hippocampal_surface_plots

June 15, 2023

[1]:

```
%load_ext autoreload
%autoreload 2
```

[2]:

```
import warnings
warnings.filterwarnings('ignore')
```

[3]:

```
import numpy as np
import nibabel as nib
import pandas as pd

from surfplot import Plot
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns

from brainspace.utils.parcellation import reduce_by_labels

import utilities

import pingouin as pg
from statannotations.Annotator import Annotator
```

[4]:

```
def reduce_data(data, subfields):
    data_reshape = data.reshape(
        data.shape[0],data.shape[1]*data.shape[2]
    )

    subfields_mean = reduce_by_labels(data_reshape,subfields,axis=1)
    subfields_mean_reshape = subfields_mean.reshape(
        subfields_mean.shape[0],data.shape[1],data.shape[2]
    )

    return data_reshape, subfields_mean_reshape
```

[58]:

```
save_fig = True
```

Subjects

[6]:

```
df = pd.read_csv('../config/participants.txt', dtype=str)
subjects = df.participant_id.to_list()
subjects = [ s for s in subjects if s != '09' ]
```

Hippocampal

[7]:

```
# Paths to surfaces
folded   = '../results/average_hippocampus/midthickness_hemi-Lflip.native.surf.
 ↪gii'
unfolded = '../resources/midthickness.L.unfolded.surf.gii'
```

[8]:

```
# Subfields
in_subfields  = '../resources/BigBrain_ManualSubfieldsUnfolded_254x126.shape.
 ↪gii'
gii_subfields = nib.load(in_subfields)
subfields     = gii_subfields.darrays[0].data
subfields_2d  = subfields.reshape((126,254), order='C')
```

[9]:

```
# Hemispheres
hemis = ['Lflip','R']
```

[10]:

```
# Maps
maps_dict = {
    1: ['CBF', 'hot', (20,60), 'Perfusion','(ml/100 g/min)', (10,75), (-10,10)],
    2: ['PWI', 'gray', (6,18), 'Perfusion-weigthed\nsignal','(a.u.)', (0,25),␣
 ↪(-5,5)],
    3: ['thickness', 'viridis', (0.5,1.5), 'Thickness','(mm)', (0.5,3), (-1,1)],
    4: ['T1', 'inferno', (1000,1800), 'T$_1$','(msec)', (1000,1800),␣
 ↪(-150,150)],
    5: ['myelin', 'cividis', (5,15), 'T$_1$w/T$_2$w','(a.u.)', (4,16),␣
 ↪(-10,10)],
    6: ['gyrification', 'hot', (0,10), 'Gyrification','(a.u.)', (0,8), (-2,2)],
    7: ['T2w', 'magma', (200,400), 'T$_2$w','(a.u.)', (150,500), (-100,100)],
    8: ['curvature', 'seismic', (-1,1), 'Curvature','(a.u.)', (-.5,.5), (-.5,.
 ↪5)],
}
```

[12]:

```
# Load input, per subject
subj_data = np.zeros((
    len(nib.load(unfolded).get_arrays_from_intent('NIFTI_INTENT_POINTSET')[0].
 ↪data),
    len(subjects),
    len(hemis),
    len(maps_dict)
))

for s, subject in enumerate(subjects):
    for h, hemi in enumerate(hemis):
        for i, idx in enumerate(maps_dict.keys()):
            subj_data[:,s,h,i] = nib.load(
                '../results/surface_maps/sub-{0}/sub-{0}_{1}_{2}.native.shape.
 ↪gii'.format(
                    subject, maps_dict[idx][0], hemi
                )
            ).darrays[0].data
```

[13]:

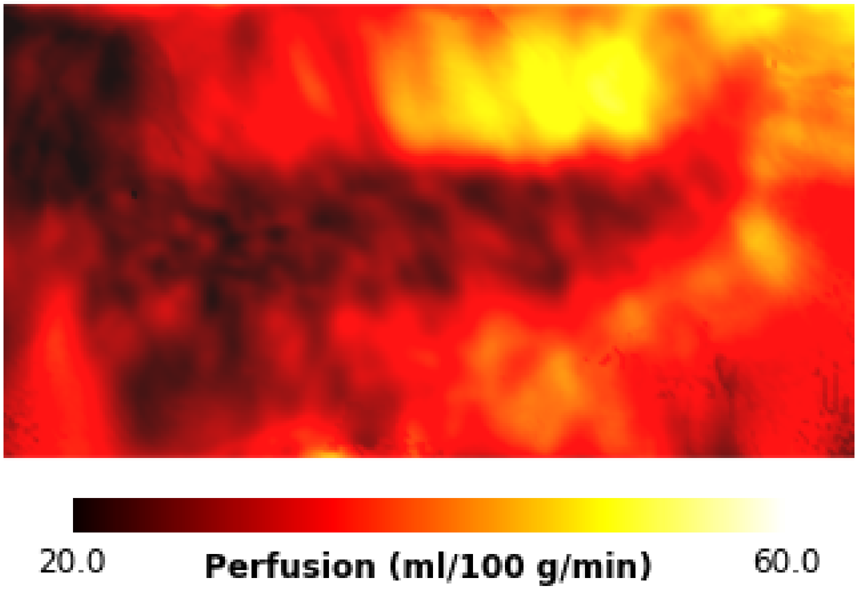
```
# Average data across hemispheres, subjects
avg_data = np.nanmean(subj_data, axis=(2,1))
```

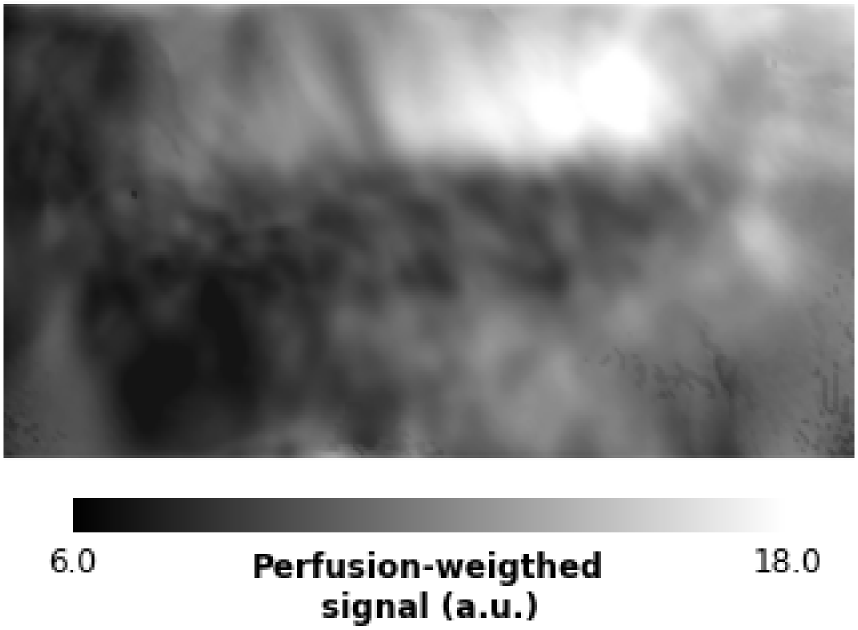
[14]:

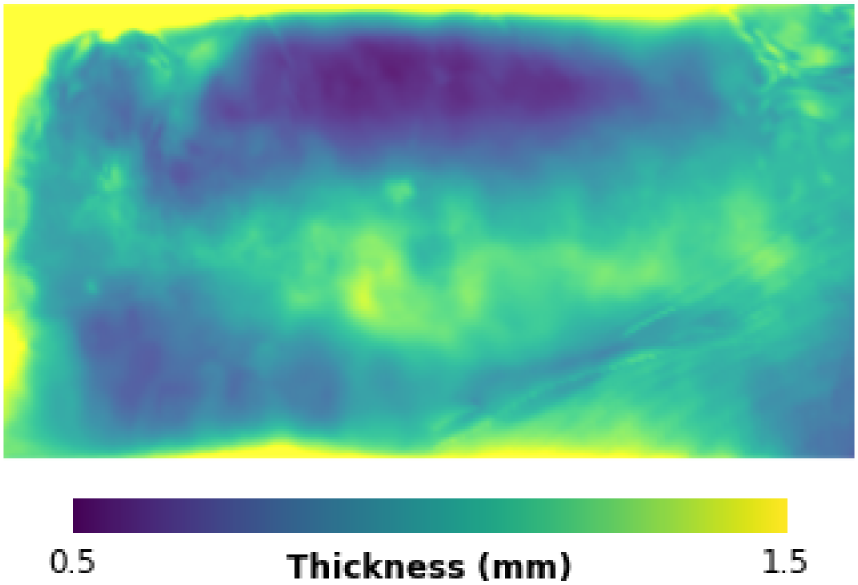
```
# Color specs
cbar_unfolded_kws = dict(
    outer_labels_only=True,
    fontsize=12,
    pad=.02,
    n_ticks=2,
    decimals=1,
    shrink=.8,
    fraction=.1,
    draw_border=False
)
```

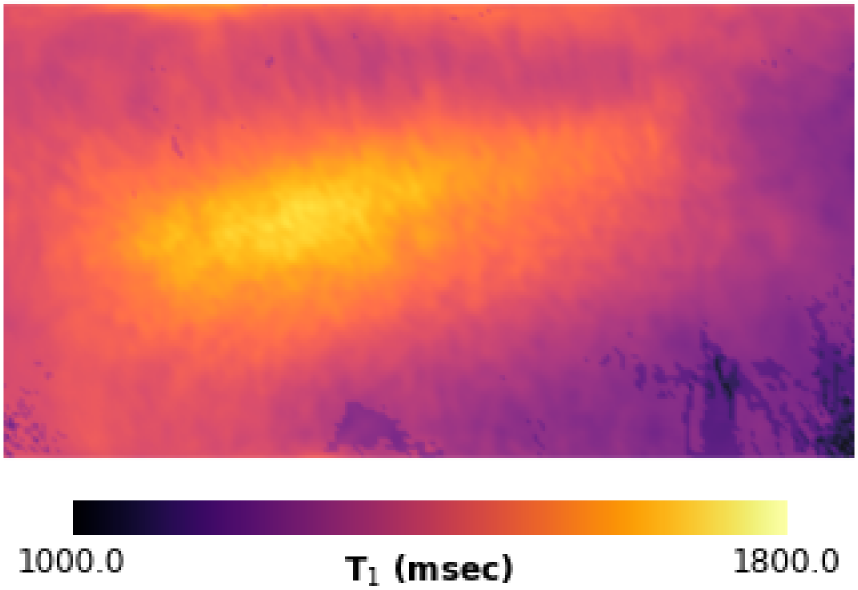
[15]:

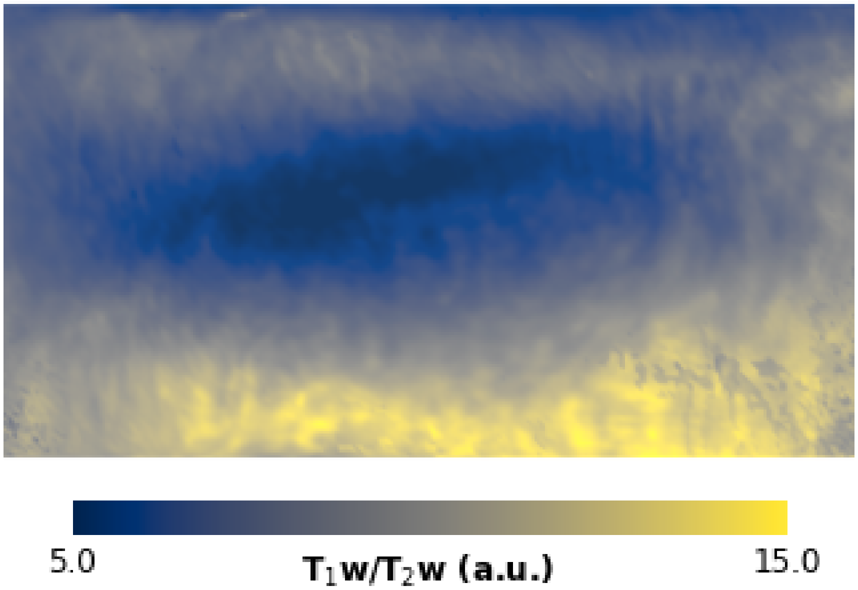
```
# Iterate through maps and plot unfolded
for i, idx in enumerate(maps_dict.keys()):
    p = Plot(unfolded, layout='row', views=['dorsal'], zoom=2, size=(500, 300))
    p.add_layer(avg_data[:,i], color_range=maps_dict[idx][2],␣
 ↪cmap=maps_dict[idx][1])

    fig = p.build(cbar_kws=cbar_unfolded_kws)
    fig.axes[1].set_xlabel(
        f'{maps_dict[idx][3]} {maps_dict[idx][4]}',
        labelpad=-11, fontsize=12, fontweight='bold'
    )

    if save_fig:
        fig.savefig('../visualization/unfolded/sub-group_{}_unfolded.png'.
 ↪format(
            maps_dict[idx][0]), dpi=600, bbox_inches='tight', transparent=True)
    fig.show()
```

