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```
clearvars
close all

% Explanation will go here.


% TO DO:
% - Incorporate NBS into the script if possible (allows for better
%replicability, we already know the results).
% - Understand bandwidth property (affects visualization, not the
 actual
%results)

%Paths, functions and toolboxes
addpath(genpath('x_Functions'));
addpath(genpath('x_Toolbox'));
%path2BN = [pwd,'/x_Toolbox/BrainNet'];

% Atlas
Atlas = '214';

% Load data
load([pwd,'/Data/Schaefer',Atlas,'/',Atlas,'Info/
Schaefer',Atlas,'_coordinates.mat']);
load([pwd,'/Data/
Schaefer',Atlas,'/',Atlas,'Info/',Atlas,'parcellation_Yeo8Index.mat']);
load([pwd,'/Data/Schaefer',Atlas,'/','SC/CTRLSC118.mat']);
load([pwd,'/Data/Schaefer',Atlas,'/','SC/ADHDSC78.mat']);
load([pwd,'/Data/Schaefer',Atlas,'/','FC/AllFC_ADHD_CTRL.mat']);
[behav.raw] = xlsread([pwd,'/Data/AdultADHD_FS_Cov_20180510.xlsx']);

N(1) = size(CTRLSC,3); %sample size
N(2) = size(ADHDSC,3);

% Colours for plots
[cb] = cbrewer('qual','Set3',12,'pchip');
cl(1,:) = [0.5 0.5 0.5];
cl(2,:) = cb(4,:);
```

Structural analysis

```
K = 0.15; % Hub definition: top 15% of connections
[deg,conCount,conStren,hubMat] = Struc_analysis(ADHDSC,CTRLSC,K);
```

```
---Degree statistics---
Deg t-test, pval = 0.23513 z = -1.1872
Weighted deg t-test, pval = 0.8946 z = 0.13249
---Connection class statistics---
Hub COUNT    t-test- k = 0.15, conn = 1 pval = 0.079761 z = -1.7521
Hub STRENGTH t-test- k = 0.15, conn = 1 pval = 0.72354 z = 0.35373
Hub COUNT    t-test- k = 0.15, conn = 2 pval = 0.22563 z = 1.2117
Hub STRENGTH t-test- k = 0.15, conn = 2 pval = 0.2311 z = 1.1975
Hub COUNT    t-test- k = 0.15, conn = 3 pval = 0.22563 z = -1.2117
Hub STRENGTH t-test- k = 0.15, conn = 3 pval = 0.4611 z = 0.73704
```

Structure - function analysis

by connection class - hub, feeder & periphery.

```
[r,logr] = StrucFunc_analysis(ADHDSC,CTRLSC,AllFC_AC,hubMat);

% Thought to test by network but this might introduce methodological
% concerns regarding how confident we can be in correlations derived
 from
% smaller numbers.
```

```
---STRUC-FUNC statistics---
Connectome-wide t-test, pval = 0.017758 z = 2.3706
Connectome-wide LOG t-test, pval = 0.016675 z = 2.3938
Hub t-test, pval = 0.01091 z = 2.5456
Hub LOG t-test, pval = 0.0035161 z = 2.9186
Feeder t-test, pval = 0.19969 z = 1.2824
Feeder LOG t-test, pval = 0.10154 z = 1.6374
Periphery t-test, pval = 0.15672 z = 1.4162
Periphery LOG t-test, pval = 0.044654 z = 2.0079
```

Behaviour

```
behav.Inat = behav.raw(1:N(2),15);
behav.Hypr = behav.raw(1:N(2),16);
[behav.r,behav.p] =
 corr([behav.Inat,behav.Hypr,r.all.ADHD',r.hub.ADHD]);

disp('---BEHAV statistics---');
disp('no correlation between behaviour and struc-func');
```

```
---BEHAV statistics---
no correlation between behaviour and struc-func
```

Figure 1: Structural degree and weighted degree

```
figure('Color','w','Position',[50 450 350 350]); hold on

subplot(1,2,1)
title('')
[~, ~, u] = ksdensity(deg.CTRL);
h1 = raincloud_plot('X',deg.CTRL,'color',
 cl(1,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(1,:),...

  'box_dodge',1,'box_dodge_amount', .35, 'dot_dodge_amount', .35, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);
h2 = raincloud_plot('X',deg.ADHD,'color',
 cl(2,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(2,:),...

