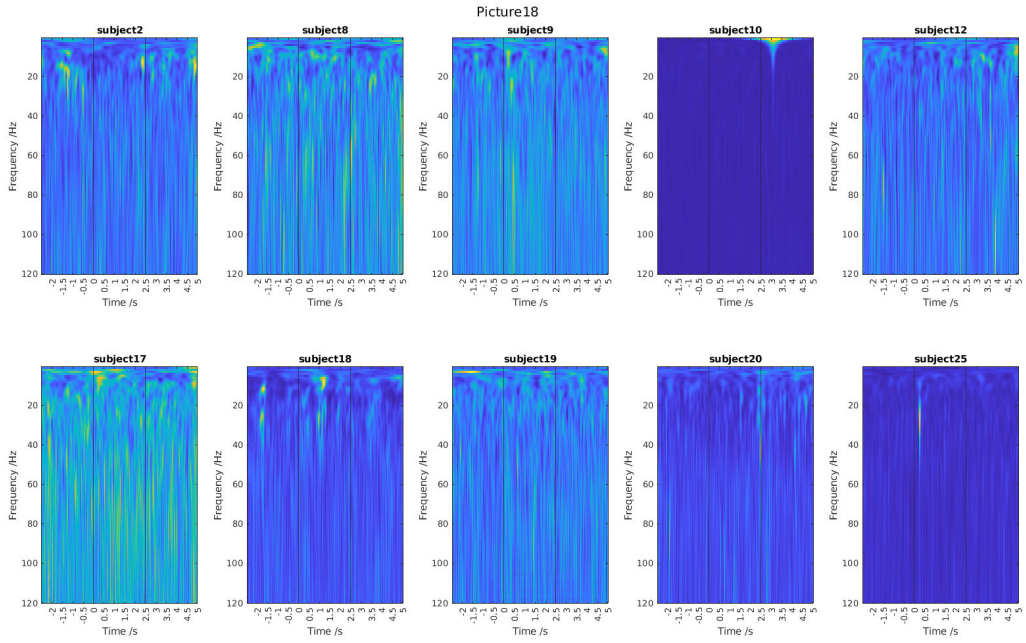
```
subject =
'subject1-27 (2turn)'
```

```
data_bd = [];
data_non_bd = [];
subjects =wavelet_subject.subjects;
for subi=1:length(subjects)
    for seqi=1:6
    data_bd{subi,seqi} = mean(cell2matrix(wavelet_subject.data_bd(subjects(subi),seqi+6
    data_non_bd{subi,seqi} = mean(cell2matrix(wavelet_subject.data_non_bd(subjects(subi
    end
end
plt_wavelet_sd(data_bd, data_non_bd, subject, plot_window)
```



