Phase 1: Protocol Validation for Brain Templates

This notebook contains results validating the AFID protocol on three openly available templates (`Agile12v2016` , `Colin27` , and `ICBM2009bAsym`).

The first step is to initialize the variables, define useful functions, and load all the raw fcsv data into `df_raters` .

Template Averages

For each template, we calculate the mean value for each AFID32 point and store it in a separate .fcsv file so that it can be loaded back into 3D Slicer.

Deviation of the values by > 10 mm will be classified as an outlier.

Phase 1: Raw Data Analysis

Also classify extreme outliers, defined as >= 10 mm from the group mean

'Total: 1.27 +/- 1.98 mm; Outliers: 24/3072 (0.78%)'

'Agile12v2016: 1.10 +/- 1.59 mm; Outliers: 3/1024 (0.29%)'

'Colin27: 1.71 +/- 2.78 mm; Outliers: 20/1024 (1.95%)'

'MNI152NLin2009bAsym: 0.99 +/- 1.11 mm; Outliers: 1/1024 (0.10%)'

Template Averages: Post-QC

Template averages were recreated after quality control and filtering of outliers.

'Total: 1.03 +/- 0.94 mm; Outliers: 1/3048 (0.03%)'

'Agile12v2016: 1.01 +/- 0.93 mm; Outliers: 0/1021 (0.00%)'

'Colin27: 1.11 +/- 1.05 mm; Outliers: 1/1004 (0.10%)'

'MNI152NLin2009bAsym: 0.97 +/- 0.80 mm; Outliers: 0/1023 (0.00%)'