  'box_dodge',1,'box_dodge_amount', .75, 'dot_dodge_amount', .75, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);
legend([h1{1} h2{1}], {'Control', 'ADHD'},'Location','best')
xlabel('Summed degree');
set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off','view',[90
 -90],'Ytick',[]);
set(gca,'Xtick',0:3000:12000);

subplot(1,2,2)
title('')
[~, ~, u] = ksdensity(deg.CTRLw);
h1 = raincloud_plot('X',deg.CTRLw,'color',
 cl(1,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(1,:),...

  'box_dodge',1,'box_dodge_amount', .35, 'dot_dodge_amount', .35, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);
h2 = raincloud_plot('X',deg.ADHDw,'color',
 cl(2,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(2,:),...

  'box_dodge',1,'box_dodge_amount', .75, 'dot_dodge_amount', .75, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);

xlabel('Summed weighted degree');
set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off','view',[90
 -90],'Ytick',[]);
set(gca,'Xtick',0:5000:100000);
```

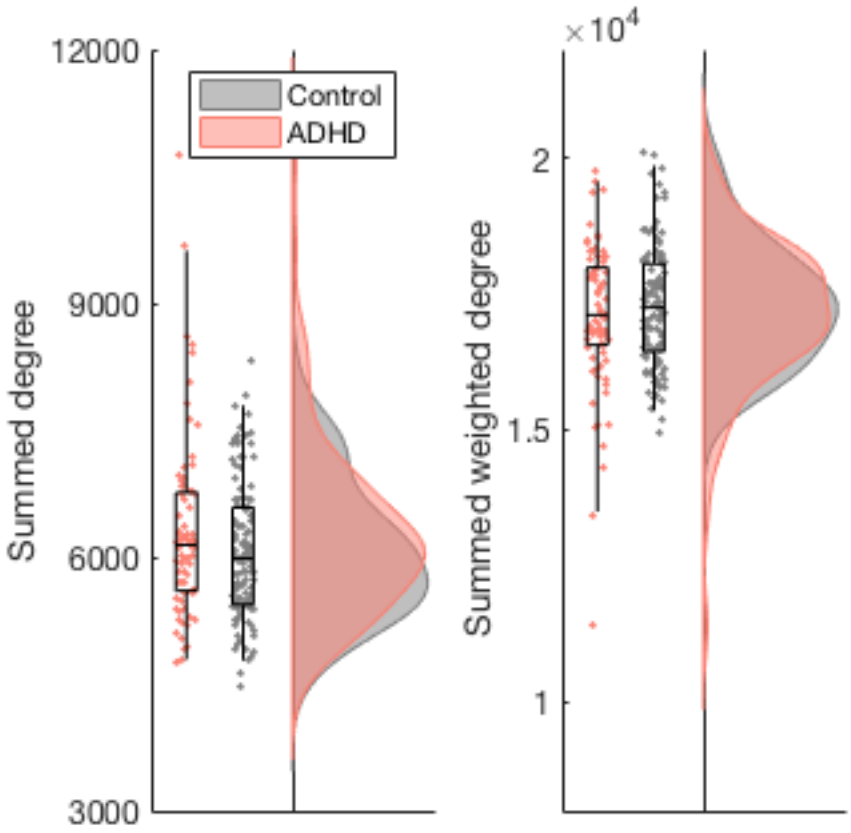


Figure 2: Structural connection classes

```
figure('Color','w','Position',[450 450 525 350]); hold on
data = conStren; % choose whether to vis connectivity weighted/
nonweighted

classlabel = {'hub','feeder','periphery'};
for i = 1:3
    subplot(1,3,i)
    title('')
    [~, ~, u] = ksdensity(data.CTRL(:,i));
    h1 = raincloud_plot('X',data.CTRL(:,i),'color',
 cl(1,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(1,:),...

  'box_dodge',1,'box_dodge_amount', .35, 'dot_dodge_amount', .35, 'box_col_match',
 0,'line_width',1,...
        'bandwidth',u);
    h2 = raincloud_plot('X',data.ADHD(:,i),'color',
 cl(2,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(2,:),...