Subject 10, picture 18

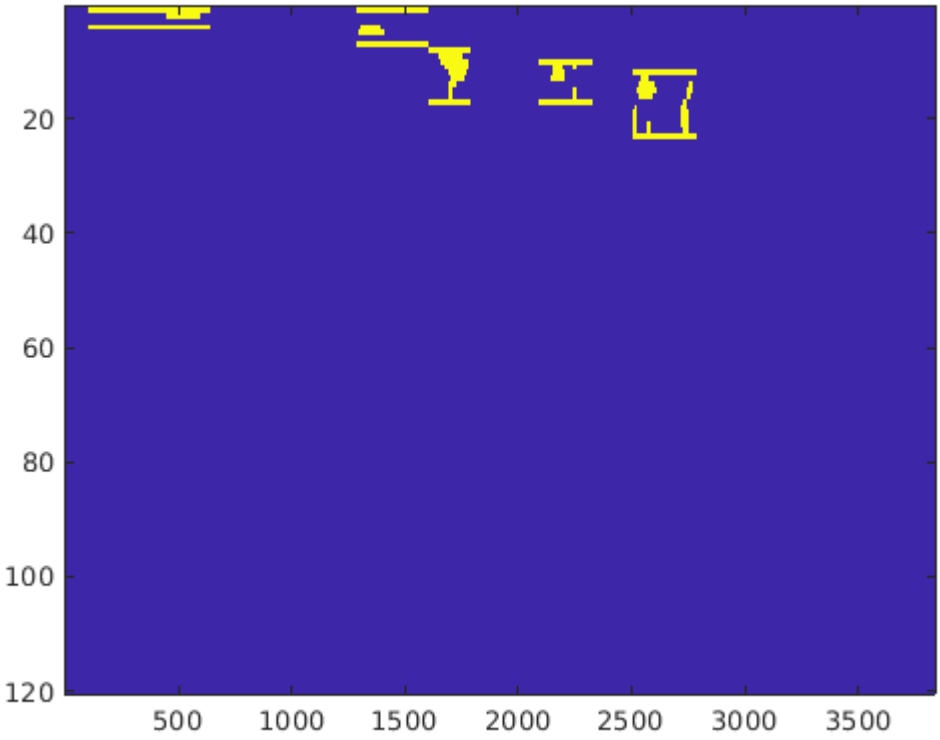
```
srate=512;
time=[-2.5,5];
time_point  =srate*(time(2)-time(1));
for pici = 18
    figure
    for i=1:10
        subplot(2,5,i)
        sub_id=wavelet_subject.subjects(i);
        imagesc(wavelet_subject.data_non_bd{sub_id, pici}(:,:))
        ylabel('Frequency /Hz')
        xticks(0:srate/2:time_point);
        xticklabels([time(1):0.5:time(2)]);
        xlabel('Time /s')
        title(['subject',num2str(sub_id)])
        xline(-srate*time(1),'-')
        xline(srate*(2.5-time(1)),'-')
        if i==1
            clim=caxis;
        else
            caxis = clim;
        end
    end
    sgtitle(['Picture',num2str(pici)])
    set(gcf, 'Position', [1 25 1920 1080]);
end
```



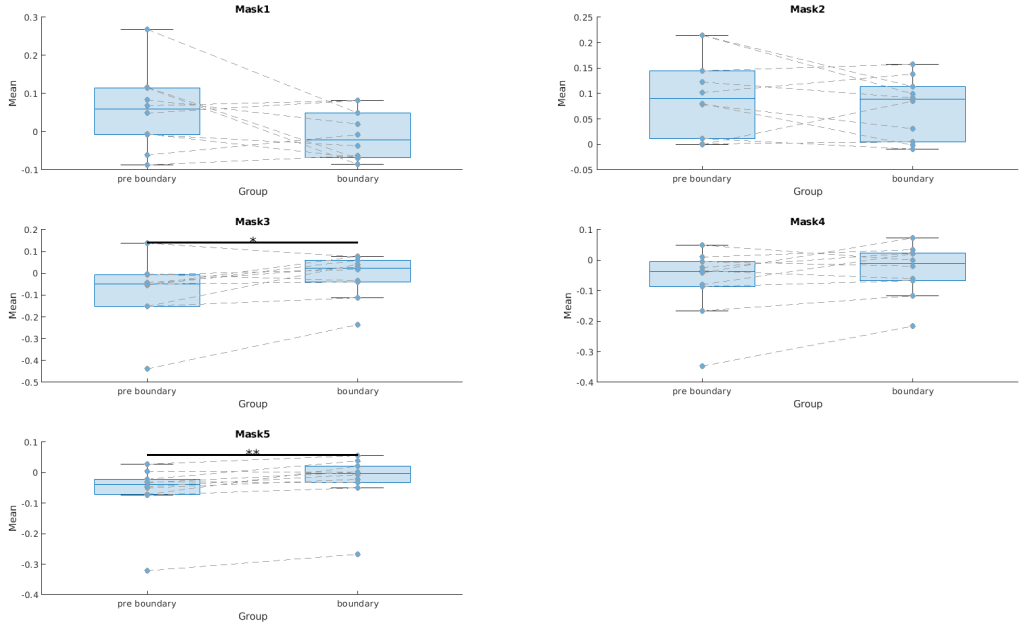
Theta (mask)

```
data_bd = [];
data_non_bd = [];
subjects =wavelet_subject.subjects;
for subi=1:length(subjects)
    data_bd(:,:,subi) = mean(cell2matrix(wavelet_subject.data_bd(subjects(subi),7:18)),
    data_non_bd(:,:,subi) = mean(cell2matrix(wavelet_subject.data_non_bd(subjects(subi)
end
wavelet_porr_h = [];
for i = 1:size(data_bd,1)
    for j = 1:size(data_bd,2)
         [wavelet_porr_h(i,j),~] = ttest(squeeze(data_bd(i,j,:)),squeeze(data_non_bd(i,
    end
end

% region select is trick
%mask_temp{1,1} = [1:4];mask_temp{1,2} = [100:640]; % positive
mask_temp{1,1} = [1:2];mask_temp{1,2} = [100:600]; % positive
%mask_temp{2,1} = [1:7];mask_temp{2,2} = [1280:1600];% positive
mask_temp{2,1} = [3:7];mask_temp{2,2} = [1280:1410];% positive
mask_temp{3,1} = [8:17];mask_temp{3,2} = [1600:1790];% negtive
mask_temp{4,1} = [10:17];mask_temp{4,2} = [2090:2330];% negtive
mask_temp{5,1} = [12:23];mask_temp{5,2} = [2500:2790];% negtive

% plot mask
mask = zeros(120,7.5*512);
for i = 1:5
    mask(mask_temp{i,1},mask_temp{i,2})=1;
end
BW2 = bwperim(mask, 4);
```

```
figure;imagesc(mask.*wavelet_porr_h|BW2)
```