AFID	Description	Agile12v2016 Pre-QC	Agile12v2016 Post-QC	Colin27 Pre-QC	Colin27 Post-QC	MNI2009bAsym Pre-QC	MNI2009bAsym Post-QC	Total Pre-QC	Total Post-QC
01	AC	0.33±0.16 (0)	0.33±0.16 (0)	0.34±0.29 (0)	0.34±0.29 (0)	0.35±0.20 (0)	0.35±0.20 (0)	0.34±0.22 (0)	0.34±0.22 (0)
02	PC	0.34±0.19 (0)	0.34±0.19 (0)	0.35±0.18 (0)	0.35±0.18 (0)	0.33±0.14 (0)	0.33±0.14 (0)	0.34±0.17 (0)	0.34±0.17 (0)
03	infracollicular sulcus	1.25±0.47 (0)	1.25±0.47 (0)	1.22±0.48 (0)	1.22±0.48 (0)	1.08±0.46 (0)	1.08±0.46 (0)	1.17±0.47 (0)	1.17±0.47 (0)
04	PMJ	0.83±0.47 (0)	0.83±0.47 (0)	0.97±0.65 (0)	0.97±0.65 (0)	0.84±0.52 (0)	0.84±0.52 (0)	0.87±0.54 (0)	0.87±0.54 (0)
05	superior interpeduncular fossa	1.15±0.61 (0)	1.15±0.61 (0)	0.96±0.60 (0)	0.96±0.60 (0)	1.12±0.50 (0)	1.12±0.50 (0)	1.08±0.57 (0)	1.08±0.57 (0)
06	R superior LMS	0.75±0.48 (0)	0.75±0.48 (0)	1.16±0.69 (0)	1.16±0.69 (0)	0.68±0.50 (0)	0.68±0.50 (0)	0.85±0.59 (0)	0.85±0.59 (0)
07	L superior LMS	0.93±0.59 (0)	0.93±0.59 (0)	1.05±0.57 (0)	1.05±0.57 (0)	0.91±0.90 (0)	0.91±0.90 (0)	0.96±0.71 (0)	0.96±0.71 (0)
08	R inferior LMS	1.55±1.14 (0)	1.55±1.14 (0)	1.61±1.07 (0)	1.61±1.07 (0)	1.47±0.96 (0)	1.47±0.96 (0)	1.54±1.05 (0)	1.54±1.05 (0)
09	L inferior LMS	1.39±1.11 (0)	1.39±1.11 (0)	1.79±1.32 (0)	1.79±1.32 (0)	1.63±1.19 (0)	1.63±1.19 (0)	1.60±1.21 (0)	1.60±1.21 (0)
10	culmen	1.03±0.73 (0)	1.03±0.73 (0)	0.68±0.24 (0)	0.68±0.24 (0)	0.61±0.32 (0)	0.61±0.32 (0)	0.77±0.50 (0)	0.77±0.50 (0)
11	intermammillary sulcus	0.73±0.34 (0)	0.73±0.34 (0)	0.68±0.34 (0)	0.68±0.34 (0)	0.70±0.38 (0)	0.70±0.38 (0)	0.70±0.35 (0)	0.70±0.35 (0)
12	R MB	0.37±0.28 (0)	0.37±0.28 (0)	0.44±0.32 (0)	0.44±0.32 (0)	0.48±0.34 (0)	0.48±0.34 (0)	0.44±0.31 (0)	0.44±0.31 (0)
13	L MB	0.43±0.27 (0)	0.43±0.27 (0)	0.53±0.32 (0)	0.53±0.32 (0)	0.50±0.31 (0)	0.50±0.31 (0)	0.49±0.30 (0)	0.49±0.30 (0)
14	pineal gland	0.70±0.33 (0)	0.70±0.33 (0)	0.94±0.33 (0)	0.94±0.33 (0)	0.68±0.51 (0)	0.68±0.51 (0)	0.77±0.42 (0)	0.77±0.42 (0)
15	R LV at AC	0.99±1.48 (0)	0.99±1.48 (0)	0.68±0.42 (0)	0.68±0.42 (0)	0.62±0.50 (0)	0.62±0.50 (0)	0.75±0.92 (0)	0.75±0.92 (0)
16	L LV at AC	1.06±1.60 (0)	1.06±1.60 (0)	0.73±0.42 (0)	0.73±0.42 (0)	0.62±0.51 (0)	0.62±0.51 (0)	0.79±0.98 (0)	0.79±0.98 (0)
17	R LV at PC	1.13±1.35 (0)	1.13±1.35 (0)	1.12±1.01 (0)	1.12±1.01 (0)	1.00±0.60 (0)	1.00±0.60 (0)	1.08±1.00 (0)	1.08±1.00 (0)
18	L LV at PC	1.23±1.46 (0)	1.23±1.46 (0)	1.32±1.02 (0)	1.32±1.02 (0)	1.03±0.58 (0)	1.03±0.58 (0)	1.18±1.05 (0)	1.18±1.05 (0)
19	genu of CC	1.00±0.46 (0)	1.00±0.46 (0)	0.63±0.24 (0)	0.63±0.24 (0)	0.78±0.48 (0)	0.78±0.48 (0)	0.80±0.44 (0)	0.80±0.44 (0)
20	splenium of CC	0.71±0.39 (0)	0.71±0.39 (0)	0.52±0.27 (0)	0.52±0.27 (0)	0.80±1.10 (0)	0.80±1.10 (0)	0.68±0.73 (0)	0.68±0.73 (0)
21	R AL temporal horn	1.44±1.20 (0)	1.44±1.20 (0)	1.52±0.79 (0)	1.52±0.79 (0)	1.15±0.89 (0)	1.15±0.89 (0)	1.36±0.98 (0)	1.36±0.98 (0)
22	L AL temporal horn	1.64±1.92 (1)	1.32±0.91 (0)	1.10±0.56 (0)	1.10±0.56 (0)	1.16±0.94 (0)	1.16±0.94 (0)	1.29±1.27 (1)	1.19±0.82 (0)
23	R superior AM temporal horn	0.62±0.38 (0)	0.62±0.38 (0)	1.31±1.71 (0)	1.31±1.71 (0)	0.83±0.91 (0)	0.83±0.91 (0)	0.91±1.15 (0)	0.91±1.15 (0)
24	L superior AM temporal horn	0.59±0.39 (0)	0.59±0.39 (0)	2.02±1.90 (0)	2.02±1.90 (0)	0.95±0.98 (0)	0.95±0.98 (0)	1.17±1.36 (0)	1.17±1.36 (0)
25	R inferior AM temporal horn	1.31±1.20 (0)	1.31±1.20 (0)	1.49±0.94 (0)	1.49±0.94 (0)	1.40±1.00 (0)	1.40±1.00 (0)	1.40±1.04 (0)	1.40±1.04 (0)
26	L inferior AM temporal horn	1.36±1.16 (0)	1.36±1.16 (0)	1.41±1.06 (0)	1.41±1.06 (0)	1.39±0.76 (0)	1.39±0.76 (0)	1.38±0.98 (0)	1.38±0.98 (0)
27	R indusium griseum origin	2.58±4.99 (1)	1.38±0.75 (0)	1.70±1.08 (0)	1.70±1.08 (0)	1.26±0.82 (0)	1.26±0.82 (0)	1.81±2.92 (1)	1.43±0.90 (0)
28	L indusium griseum origin	2.57±4.91 (1)	1.52±1.14 (0)	2.11±1.44 (0)	2.11±1.44 (0)	1.40±0.98 (0)	1.40±0.98 (0)	1.99±2.94 (1)	1.66±1.22 (0)
29	R ventral occipital horn	1.59±1.07 (0)	1.59±1.07 (0)	11.38±4.82 (10)	0.80±0.45 (0)	2.07±4.11 (1)	1.34±1.25 (0)	4.84±5.78 (11)	1.30±1.08 (0)
30	L ventral occipital horn	1.09±1.13 (0)	1.09±1.13 (0)	10.04±4.78 (10)	1.63±2.94 (1)	1.25±1.32 (0)	1.25±1.32 (0)	3.96±5.02 (10)	1.28±1.78 (1)
31	R olfactory sulcal fundus	1.17±0.68 (0)	1.17±0.68 (0)	1.41±0.95 (0)	1.41±0.95 (0)	1.14±0.59 (0)	1.14±0.59 (0)	1.23±0.75 (0)	1.23±0.75 (0)
32	L olfactory sulcal fundus	1.23±0.54 (0)	1.23±0.54 (0)	1.41±1.00 (0)	1.41±1.00 (0)	1.13±0.63 (0)	1.13±0.63 (0)	1.25±0.74 (0)	1.25±0.74 (0)

Demographics of Raters

Details regarding experience, etc.

rater_id	imaging_exp	neuro_exp	slicer_exp	description
Rater01	24	24	24	undergrad_student
Rater02	0	0	0	medical_student
Rater03	8	0	8	undergrad_student
Rater04	24	6	0	grad_student
Rater05	0	24	0	grad_student
Rater06	24	12	12	grad_student
Rater07	12	48	12	grad_student
Rater08	0	0	0	undergrad_student

'Imaging Experience: 11.5 +/- 11.2 months (Range: 0.0-24.0)'

'Neuroanatomy Experience: 14.2 +/- 17.0 months (Range: 0.0-48.0)'

'3D Slicer Experience: 7.0 +/- 8.8 months (Range: 0.0-24.0)'

Secondary Analyses

We first evaluated whether there was any evidence of learning across sessions (excluding session 0 which was completed as part of a group tutorial). There were negative trends in the mean AFLE with increasing session number but these did not meet thresholds of statistical analysis. The first column is the effect, second column is the associated p-value.