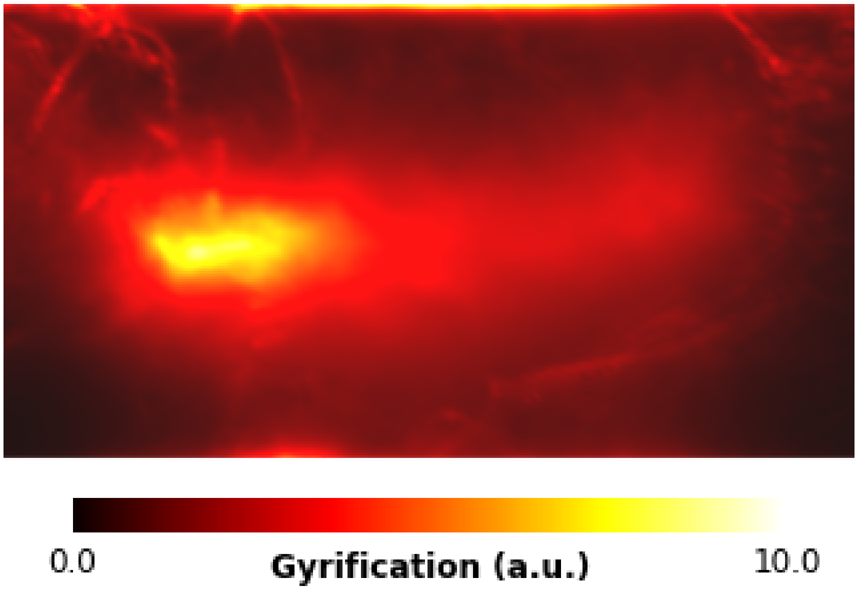

20.0
Perfusion (ml/100 g/min)
60.0

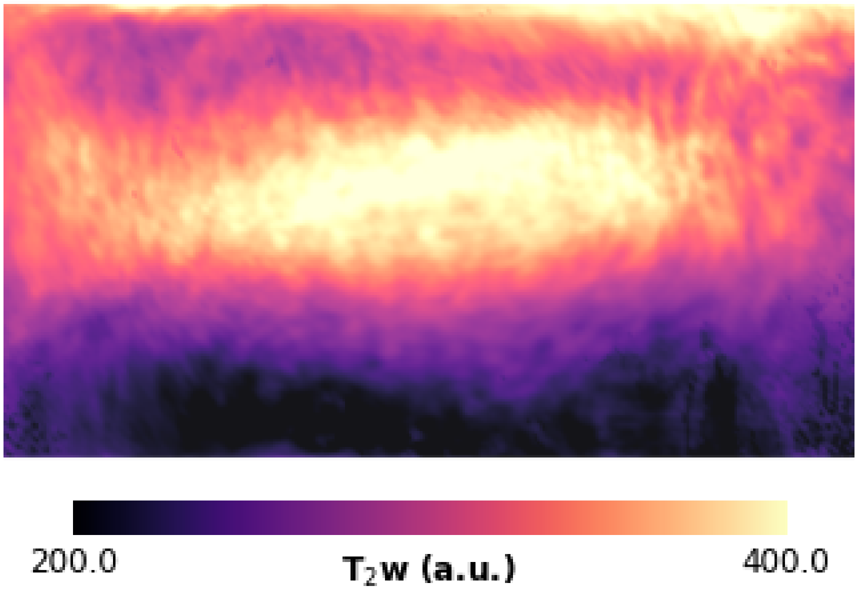

6.0
Perfusion-weigthed signal (a.u.)
18.0

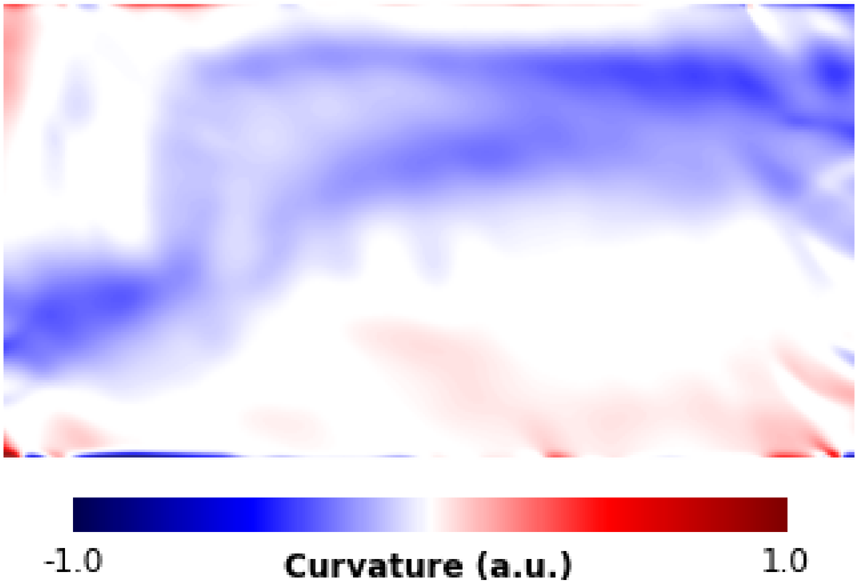

0.5
Thickness (mm)
1.5


1000.0
T_1 (msec)
1800.0


5.0
T_1w/T_2w (a.u.)
15.0

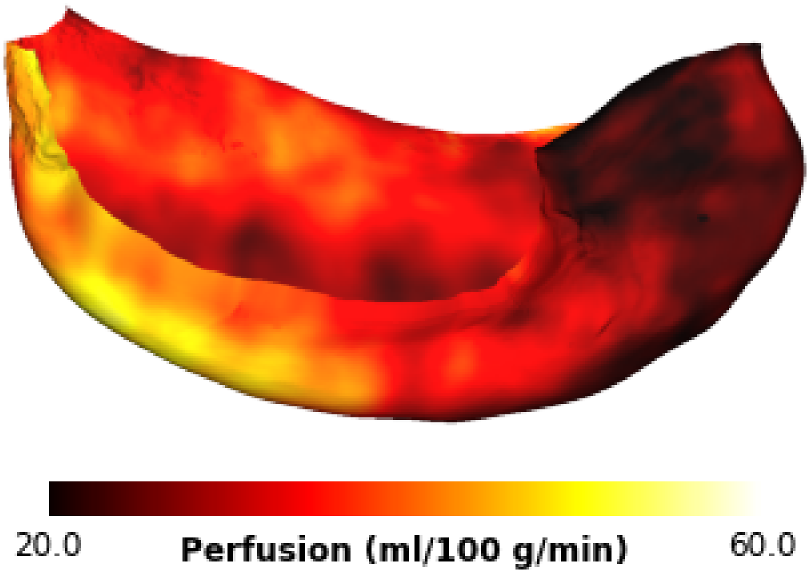

0.0
Gyrification (a.u.)
10.0

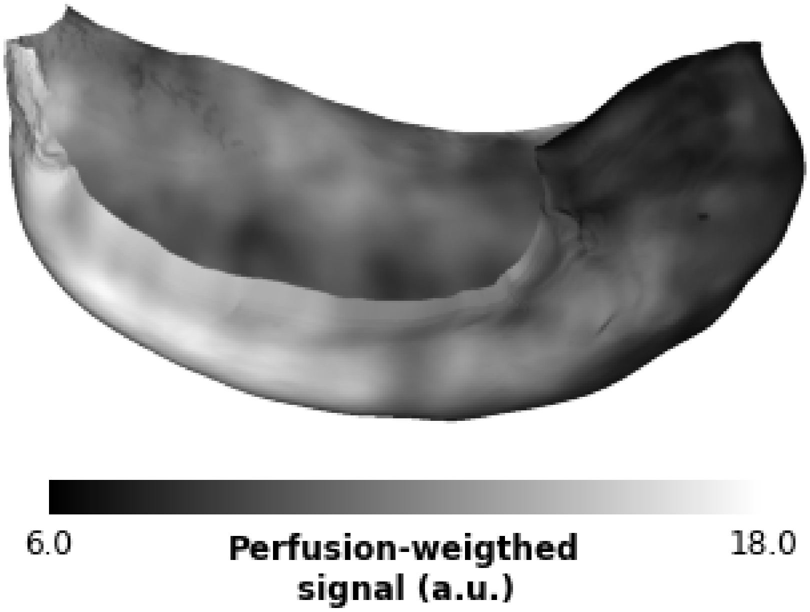


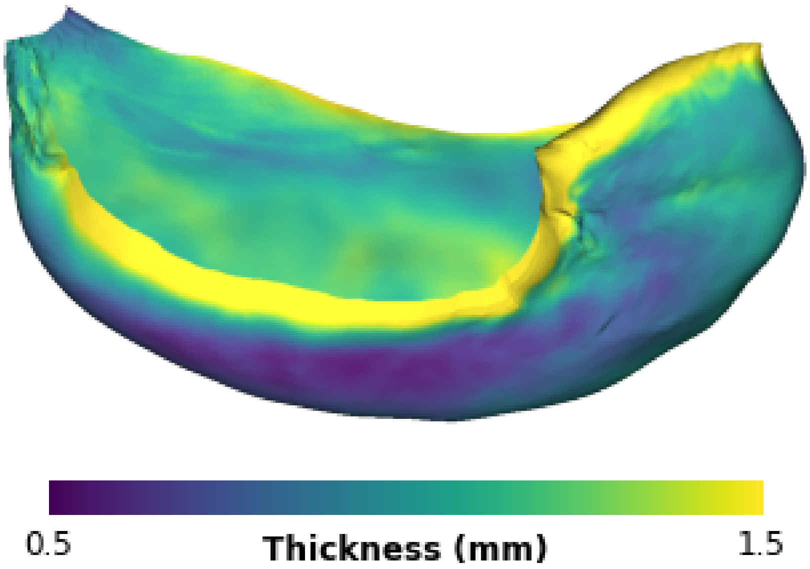


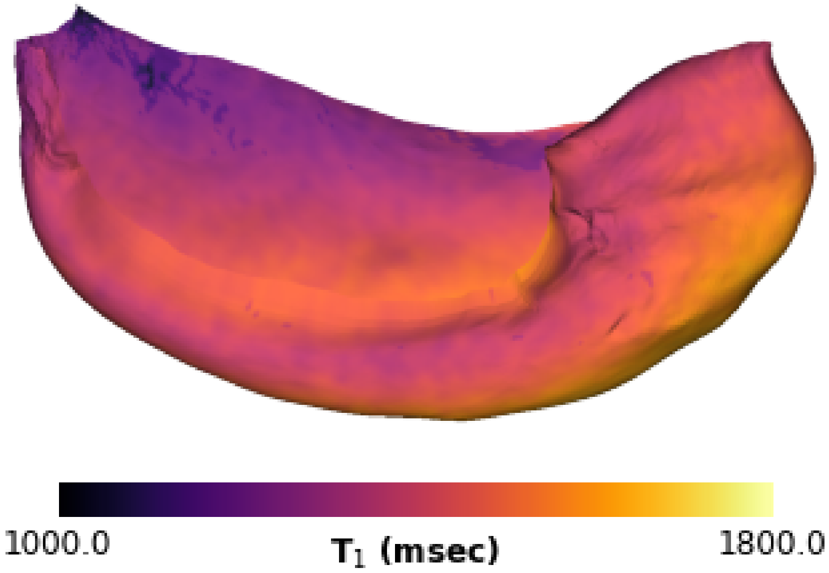
[16]:
```
# Iterate through maps and plot folded
for i, idx in enumerate(maps_dict.keys()):