  'box_dodge',1,'box_dodge_amount', .75, 'dot_dodge_amount', .75, 'box_col_match',
 0,'line_width',1,...
```

```
        'bandwidth',u);

    xlabel(['Mean ',classlabel{i},' strength']);
    set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off','view',
[90 -90],'Ytick',[]);
    %set(gca,'Xtick',0:3000:12000);
end
```

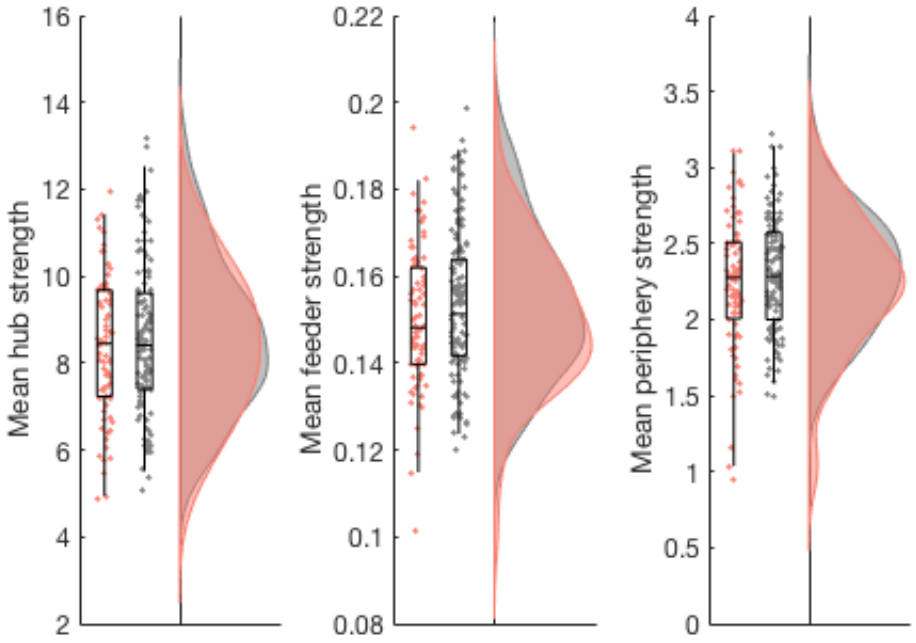


Figure 3: Group hub topology

```
figure('Color','w','Position',[850 450 525 525]); hold on

% have to calculate hubs at the group level
%CTRL
tmp = sort(sum(mean(CTRLSC,3)),'descend');
Klevel = tmp(round(length(tmp)*K));
tmp = sum(mean(CTRLSC,3));
ind = (tmp>=Klevel); % binary list of hubs satisfying K
ind = find(ind); % find hubs
[~,~,~,MAT] = find_hubs(mean(CTRLSC,3),Klevel);

subplot(3,2,[1 3])
draw_hubconnectome(MAT,COG,ind,cl(1,:),20,1,1);
axis off
title('CTRL Hub topology');

subplot(3,2,5)
draw_hubconnectome(MAT,COG,ind,cl(1,:),20,1,2);
axis off
```

```
% ADHD
tmp = sort(sum(mean(ADHDSC,3)),'descend');
Klevel = tmp(round(length(tmp)*K));
tmp = sum(mean(ADHDSC,3));
ind = (tmp>=Klevel); % binary list of hubs satisfying K
ind = find(ind); % find hubs
[~,~,~,MAT] = find_hubs(mean(ADHDSC,3),Klevel);

subplot(3,2,[2 4])
draw_hubconnectome(MAT,COG,ind,cl(2,:),20,1,1);
axis off
title('ADHD Hub topology');