Summary text on learning: As a secondary analysis, we explored whether any evidence of learning over the 4 independent rating sessions could be identified (Supporting Information S1 file). Using linear modeling, we identified a general decrease in mean AFLE with increasing session number although this did not meet thresholds of statistical significance (estimate = -0.02 mm/session; p-value = 0.11). These trends were explored on the individual rater level. For two out of 8 raters, AFLE varied with session number. Rater04 demonstrated a general linear improvement of -0.17 mm/session from an initial mean AFLE of 1.64 mm (i.e. the worst performing initial session); however Rater02 worsened at a rate of 0.12 mm/session from an initial mean AFLE of 0.59 mm (i.e. the best performing initial session). No significant effect with individual AFIDs was identified. All subgroup analyses were multiple comparisons corrected using FDR (q-value < 0.05).

(Intercept)	1.090	0.0000
session	-0.024	0.1141

Did specific raters demonstrate any learning?

Because of the trends, we explored further to determine whether any specific raters demonstrated any learning. After multiple comparisons correction, only two raters demonstrated statistically significant change with session number. Rater #4 was observed to start at a baseline increased rating error in the first session (1.64 mm) but demonstrated a decrease in AFLE with session number improving by 0.1-0.2 mm per session based on the linear model (statistically significant improvement). On the contrary, Rater #2 who started with an intercept of 0.59 mm (better than the average) showed worsening of rater error with time.

rater	(Intercept)	pval_(Intercept)	session	pval_session	pval_session_adjusted	pval_session_significant
1	0.78	0	0.02	0.5644	0.6450	FALSE
2	0.59	0	0.12	0.0001	0.0009	TRUE
3	1.30	0	-0.06	0.1624	0.2783	FALSE
4	1.64	0	-0.17	0.0002	0.0009	TRUE
5	1.05	0	0.04	0.2881	0.3841	FALSE
6	1.08	0	-0.04	0.1739	0.2783	FALSE
7	0.84	0	0.02	0.7086	0.7086	FALSE
8	1.45	0	-0.12	0.0210	0.0560	FALSE

Did AFLE improve for specific AFIDs?

We wanted to see if specific AFIDs tended to improve with more training (i.e. more sessions). This analysis did not survive multiple comparisons analysis.

fid	(Intercept)	pval_(Intercept)	session	pval_session	pval_session_adjusted	pval_session_significant
1	0.36	0.0000	-0.01	0.7009	0.8307	FALSE
2	0.38	0.0000	-0.01	0.3531	0.7955	FALSE
3	1.28	0.0000	-0.03	0.4534	0.7955	FALSE
4	0.65	0.0000	0.09	0.0588	0.4391	FALSE
5	1.08	0.0000	0.00	0.9802	0.9802	FALSE
6	0.71	0.0000	0.06	0.2590	0.7296	FALSE
7	0.92	0.0000	0.01	0.8661	0.8941	FALSE
8	1.76	0.0000	-0.08	0.4408	0.7955	FALSE
9	1.82	0.0000	-0.07	0.5221	0.7955	FALSE
10	0.79	0.0000	-0.01	0.8035	0.8866	FALSE
11	0.85	0.0000	-0.06	0.0686	0.4391	FALSE
12	0.47	0.0000	-0.01	0.6396	0.8307	FALSE
13	0.41	0.0000	0.03	0.2885	0.7296	FALSE
14	1.02	0.0000	-0.10	0.0076	0.2431	FALSE
15	0.68	0.0051	0.03	0.6932	0.8307	FALSE
16	0.74	0.0044	0.03	0.7880	0.8866	FALSE
17	1.00	0.0002	0.04	0.6840	0.8307	FALSE
18	1.25	0.0000	-0.02	0.8506	0.8941	FALSE
19	0.87	0.0000	-0.02	0.5664	0.8239	FALSE
20	0.86	0.0000	-0.09	0.0188	0.3005	FALSE
21	1.22	0.0000	0.07	0.4391	0.7955	FALSE
22	1.05	0.0000	0.07	0.3945	0.7955	FALSE
23	1.21	0.0000	-0.13	0.1677	0.7296	FALSE
24	1.34	0.0001	-0.08	0.5017	0.7955	FALSE
25	1.76	0.0000	-0.13	0.1829	0.7296	FALSE
26	1.64	0.0000	-0.10	0.2964	0.7296	FALSE
27	1.04	0.0000	0.15	0.0629	0.4391	FALSE
28	1.47	0.0000	0.08	0.4954	0.7955	FALSE
29	1.79	0.0000	-0.18	0.0984	0.5246	FALSE
30	1.82	0.0004	-0.20	0.2627	0.7296	FALSE
31	1.46	0.0000	-0.09	0.2158	0.7296	FALSE
32	1.33	0.0000	-0.03	0.6341	0.8307	FALSE