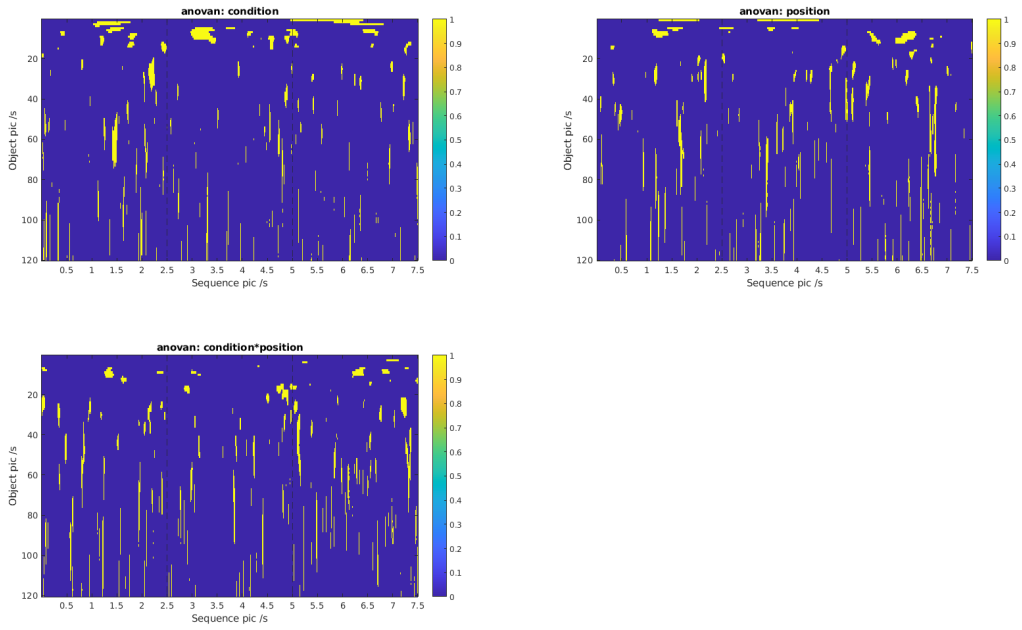

```
% mask
figure
for i=1:5
    subplot(3,2,i)
    mask_bd = squeeze(mean(mean(data_bd(mask_temp{i,1},mask_temp{i,2},:),1),2));
    mask_non_bd = squeeze(mean(mean(data_non_bd(mask_temp{i,1},mask_temp{i,2},:),1),2))
    plt_bar_line([mask_bd ,mask_non_bd],{'pre boundary','boundary'})
    title(['Mask',num2str(i)])
end
```



