

image_metrics

June 15, 2023

```
[1]: %load_ext autoreload
      %autoreload 2

[2]: import warnings
      warnings.filterwarnings('ignore')

[3]: import numpy as np
      import pandas as pd
      import nibabel as nib
      import seaborn as sns
      from surfplot import Plot
      import matplotlib.pyplot as plt
      from scipy.stats import linregress, spearmanr
      from brainspace.utils.parcellation import reduce_by_labels

      import utilities

[4]: unfolded = '../resources/midthickness.L.unfolded.surf.gii'
      coords = nib.load(unfolded).get_arrays_from_intent('NIFTI_INTENT_POINTSET')[0].
      ↪data
      nvertices = len(coords)

[5]: # Atlas
      atlas      = '../resources/BigBrain_ManualSubfieldsUnfolded_254x126.shape.gii'
      subfields = nib.load(atlas).darrays[0].data

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

[7]: # Hemispheres
      hemis = ['Lflip', 'R']

[39]: # Maps
      maps_dict = {
          1: ['pveGM', 'red', (0,1), 'GM PVE', '(a.u.)', (0,25), (-5,5)],
```

```

2: ['pveWM', 'green', (0,1), 'WM PVE','(a.u.)', (0,3), (-1,1)],
3: ['pveCSF', 'blue', (0,1), 'CSF PVE','(a.u.)', (1000,1800), (-150,150)],
4: ['Shiftmap', 'cividis', (5,15), 'Image distortion','(mm)', (-.5,.3), (-.
↪5,.5)],
5: ['B1map', 'hot', (5,15), 'B$_{1}^{+}$','( T)', (8,18), (8,18)],
6: ['tSNR', 'winter', (0,8), 'tSNR', '(a.u.)', (0,8), (0,8)],
7: ['CBF', 'hot', (20,60), 'Perfusion','(ml/100 g/min)', (10,75), (-10,10)],
}

```

```

[16]: # Load input, per subject
fname = '../results/surface_maps/sub-{0}/sub-{0}_{1}_{2}.native.shape.gii'

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()):
            if i != 7:
                subj_data[:,s,h,i] = nib.load(
                    fname.format(
                        subject,
                        f"'{tpl-hires_}' if idx == 4 else_
↪''{maps_dict[idx][0]}",
                        hemi
                    )
                ).darrays[0].data

avg_data = np.nanmean(subj_data, axis=(2,1))

```

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[17]: # Average PWI
avg_pwi = np.nanmean(subj_data[:, :, :, 0], axis=(1,2))

```

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[18]: # Convert shiftmap to unit mm
subj_data[:, :, :, 3] = subj_data[:, :, :, 3]*1.5

```

```

[31]: save_fig = True

```

0.1 PVE

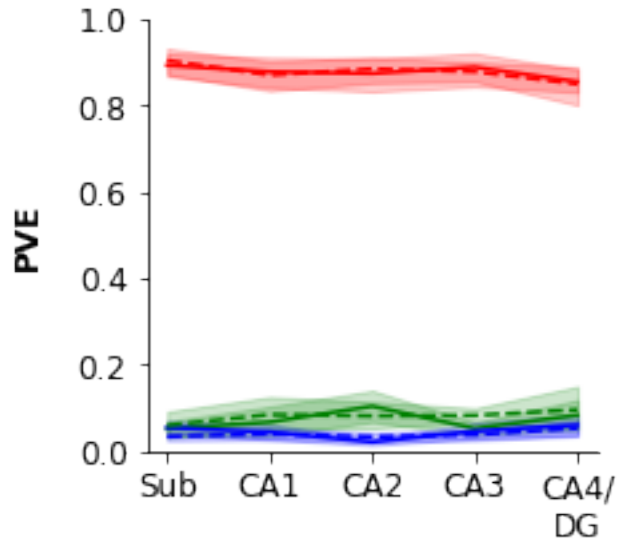
```
[34]: pve = avg_data[:,[0,1,2]]  
      for r in range(0,nvertices):  
          pve[r,:] = pve[r,;]/sum(pve[r,:])
```

```
[35]: pve_2d = pve.reshape((126,254,3), order='C')  
      pve_2d = np.flipud(pve_2d)
```

```
[36]: plt.imshow(pve_2d, aspect='equal')  
      plt.axis('off')  
      if save_fig:  
          filename = "../visualization/unfolded/sub-group_pve_rgb_unfolded.png"  
          plt.savefig(filename, bbox_inches='tight')
```



```
[21]: filename = '../visualization/subfield-averages/sub-group_pve_subfields_averages.  
      ↪png'  
      utilities.lineplot(  
          subj_data[:, :, :, 0:3], subfields, ['red', 'green', 'blue'], [0,1], 'PVE',  
          ↪filename  
      )
```