Impact of AC and PC on AFLE

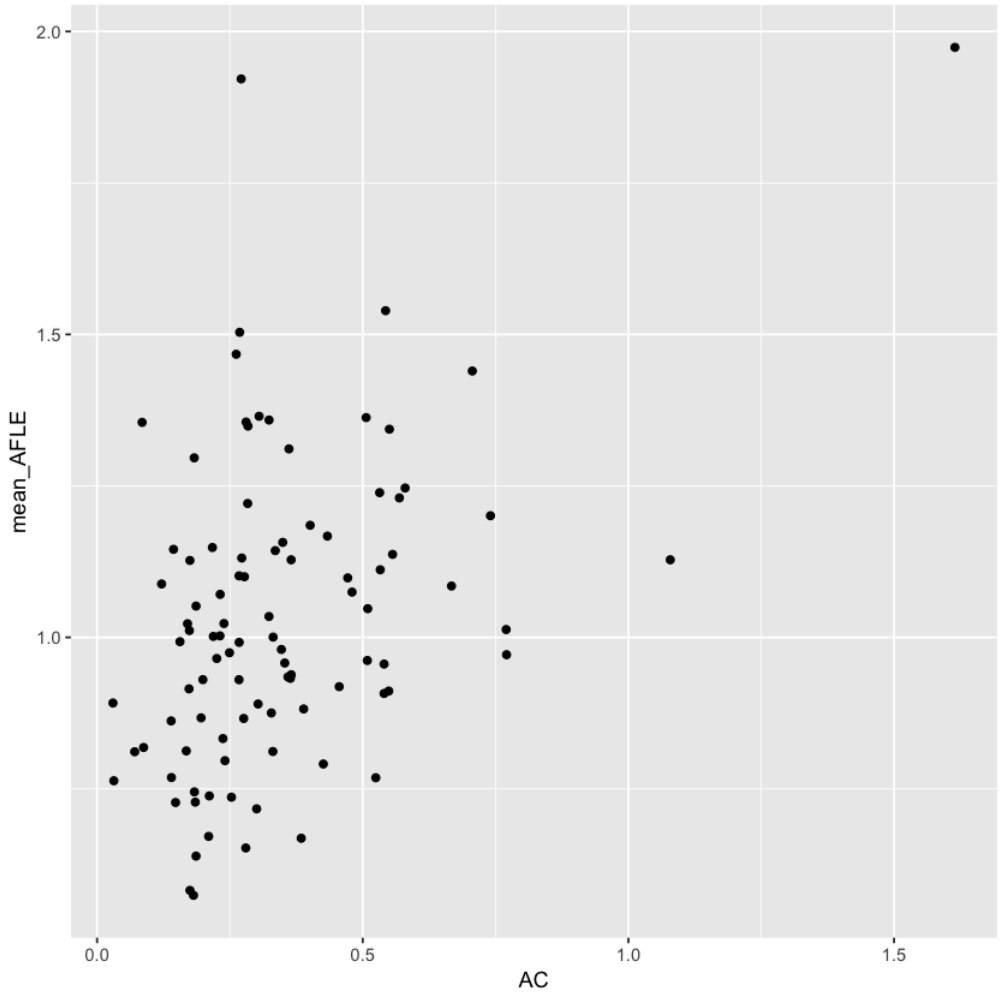
Analysis completed at the request of reviewers. We identified that the global AFLE values varied linearly with the accuracy of AC placement but not PC placement.

```
Call:
lm(formula = mean_AFLE ~ AC, data = df_ACPC_impact)

Residuals:
     Min       1Q   Median       3Q      Max
-0.38205 -0.16274 -0.02348  0.11585  0.92690

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.86087    0.04325  19.903  < 2e-16 ***
AC           0.49349    0.10538   4.683 9.51e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2302 on 94 degrees of freedom
Multiple R-squared:  0.1892,    Adjusted R-squared:  0.1805
F-statistic: 21.93 on 1 and 94 DF,  p-value: 9.511e-06
```

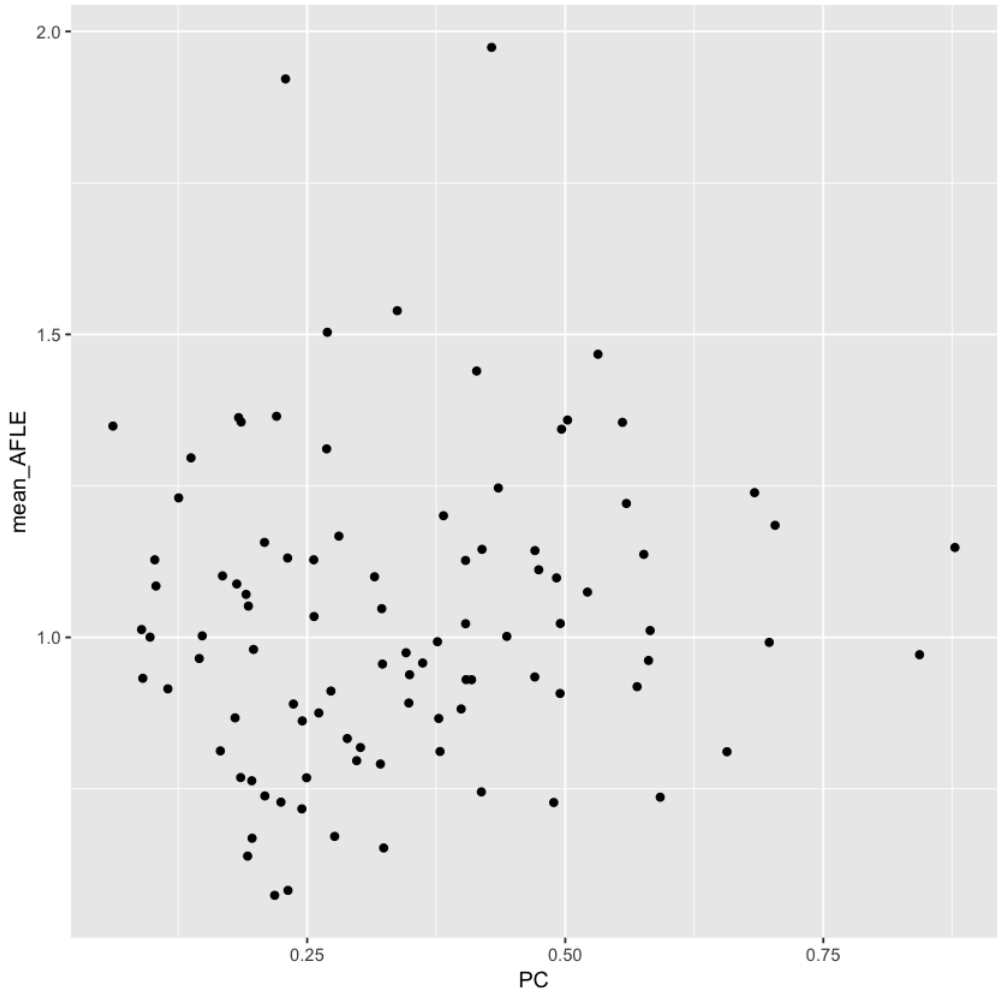



```
Call:
lm(formula = mean_AFLE ~ PC, data = df_ACPC_impact)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.43827 -0.15525 -0.03379  0.11150  0.92972 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  0.97976    0.05771  16.977   <2e-16 ***
PC           0.14993    0.15099   0.993    0.323    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2543 on 94 degrees of freedom
Multiple R-squared:  0.01038,   Adjusted R-squared:  -0.0001473 
F-statistic: 0.986 on 1 and 94 DF,  p-value: 0.3233
```