Theta (anova)

```
% anovan
wavelet_bd = (cell2matrix(wavelet_subject.data_bd(:,7))+cell2matrix(wavelet_subject.dat
wavelet_pre_bd = (cell2matrix(wavelet_subject.data_bd(:,6))+cell2matrix(wavelet_subject
wavelet_non_bd = (cell2matrix(wavelet_subject.data_non_bd(:,7))+cell2matrix(wavelet_sub
wavelet_pre_non_bd = (cell2matrix(wavelet_subject.data_non_bd(:,6))+cell2matrix(wavelet

obj2seq = cat(3, wavelet_bd,wavelet_pre_bd,wavelet_non_bd,wavelet_pre_non_bd);
condition  = reshape(repmat([1,1,2,2], 10, 1),[],1);
position  = reshape(repmat([1,2,1,2], 10, 1),[],1);
p=[];
for i = 1:size(obj2seq,1)
    for j=1:size(obj2seq,2)
        p(i,j,:) = anovan(squeeze(obj2seq(i,j,:)),{condition position},'model','interac
    end
end

a = p; a(a<0.05)=-1; a(a>=0.05)=0; a=abs(a);
anovan_name = {'condition','position','condition*position'};
figure
for i= 1:3
    subplot(2,2,i)
    if i<4
        imagesc(a(:,:,i))
        title(['anovan: ',anovan_name{i}])
    else
        imagesc(pic_corr_h)
        title('Mask')
```

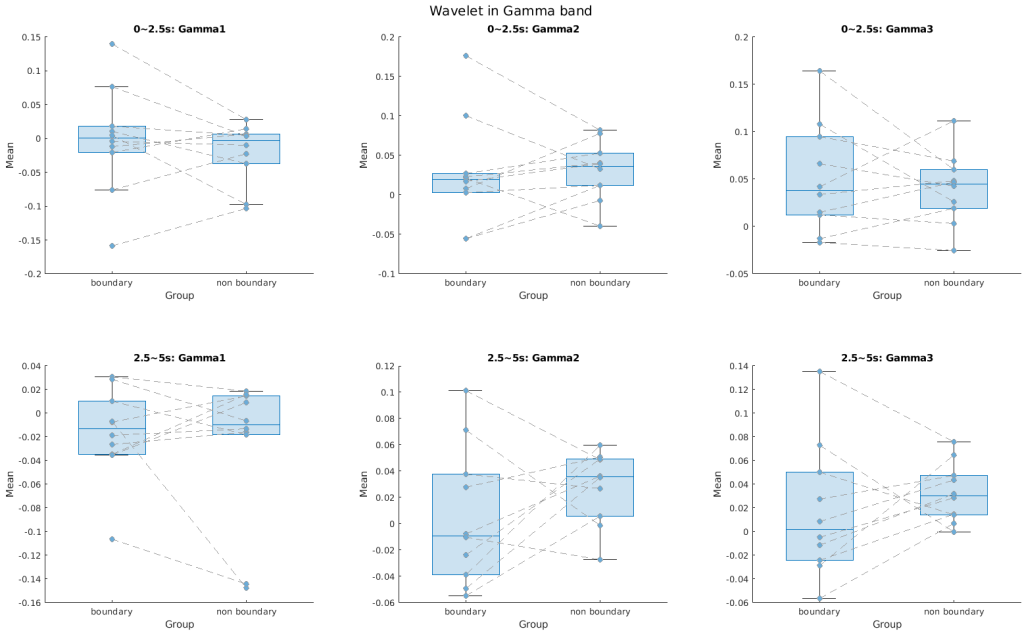
```
    end
    yticks(0:20:120);
    yticklabels([0:20:120]);
    ylabel('Object pic /s')
    xticks(0:256:7.5*512);
    xticklabels([0:256:7.5*512]/512);
    xlabel('Sequence pic /s')
    xline(2.5*512,'--')
    xline(5*512,'--')
    colorbar()
end
set(gcf, 'Position', [1 25 1920 1080]);
```