    p = Plot(folded, layout='row', views=['medial'], zoom=1.8, elevation=90,␣
 ↪size=(500, 300))
```

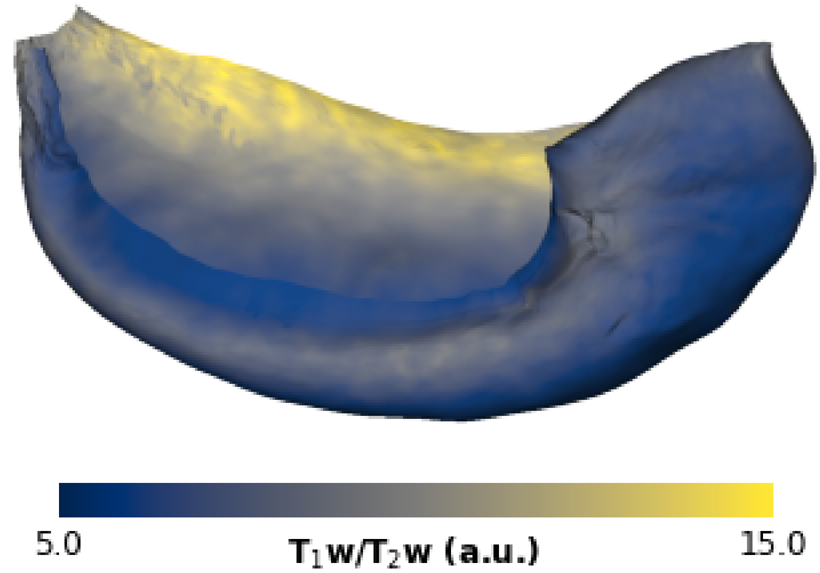
```
    p.add_layer(avg_data[:,i], color_range=maps_dict[idx][2],␣
↪cmap=maps_dict[idx][1])

    fig = p.build(cbar_kws=cbar_unfolded_kws)
    fig.axes[1].set_xlabel(
        f'{maps_dict[idx][3]} {maps_dict[idx][4]}',
        labelpad=-11, fontsize=12, fontweight='bold'
    )

    if save_fig:
        fig.savefig('../visualization/folded/sub-group_{}_folded.png'.
↪format(maps_dict[idx][0]), dpi=600, bbox_inches='tight')
    fig.show()
```