Intra-Rater AFLE

template	mean	sd
Agile12v2016	1.13	0.86
Colin27	1.14	0.92
MNI152NLin2009bAsym	1.03	0.78

'Intra-Rater AFLE: 1.10 +/- 0.86 mm'

Inter-Rater AFLE

template	mean	sd
Agile12v2016	1.14	0.48
Colin27	1.36	0.88
MNI152NLin2009bAsym	1.07	0.46

'Inter-Rater AFLE: 1.19 +/- 0.64 mm'

Summary of Validation Results (Post-QC)

Mean AFLE, Intra-Rater AFLE, Inter-Rater AFLE

AFID	Description	Agile12v2016 Mean AFLE	Colin27 Mean AFLE	MNI2009bAsym Mean AFLE	Total Mean AFLE	Agile12v2016 Intra-Rater	Colin27 Intra-Rater	MNI2009bAsym Intra-Rater	Total Intra-Rater	Agile12v2016 Inter-Rater	Colin27 Inter-Rater	MNI2009bAsym Inter-Rater	Total Inter-Rater
01	AC	0.33±0.16	0.34±0.29	0.35±0.20	0.34±0.22	0.41±0.15	0.49±0.35	0.44±0.23	0.45±0.24	0.31±0.16	0.30±0.12	0.37±0.16	0.33±0.04
02	PC	0.34±0.19	0.35±0.18	0.33±0.14	0.34±0.17	0.43±0.22	0.42±0.13	0.39±0.17	0.41±0.17	0.33±0.10	0.39±0.13	0.34±0.13	0.35±0.03
03	infracollicular sulcus	1.25±0.47	1.22±0.48	1.08±0.46	1.17±0.47	0.93±0.36	0.70±0.32	0.70±0.40	0.78±0.36	1.60±0.72	1.67±0.76	1.47±0.75	1.58±0.10
04	PMJ	0.83±0.47	0.97±0.65	0.84±0.52	0.87±0.54	0.80±0.23	0.89±0.49	0.76±0.28	0.81±0.34	1.06±0.50	1.23±0.74	1.17±0.55	1.15±0.08
05	superior interpeduncular fossa	1.15±0.61	0.96±0.60	1.12±0.50	1.08±0.57	1.04±0.37	1.02±0.61	1.00±0.51	1.02±0.48	1.38±0.83	1.07±0.59	1.20±0.63	1.22±0.16
06	R superior LMS	0.75±0.48	1.16±0.69	0.68±0.50	0.85±0.59	1.07±0.38	1.44±0.50	0.91±0.46	1.14±0.48	0.63±0.28	1.17±0.59	0.55±0.34	0.78±0.34
07	L superior LMS	0.93±0.59	1.05±0.57	0.91±0.90	0.96±0.71	1.18±0.32	1.04±0.44	1.27±0.87	1.16±0.58	1.03±0.46	1.25±0.68	0.62±0.31	0.97±0.32
08	R inferior LMS	1.55±1.14	1.61±1.07	1.47±0.96	1.54±1.05	1.81±1.07	1.49±0.77	1.35±0.81	1.55±0.88	1.65±1.08	2.06±1.16	1.87±1.28	1.86±0.21
09	L inferior LMS	1.39±1.11	1.79±1.32	1.63±1.19	1.60±1.21	1.66±0.91	1.88±1.37	1.60±1.22	1.71±1.14	1.53±1.07	2.06±1.29	2.05±1.45	1.88±0.31
10	culmen	1.03±0.73	0.68±0.24	0.61±0.32	0.77±0.50	1.16±0.70	0.72±0.22	0.61±0.25	0.83±0.49	1.10±0.41	0.77±0.25	0.70±0.29	0.85±0.21
11	intermammillary sulcus	0.73±0.34	0.68±0.34	0.70±0.38	0.70±0.35	0.69±0.41	0.74±0.41	0.83±0.47	0.76±0.42	0.82±0.39	0.72±0.31	0.68±0.36	0.74±0.07
12	R MB	0.37±0.28	0.44±0.32	0.48±0.34	0.44±0.31	0.51±0.31	0.47±0.14	0.54±0.34	0.51±0.27	0.32±0.18	0.51±0.42	0.51±0.39	0.45±0.11
13	L MB	0.43±0.27	0.53±0.32	0.50±0.31	0.49±0.30	0.52±0.29	0.50±0.15	0.58±0.28	0.53±0.24	0.40±0.19	0.63±0.45	0.52±0.33	0.52±0.12
14	pineal gland	0.70±0.33	0.94±0.33	0.68±0.51	0.77±0.42	0.91±0.24	1.16±0.37	0.83±0.57	0.97±0.42	0.63±0.25	0.70±0.41	0.68±0.35	0.67±0.04
15	R LV at AC	0.99±1.48	0.68±0.42	0.62±0.50	0.75±0.92	1.29±1.50	0.74±0.41	0.74±0.45	0.92±0.93	1.10±0.66	0.81±0.35	0.73±0.30	0.88±0.20
16	L LV at AC	1.06±1.60	0.73±0.42	0.62±0.51	0.79±0.98	1.34±1.50	0.76±0.33	0.78±0.41	0.96±0.92	1.31±1.09	0.91±0.35	0.77±0.32	0.99±0.28
17	R LV at PC	1.13±1.35	1.12±1.01	1.00±0.60	1.08±1.00	1.35±1.35	1.19±1.04	0.90±0.60	1.14±1.01	1.29±0.65	1.38±0.59	1.32±0.58	1.33±0.05
18	L LV at PC	1.23±1.46	1.32±1.02	1.03±0.58	1.18±1.05	1.48±1.29	1.18±1.07	0.91±0.54	1.19±1.00	1.50±1.04	1.65±0.72	1.40±0.61	1.52±0.13
19	genu of CC	1.00±0.46	0.63±0.24	0.78±0.48	0.80±0.44	1.10±0.66	0.62±0.21	0.84±0.42	0.85±0.49	0.99±0.46	0.75±0.28	0.99±0.48	0.91±0.14
20	splenium of CC	0.71±0.39	0.52±0.27	0.80±1.10	0.68±0.73	0.90±0.40	0.69±0.21	0.86±0.52	0.81±0.39	0.67±0.32	0.47±0.15	0.67±0.29	0.60±0.11
21	R AL temporal horn	1.44±1.20	1.52±0.79	1.15±0.89	1.36±0.98	1.55±1.26	1.71±0.59	1.33±1.12	1.53±1.00	1.72±1.00	1.65±0.80	1.32±0.67	1.56±0.21
22	L AL temporal horn	1.32±0.91	1.10±0.56	1.16±0.94	1.19±0.82	1.32±1.07	1.29±0.39	1.49±0.93	1.36±0.82	1.46±0.91	1.15±0.52	1.31±0.62	1.30±0.16
23	R superior AM temporal horn	0.62±0.38	1.31±1.71	0.83±0.91	0.91±1.15	0.70±0.36	1.73±1.90	0.72±0.33	1.05±1.19	0.69±0.37	1.35±0.74	0.80±0.34	0.95±0.35
24	L superior AM temporal horn	0.59±0.39	2.02±1.90	0.95±0.98	1.17±1.36	0.66±0.31	2.42±2.12	0.80±0.26	1.29±1.44	0.71±0.36	2.08±1.07	0.89±0.32	1.23±0.74
25	R inferior AM temporal horn	1.31±1.20	1.49±0.94	1.40±1.00	1.40±1.04	1.65±0.97	1.36±0.81	1.44±0.68	1.48±0.80	1.55±0.86	1.80±1.14	1.87±1.25	1.74±0.17
26	L inferior AM temporal horn	1.36±1.16	1.41±1.06	1.39±0.76	1.38±0.98	1.56±0.94	1.37±0.99	1.40±0.88	1.44±0.90	1.67±0.88	1.70±1.21	1.67±0.78	1.68±0.01
27	R indusium griseum origin	1.38±0.75	1.70±1.08	1.26±0.82	1.43±0.90	1.10±0.54	1.55±1.00	1.18±0.86	1.28±0.81	1.71±1.08	2.00±1.17	1.35±0.78	1.69±0.33
28	L indusium griseum origin	1.52±1.14	2.11±1.44	1.40±0.98	1.66±1.22	1.37±0.74	1.61±1.32	1.45±0.75	1.47±0.94	2.12±1.35	2.74±1.76	1.59±0.90	2.15±0.57
29	R ventral occipital horn	1.59±1.07	0.80±0.45	1.34±1.25	1.30±1.08	1.85±1.28	0.95±0.24	2.08±1.63	1.69±1.29	1.58±0.85	0.93±0.63	1.13±0.59	1.21±0.33
30	L ventral occipital horn	1.09±1.13	1.63±2.94	1.25±1.32	1.28±1.78	1.22±1.15	0.86±0.31	1.90±1.45	1.37±1.16	1.36±0.88	4.98±6.77	1.12±0.60	2.49±2.16
31	R olfactory sulcal fundus	1.17±0.68	1.41±0.95	1.14±0.59	1.23±0.75	1.44±0.75	1.91±0.65	1.23±0.56	1.53±0.69	0.96±0.51	1.35±0.68	1.20±0.69	1.17±0.19
32	L olfactory sulcal fundus	1.23±0.54	1.41±1.00	1.13±0.63	1.25±0.74	1.24±0.57	1.56±1.13	1.07±0.43	1.29±0.77	1.29±0.71	1.41±1.00	1.27±0.66	1.32±0.08