0.2 Fieldmap

```
[20]: # 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
)
```

```
[43]: # gii = nib.load(f'../results/surface_maps/group/sub-group_Fieldmap_LR_avg.
      ↪native.shape.gii')
fieldmap = avg_data[:,3]
print(f'Maximum distortion is {np.nanmin(fieldmap)} +/- {np.nanstd(fieldmap)}_
      ↪mm')
```

Maximum distortion is -0.3034347238019109 +/- 0.06087357198507875 mm

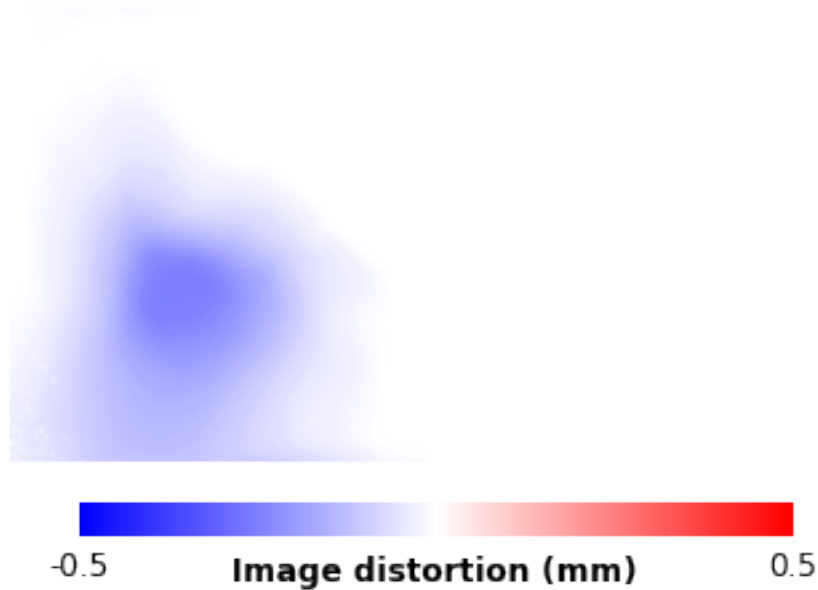
```
[38]: p = Plot(unfolded, layout='row', views=['dorsal'], zoom=2, size=(500, 300))
p.add_layer(fieldmap, color_range=(-0.5,0.5), cmap='bwr')

fig = p.build(cbar_kws=cbar_unfolded_kws)
fig.axes[1].set_xlabel('Image distortion (mm)', labelpad=-11, fontsize=12,
      ↪fontweight='bold')
```

```

if save_fig:
    fig.savefig('../visualization/unfolded/sub-group_shiftmap_unfolded.png',
        ↪dpi=600, bbox_inches='tight')
fig.show()

```

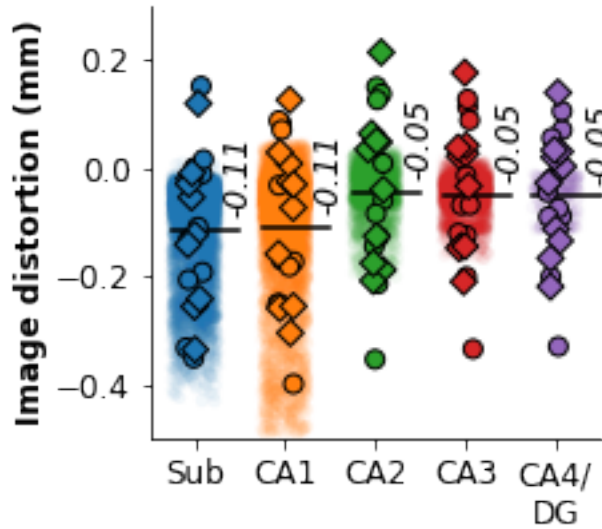


```

[40]: filename = '../visualization/subfield-averages/
        ↪sub-group_fieldmap_subfields_averages.png'
utilities.plot_subfield_data(
    subj_data[:, :, :, 3], subfields, maps_dict[4], filename, scale=.7,
    stats=False, save_fig=save_fig
)

df_stats, rm, pw = utilities.subfield_stats(subj_data, 4, 5, subjects,
        ↪subfields)
print(rm)