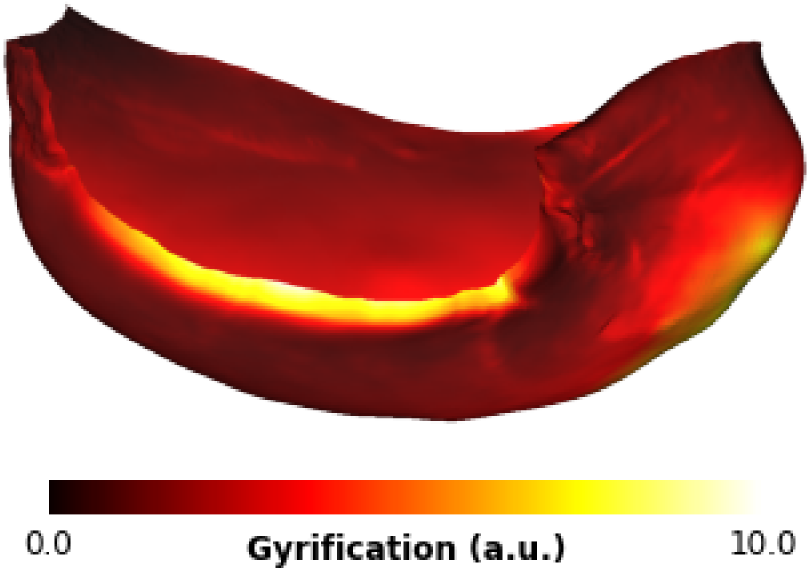


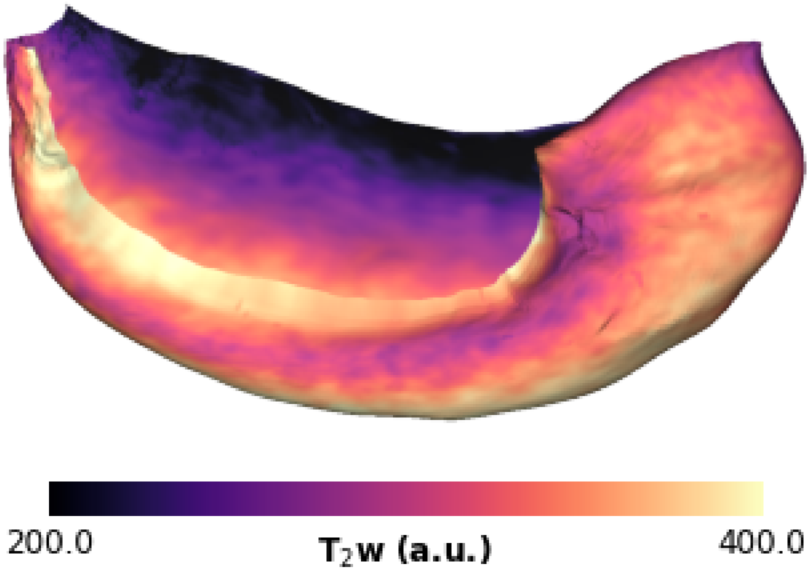

6.0
Perfusion-weigthed
signal (a.u.)
18.0

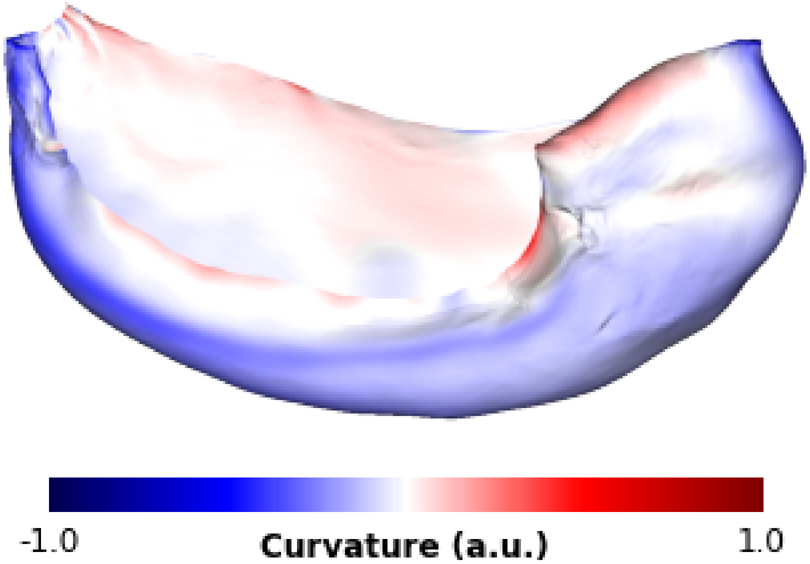

0.5
Thickness (mm)
1.5


1000.0
T_1 (msec)
1800.0


5.0
T_1w/T_2w (a.u.)
15.0

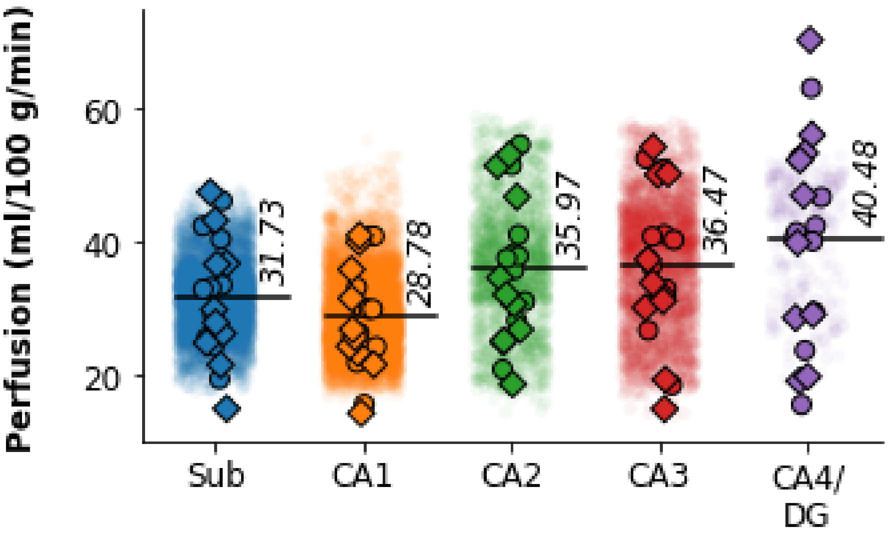

0.0
Gyrification (a.u.)
10.0

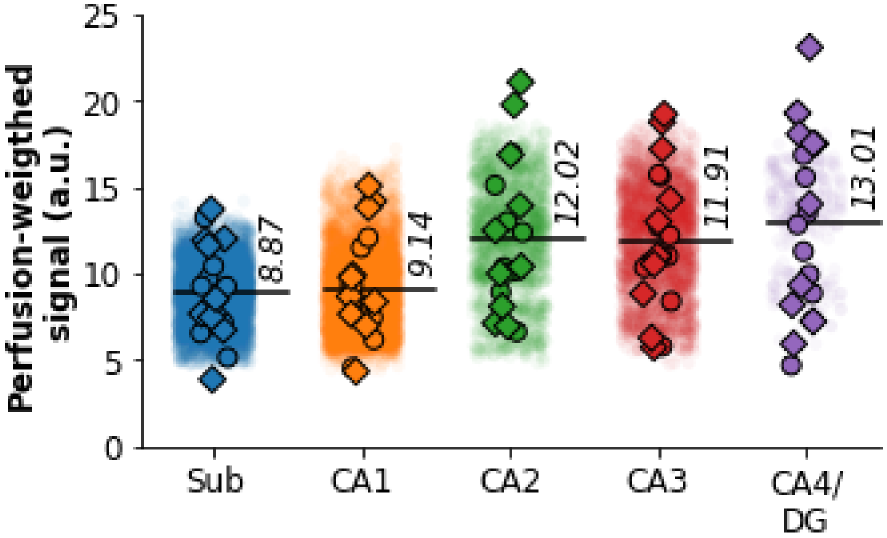

200.0
T_2w (a.u.)
400.0

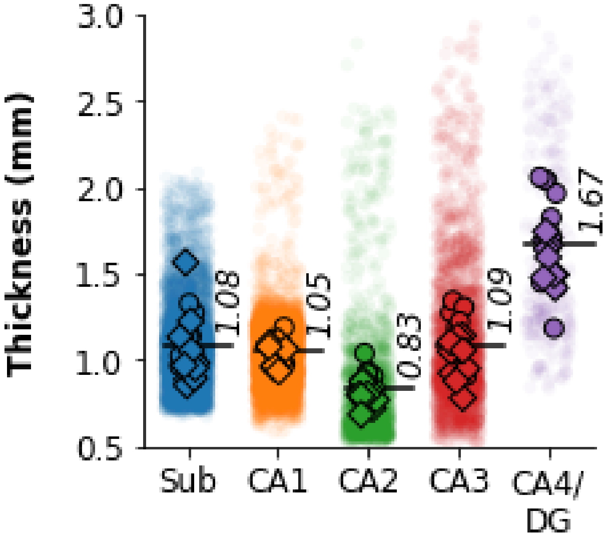


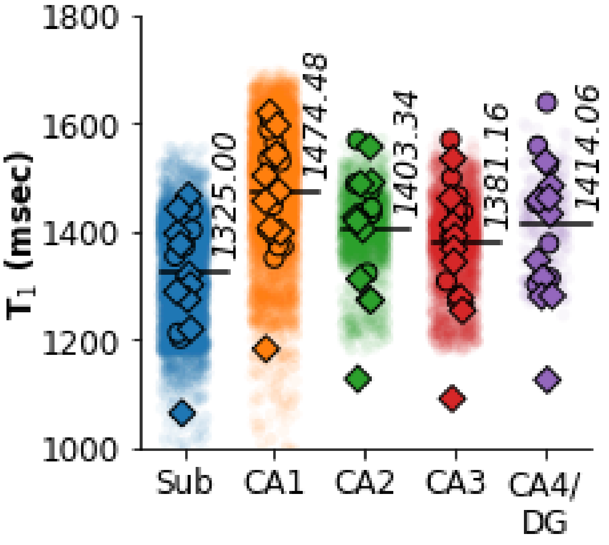
Swarm plots

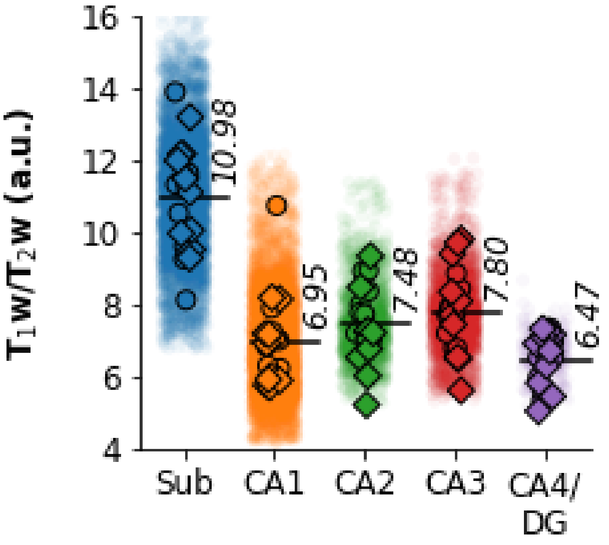
[17]:
```
for i, idx in enumerate(maps_dict.keys()):