ANOVA for Templates

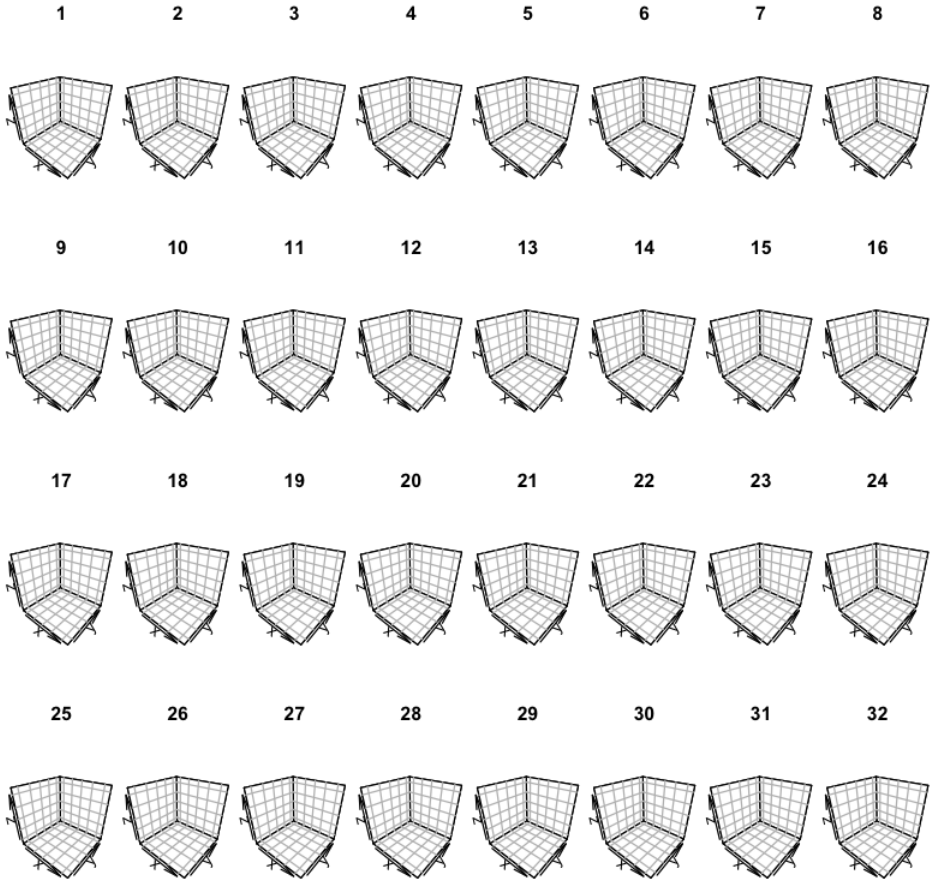
A difference in placement error between templates was identified by ANOVA.