subplot(3,2,6)
draw_hubconnectome(MAT,COG,ind,cl(2,:),20,1,2);
axis off
```

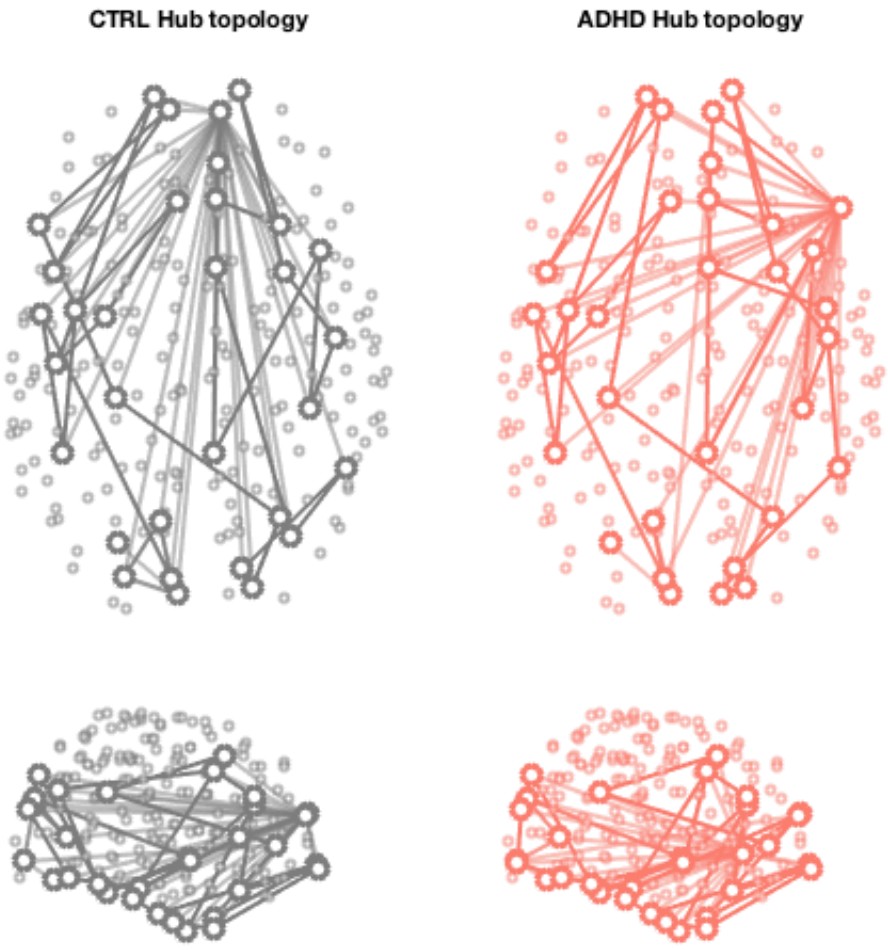


Figure 4: SC-FC correlations

```
figure('Color','w','Position',[50 50 800 350]); hold on
data = r; % choose 'logr' or 'r'
xlims = [0 .55]; %same across plots for comparison

subplot(1,4,1)
title('')
[~, ~, u] = ksdensity(data.all.CTRL);
h1 = raincloud_plot('X',data.all.CTRL,'color',
 cl(1,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(1,:),...

  'box_dodge',1,'box_dodge_amount', .35, 'dot_dodge_amount', .35, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);
h2 = raincloud_plot('X',data.all.ADHD,'color',
 cl(2,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(2,:),...

  'box_dodge',1,'box_dodge_amount', .75, 'dot_dodge_amount', .75, 'box_col_match',
 0,'line_width',1,...
    'bandwidth',u);

line([.3 .3],[.25*-15 .75*-15],'Color','k');
text(.31,.5*-15,'*','HorizontalAlignment','center','FontSize',16)

legend([h1{1} h2{1}], {'Control', 'ADHD'},'Location','best')
xlabel('r value');
ylabel('Connectome');
set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off','view',[90
 -90],'Ytick',[]);

set(gca,'Xtick',0:0.1:1);
set(gca,'YLim',[-15 15]); % Need to verify this code.

classlabel = {'Hub','Feeder','Periphery'};
for i = 1:3
    subplot(1,4,1+i)
    title('')
    [~, ~, u] = ksdensity(data.hub.CTRL(:,i));
    h1 = raincloud_plot('X',data.hub.CTRL(:,i),'color',
 cl(1,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(1,:),...

  'box_dodge',1,'box_dodge_amount', .35, 'dot_dodge_amount', .35, 'box_col_match',
 0,'line_width',1,...
        'bandwidth',u);
    h2 = raincloud_plot('X',data.hub.ADHD(:,i),'color',
 cl(2,:),'box_on',1,'alpha',0.5,'cloud_edge_col', cl(2,:),...