    filename = '../visualization/subfield-averages/
 ↪sub-group_{}_subfields_averages.png'.format(maps_dict[idx][0])
    utilities.plot_subfield_data(
        subj_data[:,:,:,i], subfields, maps_dict[idx], filename, scale=1 if i<2␣
 ↪else .7,
        stats=False, save_fig=save_fig
    )
```

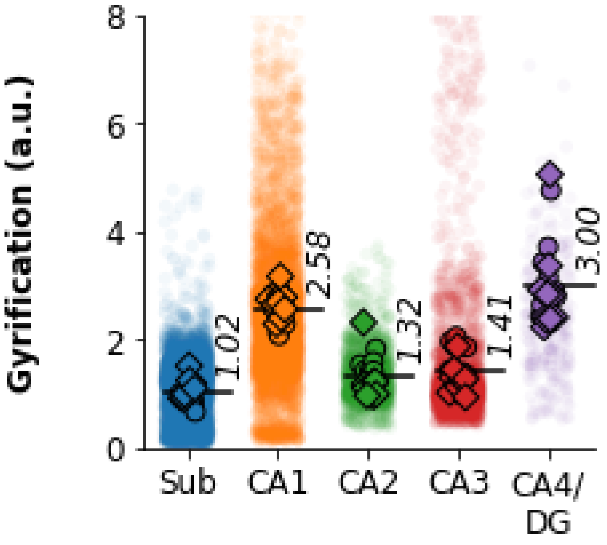


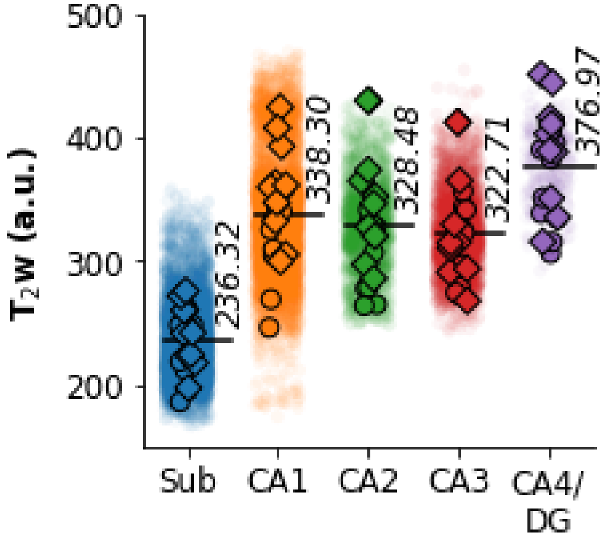

Perfusion-weigthed signal (a.u.)
25
20
15
10
5
0
Sub
CA1
CA2
CA3
CA4/ DG
8.87
9.14
12.02
11.91
13.01

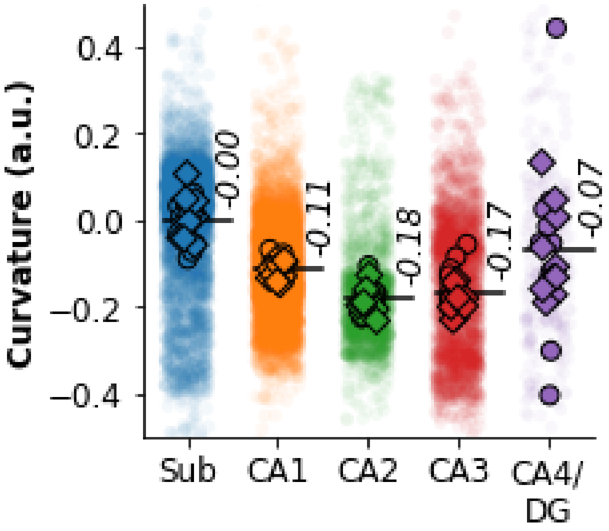

Thickness (mm)
3.0
2.5
2.0
1.5
1.0
0.5
Sub
CA1
CA2
CA3
CA4/ DG
1.08
1.05
0.83
1.09
1.67