'F-value: 7.88; p-value: 0.0004'

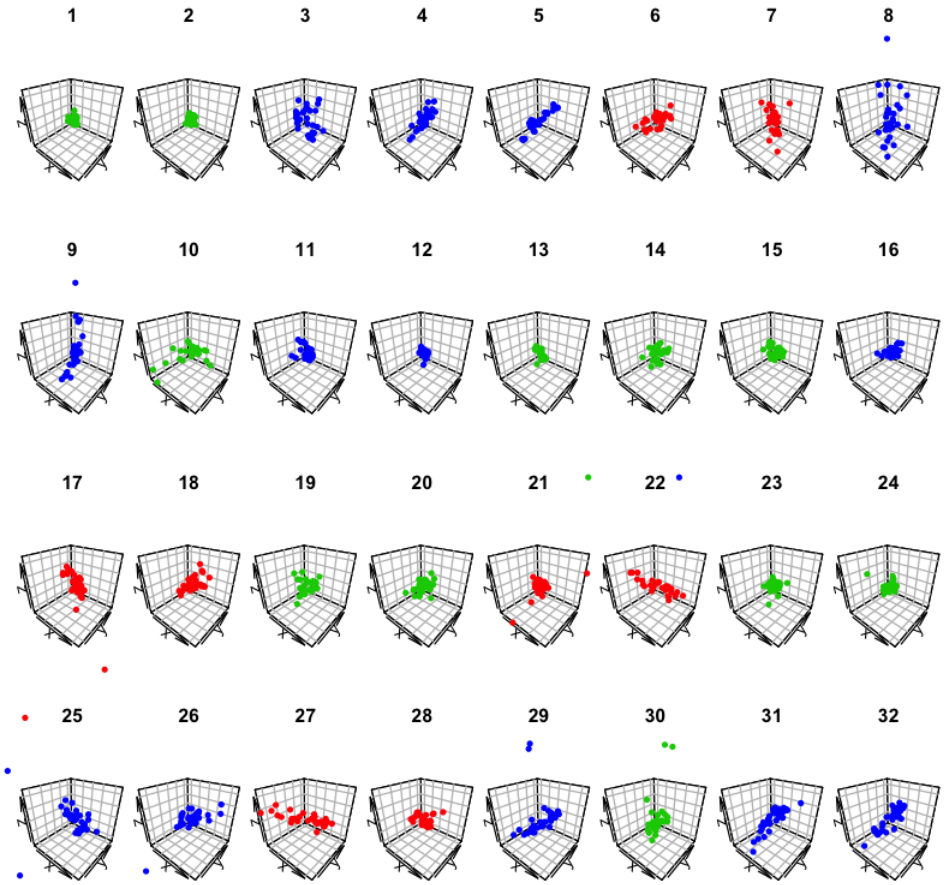
fid	Fval	pval	adjusted	significant
1	0.03	0.9695	0.9767	FALSE
2	0.13	0.8760	0.9490	FALSE
3	1.45	0.2406	0.5918	FALSE
4	0.72	0.4900	0.7215	FALSE
5	1.01	0.3696	0.6571	FALSE
6	7.28	0.0011	0.0119	TRUE
7	0.38	0.6840	0.8755	FALSE
8	0.16	0.8535	0.9490	FALSE
9	0.90	0.4118	0.6935	FALSE
10	7.61	0.0008	0.0119	TRUE
11	0.12	0.8897	0.9490	FALSE
12	1.05	0.3546	0.6571	FALSE
13	0.84	0.4362	0.6979	FALSE
14	4.04	0.0206	0.1319	FALSE
15	1.57	0.2124	0.5918	FALSE
16	1.83	0.1659	0.5310	FALSE
17	0.17	0.8398	0.9490	FALSE
18	0.71	0.4960	0.7215	FALSE
19	6.38	0.0025	0.0198	TRUE
20	1.30	0.2779	0.5918	FALSE
21	1.39	0.2530	0.5918	FALSE
22	0.61	0.5467	0.7289	FALSE
23	3.19	0.0456	0.1826	FALSE
24	11.61	0.0000	0.0009	TRUE
25	0.24	0.7905	0.9490	FALSE
26	0.02	0.9767	0.9767	FALSE
27	2.22	0.1142	0.4060	FALSE
28	3.32	0.0401	0.1826	FALSE
29	3.76	0.0271	0.1443	FALSE
30	0.61	0.5433	0.7289	FALSE
31	1.28	0.2819	0.5918	FALSE
32	1.23	0.2959	0.5918	FALSE