  'box_dodge',1,'box_dodge_amount', .75, 'dot_dodge_amount', .75, 'box_col_match',
 0,'line_width',1,...
        'bandwidth',u);

    xlabel('r value');
```

```
    ylabel(classlabel{i});
    set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off','view',
[90 -90],'Ytick',[]);
    set(gca,'Xtick',0:0.1:1);

    if i ==1
        line([.5 .5],[.25*-7 .75*-7],'Color','k');

 text(.51,.5*-7,'*','HorizontalAlignment','center','FontSize',16)
    end
end
```

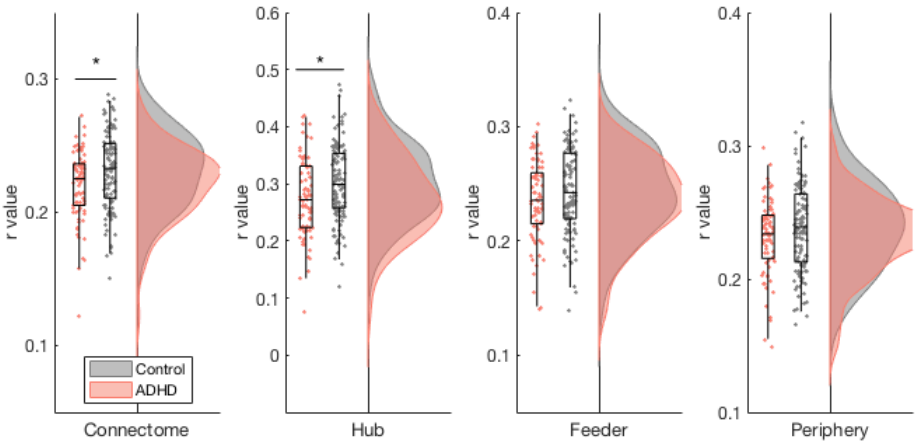
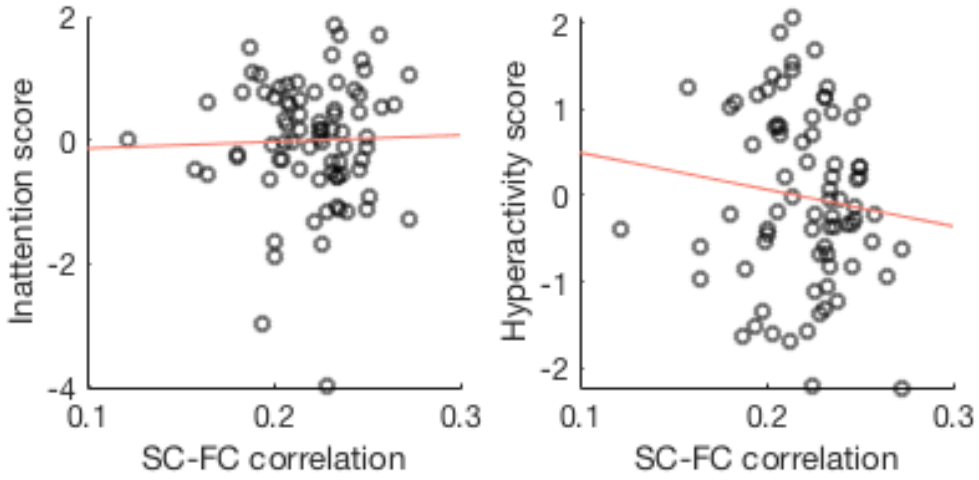


Figure 5: No relationship with behavior

```
figure('Color','w','Position',[850 50 450 200]); hold on

subplot(1,2,1)
scatter(r.all.ADHD',behav.Inat,...
        'MarkerEdgeColor','k',...
        'MarkerEdgeAlpha', 0.5,...
        'LineWidth',1); hold on;
h = lsline;
set(h,'LineWidth',1, 'Color',cl(2,:));
set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off');
ylabel('Inattention score');
xlabel('SC-FC correlation');

subplot(1,2,2)
scatter(r.all.ADHD',behav.Hypr,...
        'MarkerEdgeColor','k',...
        'MarkerEdgeAlpha', 0.5,...
        'LineWidth',1); hold on;
h = lsline;
set(h,'LineWidth',1, 'Color',cl(2,:));
set(gca,'FontName', 'Helvetica','FontSize', 12,'box','off');
ylabel('Hyperactivity score');
xlabel('SC-FC correlation');
```



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