```



	Source	W	ddof1	Q	p-unc
Friedman	Subfield	0.916	4	36.64	2.136644e-07

```
[30]: df_stats, rm, pw = utilities.subfield_stats(subj_data, 4, 5, subjects,
        ↪subfields, within='Hemisphere')
print(rm)
```

	Source	W	ddof1	Q	p-unc
Friedman	Hemisphere	0.16	1	1.6	0.205903

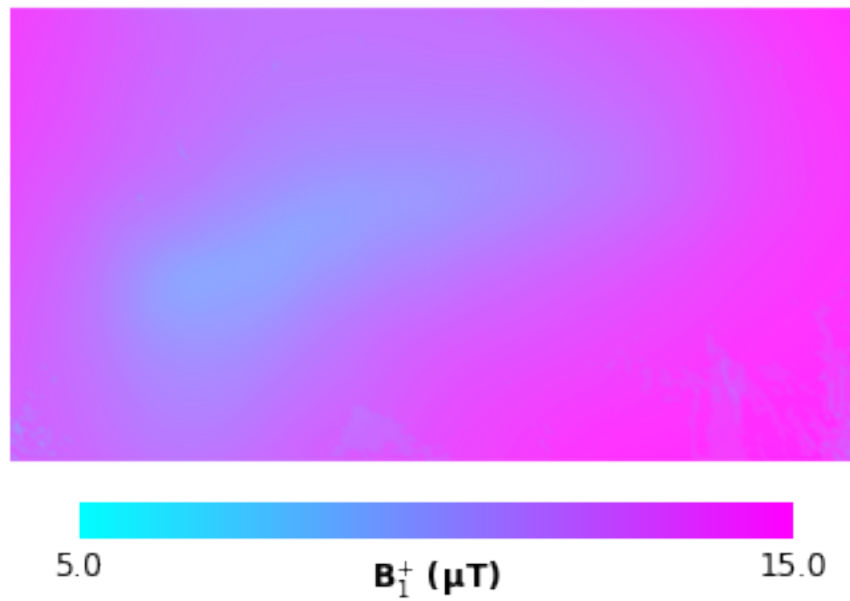
0.2.1 B1

```
[52]: b1 = avg_data[:,4]
print(f'Average B1+ is {np.nanmean(b1)} +/- {np.nanstd(b1)}')
```

Average B1+ is 12.029949625150632 +/- 1.146660869313834

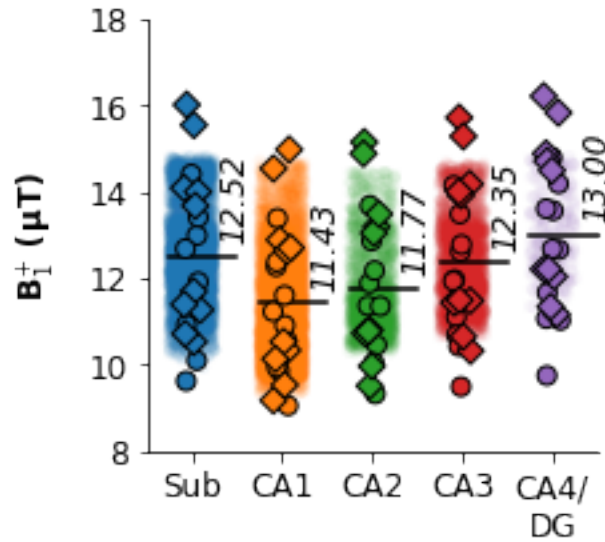
```
[51]: p = Plot(unfolded, layout='row', views=['dorsal'], zoom=2, size=(500, 300))
p.add_layer(b1, color_range=(5,15), cmap='cool')

fig = p.build(cbar_kws=cbar_unfolded_kws)
fig.axes[1].set_xlabel('B$_{1}^{+}$ ( T)', labelpad=-11, fontsize=12,
        ↪fontweight='bold')
if save_fig:
    fig.savefig('../visualization/unfolded/sub-group_B1_unfolded.png', dpi=600,
        ↪bbox_inches='tight')
fig.show()
```



```
[58]: filename = '../visualization/subfield-averages/sub-group_b1_subfields_averages.
      ↪png'
utilities.plot_subfield_data(
    subj_data[:, :, :, 4], subfields, maps_dict[5], filename, scale=.7,
    stats=False, save_fig=save_fig
)

df_stats, rm, pw = utilities.subfield_stats(subj_data, 4, 5, subjects, ↪
      ↪subfields)
print(rm)
```