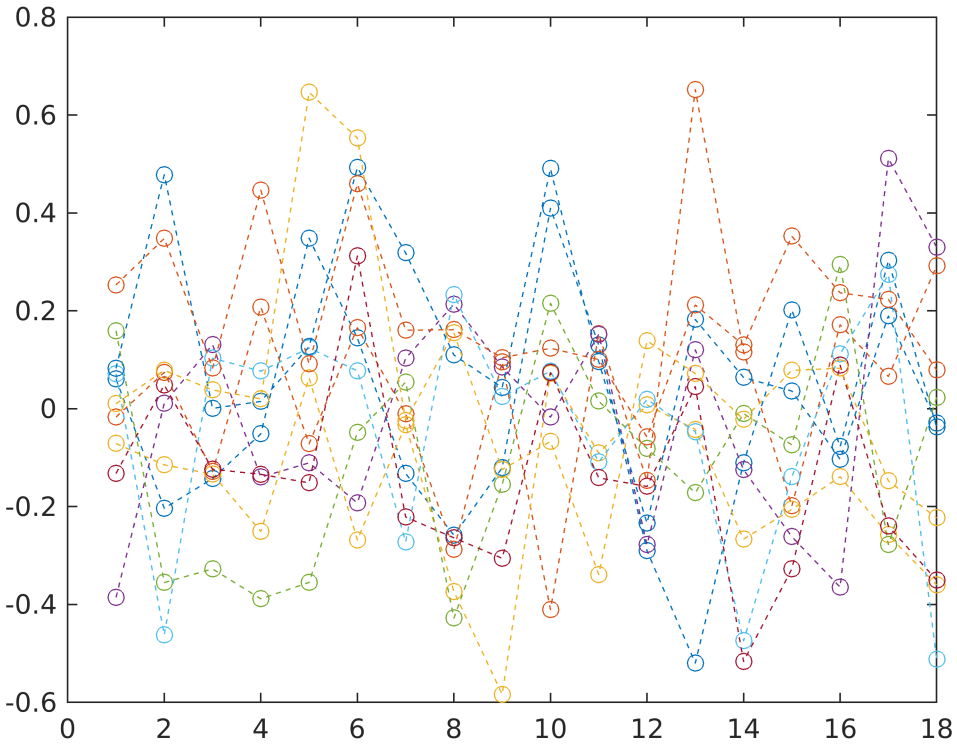
Gamma (average time)

```
% Time window: 0-2.5s,2.5-4.5s
% Frequency band:  low gamma, 28-48 Hz; mid-gamma,48-90 Hz; high gamma, 90-100 Hz
gamma_band={[28:48],[48:90],[90:100]};
time_id = {[2.5*srate+1:5*srate],[5*srate+1:7*srate]};
time_name = {'pic','after'};
bd_type = {'bd','non_bd'};
gamma=[];
for typei = 1:2
    for timei = 1:2
        for gammai=1:3
            if typei ==1
                gamma.(bd_type{typei}).(time_name{timei})(gammai,:) = squeeze(mean(mean
            else
                gamma.(bd_type{typei}).(time_name{timei})(gammai,:) = squeeze(mean(mean
            end
        end
    end
```

```
end

figure
for i=1:3
    subplot(2,3,i)
    plt_bar_line([gamma.bd.pic(i,:)' ,gamma.non_bd.pic(i,:)'],{'boundary','non boundary
    title(['0~2.5s: ','Gamma',num2str(i)])
    subplot(2,3,i+3)
    plt_bar_line([gamma.bd.after(i,:)' ,gamma.non_bd.after(i,:)'],{'boundary','non bour
    title(['2.5~5s: ','Gamma',num2str(i)])
end
sgtitle('Wavelet in Gamma band')
```




```
% wavelet in 18 picture
% if neccesary,can pay attention to after gamma1/gamma3
data_wavelet18 = [];
gammai =3;
for i=1:18
    data_temp = cell2matrix(wavelet_subject.data_bd(:,i));
    data_wavelet18(i,:) = squeeze(mean(mean(data_temp(gamma_band{gammai},time_id{2},:),
end
figure;plot(normalize(data_wavelet18, 'norm', 2),'o--');
```



boundary pre vs boundary after

```
rsa_seq = load_mat([group_dir,'rsa_seq_pre_after_group.mat']);
index = [7,13,25,31,43,47];
bd_id = [index,index+18*6];
non_bd_id = [index+18*3,index+18*9];

plt_rsa_seq_pre_after(rsa_seq.same, subject, plot_window)
```

Periodicity of 18 pictures

Cycle