T$_1$ (msec)
1800
1600
1400
1200
1000
Sub
CA1
CA2
CA3
CA4/
DG
1325.00
1474.48
1403.34
1381.16
1414.06


T$_1$w/T$_2$w (a.u.)
16
14
12
10
8
6
4
Sub
CA1
CA2
CA3
CA4/
DG
10.98
6.95
7.48
7.80
6.47

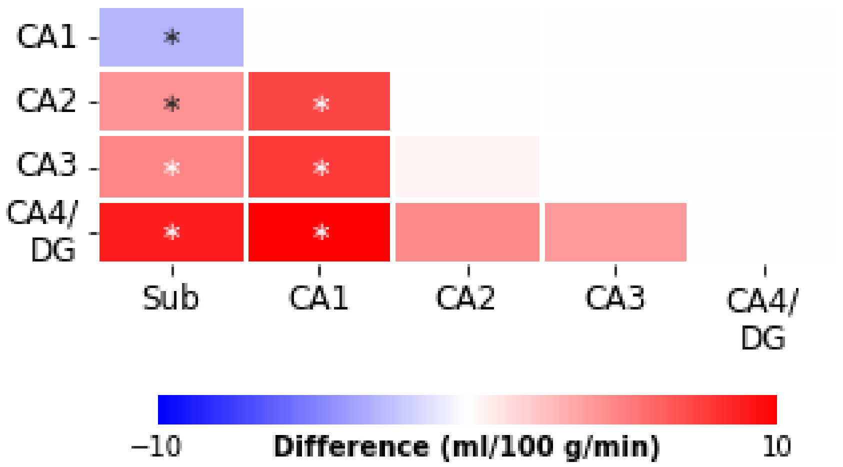

Gyrification (a.u.)
8
6
4
2
0
1.02
2.58
1.32
1.41
3.00
Sub
CA1
CA2
CA3
CA4/
DG

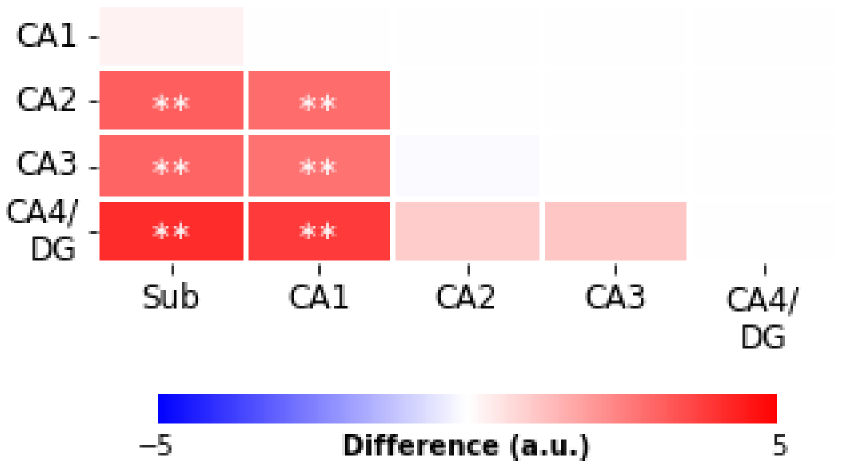

T$_2$w (a.u.)
500
400
300
200
236.32
338.30
328.48
322.71
376.97
Sub
CA1
CA2
CA3
CA4/
DG

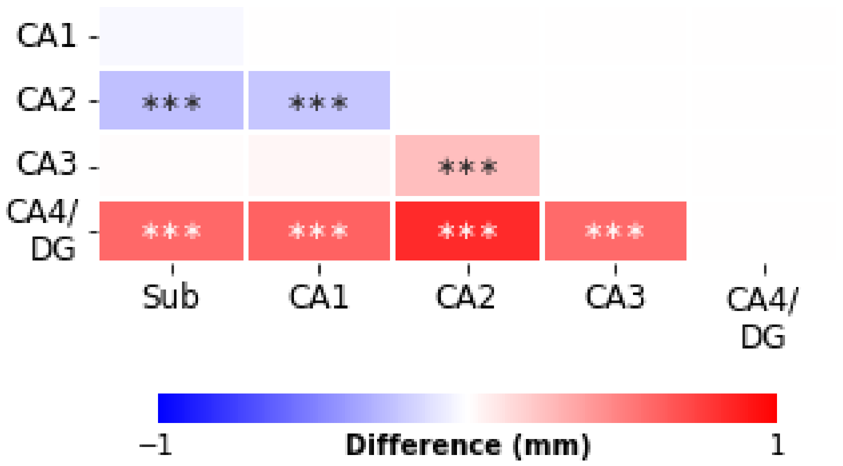


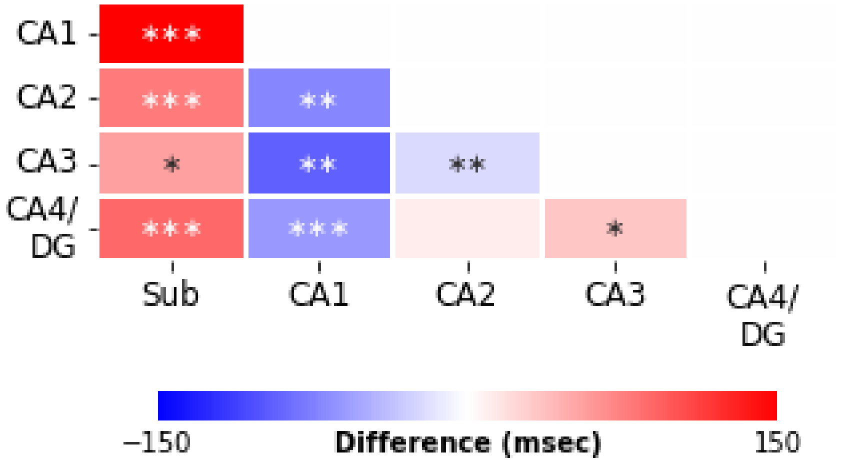
```
[18]: for i, idx in enumerate(maps_dict.keys()):
          df_stats, rm, pw = utilities.subfield_stats(
              subj_data, i, idx, subjects, subfields
          )
          print(rm)

          # Heatmap
          filename = '../visualization/subfield-averages/
       ↪sub-group_{}_subfields_stat_differences.png'.format(maps_dict[idx][0])
          utilities.plot_subfield_pairs(df_stats, rm, pw, i, maps_dict[idx],␣
       ↪filename, save_fig=save_fig)
```