	Source	W	ddof1	Q	p-unc
Friedman	Subfield	0.916	4	36.64	2.136644e-07

```
[86]: df_stats, rm, pw = utilities.subfield_stats(subj_data, 5, 6, subjects,
        ↪subfields, within='Hemisphere')
print(rm)
```

	Source	W	ddof1	Q	p-unc
Friedman	Hemisphere	0.206612	1	2.272727	0.131668

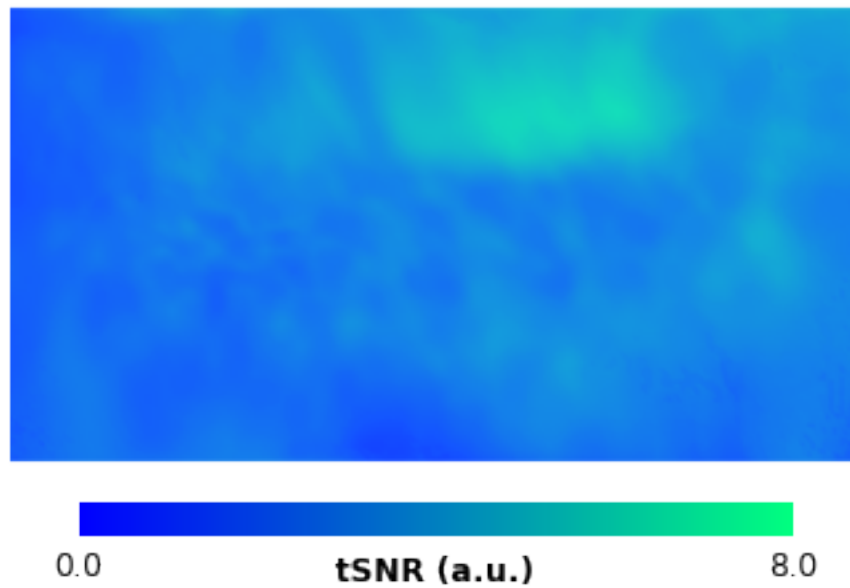
0.2.2 tSNR

```
[12]: tsnr = avg_data[:,5]
print(f'Average tSNR+ is {np.nanmean(tsnr)} +/- {np.nanstd(tsnr)}')
```

Average tSNR+ is 3.3463836650598315 +/- 0.8379328337527037

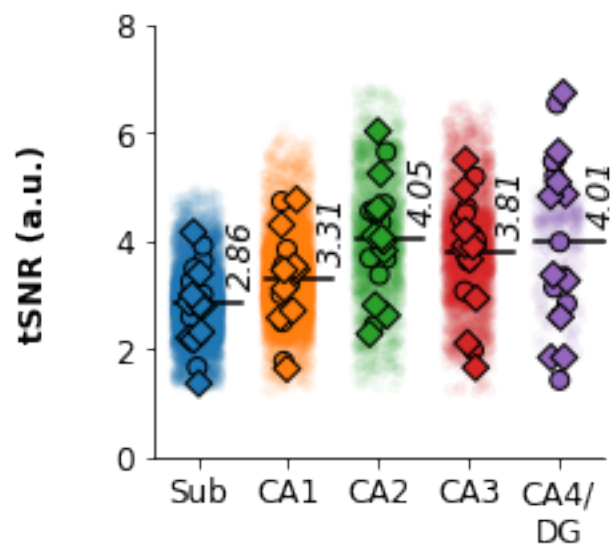
```
[18]: p = Plot(unfolded, layout='row', views=['dorsal'], zoom=2, size=(500, 300))
p.add_layer(tsnr, color_range=(0,8), cmap='winter')

fig = p.build(cbar_kws=cbar_unfolded_kws)
fig.axes[1].set_xlabel('tSNR (a.u.)', labelpad=-11, fontsize=12,
        ↪fontweight='bold')
if save_fig:
    fig.savefig('../visualization/unfolded/sub-group_tSNR_unfolded.png',
        ↪dpi=600, bbox_inches='tight')
fig.show()
```

```
[62]: filename = '../visualization/subfield-averages/
↳sub-group_tsnr_subfields_averages.png'
utilities.plot_subfield_data(
    subj_data[:, :, :, 5], subfields, maps_dict[6], filename, scale=.7,
    stats=False, save_fig=save_fig
)

df_stats, rm, pw = utilities.subfield_stats(subj_data, 5, 6, subjects,
↳subfields)
print(rm)
```



	Source	W	ddof1	Q	p-unc
Friedman	Subfield	0.55	4	22.0	0.0002