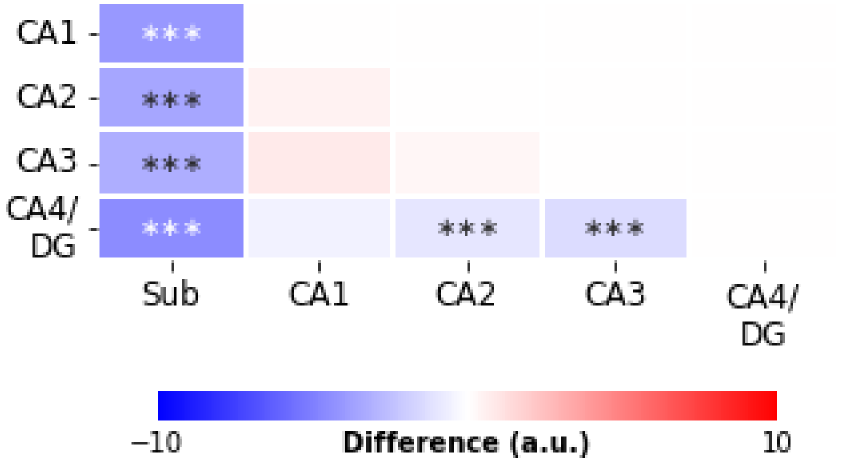
```
            Source      W  ddof1      Q     p-unc
Friedman  Subfield  0.492      4  19.68  0.000578
            Source      W  ddof1      Q     p-unc
Friedman  Subfield  0.566      4  22.64  0.000149
            Source      W  ddof1      Q     p-unc
Friedman  Subfield  0.814      4  32.56  0.000001
            Source     W  ddof1     Q     p-unc
Friedman  Subfield  0.79      4  31.6  0.000002
            Source     W  ddof1     Q         p-unc
Friedman  Subfield  0.85      4  34.0  7.451888e-07
            Source      W  ddof1      Q         p-unc
Friedman  Subfield  0.916      4  36.64  2.136644e-07
            Source      W  ddof1      Q         p-unc
Friedman  Subfield  0.862      4  34.48  5.940021e-07
            Source     W  ddof1     Q     p-unc
Friedman  Subfield  0.67      4  26.8  0.000022
```

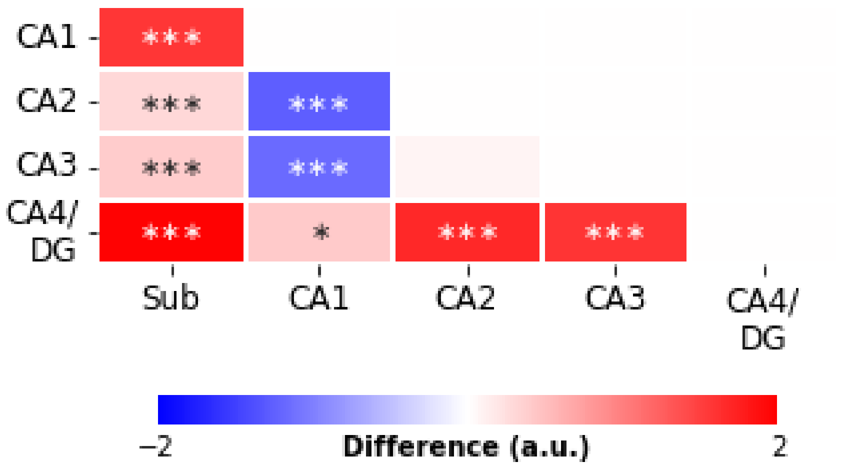

CA1
CA2
CA3
CA4/
DG
*
*
*
*
*
*
*
Sub
CA1
CA2
CA3
CA4/
DG
−10
Difference (ml/100 g/min)
10

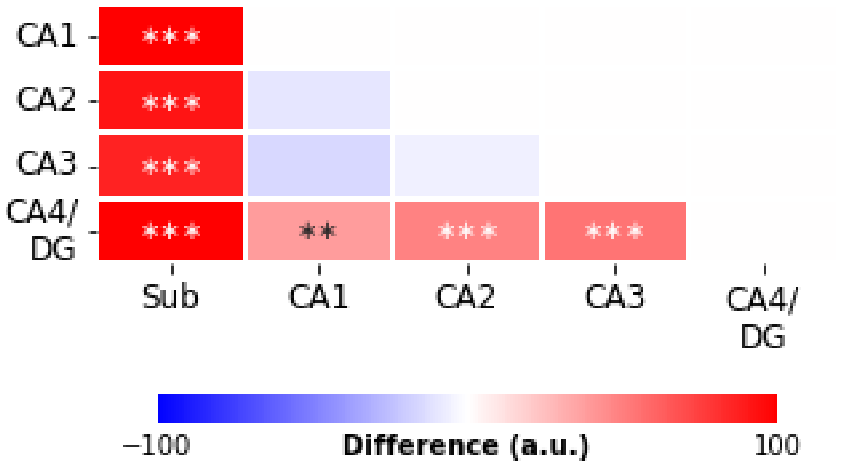

CA1
CA2
CA3
CA4/
DG
**
**
**
**
**
**
Sub
CA1
CA2
CA3
CA4/
DG
−5
Difference (a.u.)
5

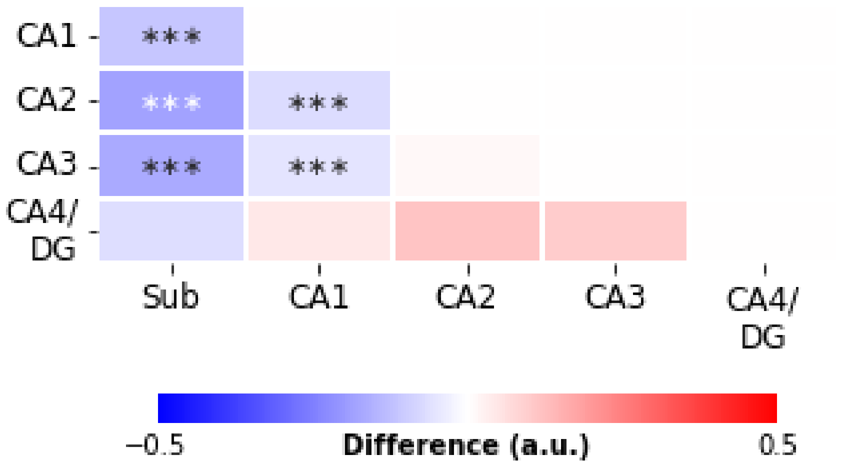

CA1
CA2
CA3
CA4/
DG
***
***
***
***
***
***
***
Sub
CA1
CA2
CA3
CA4/
DG
−1
Difference (mm)
1


CA1
CA2
CA3
CA4/
DG
***
***
**
*
**
**
***
***
*
Sub
CA1
CA2
CA3
CA4/
DG
−150
Difference (msec)
150


CA1
CA2
CA3
CA4/
DG
***
***
***
***
***
***
Sub
CA1
CA2
CA3
CA4/
DG
−10
Difference (a.u.)
10


CA1
CA2
CA3
CA4/
DG
Sub
CA1
CA2
CA3
CA4/
DG
***
***
***
***
***
*
***
***
−2
Difference (a.u.)
2


CA1
CA2
CA3
CA4/
DG
Sub
CA1
CA2
CA3
CA4/
DG
***
***
***
***
**
***
***
−100
Difference (a.u.)
100


CA1
CA2
CA3
CA4/
DG
Sub
CA1
CA2
CA3
CA4/
DG
***
***
***
***
***
−0.5
Difference (a.u.)
0.5