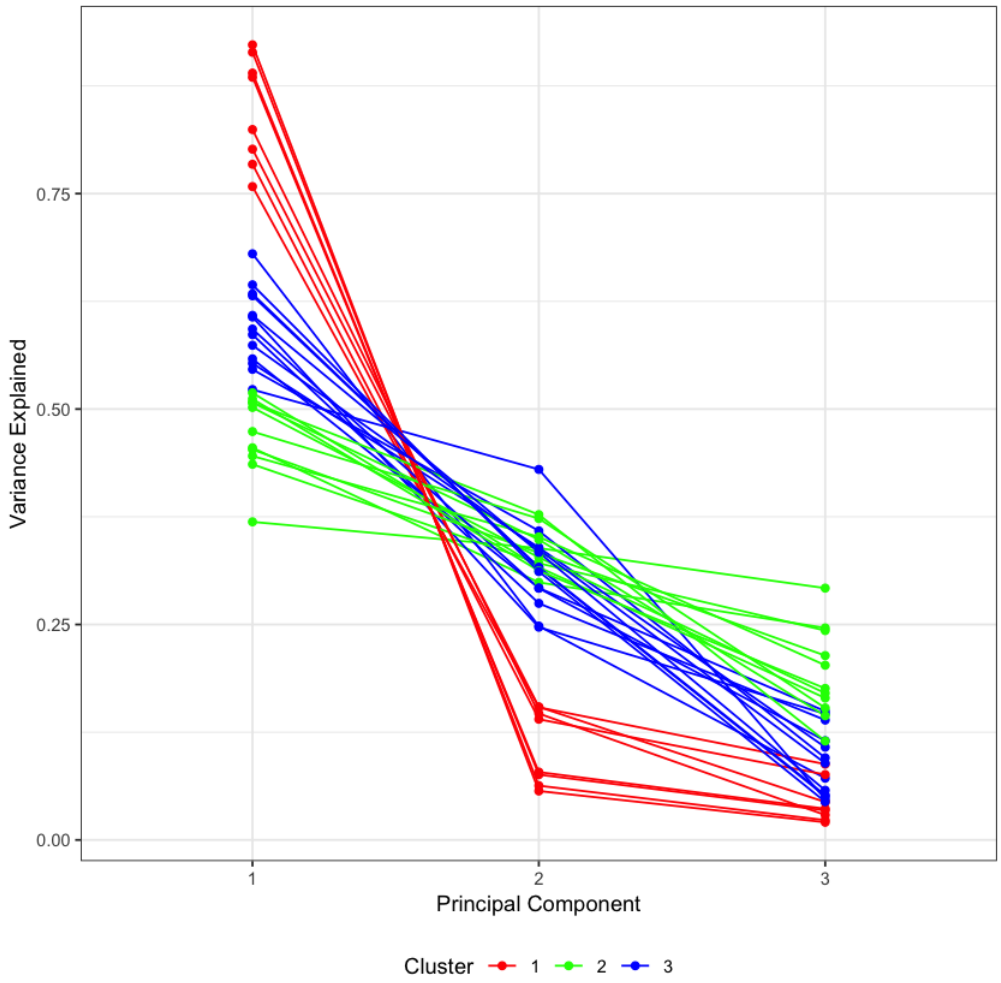
K-means clustering of point cloud distributions

Across all templates; and template specific

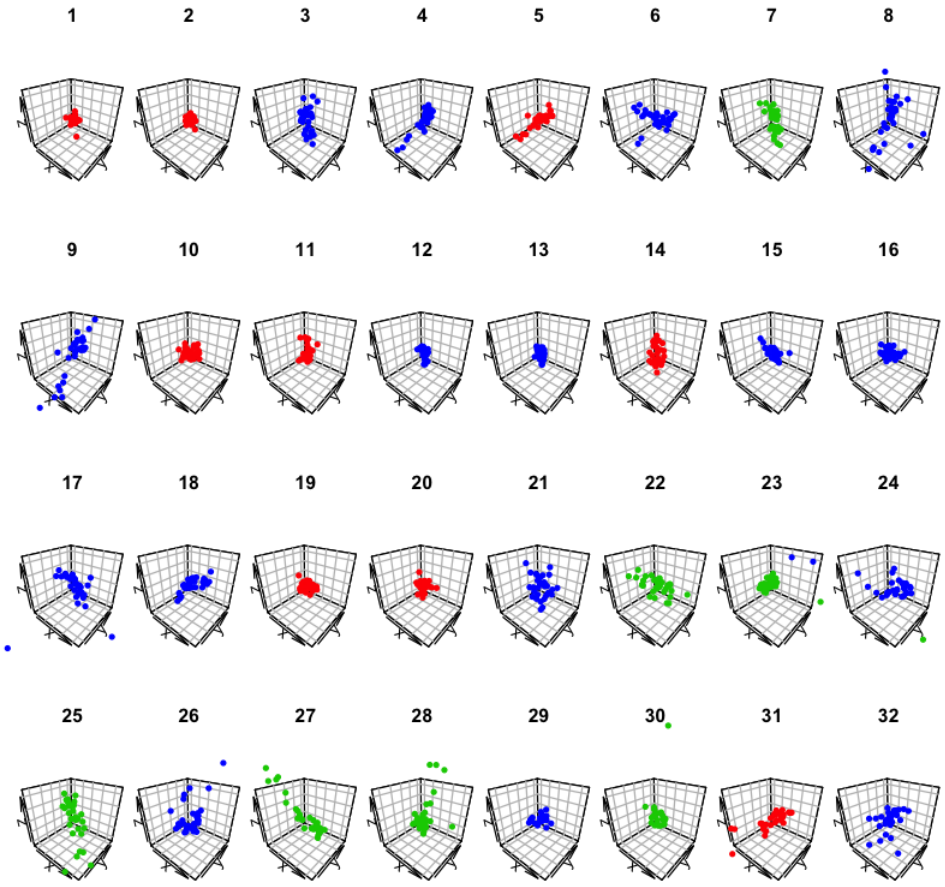


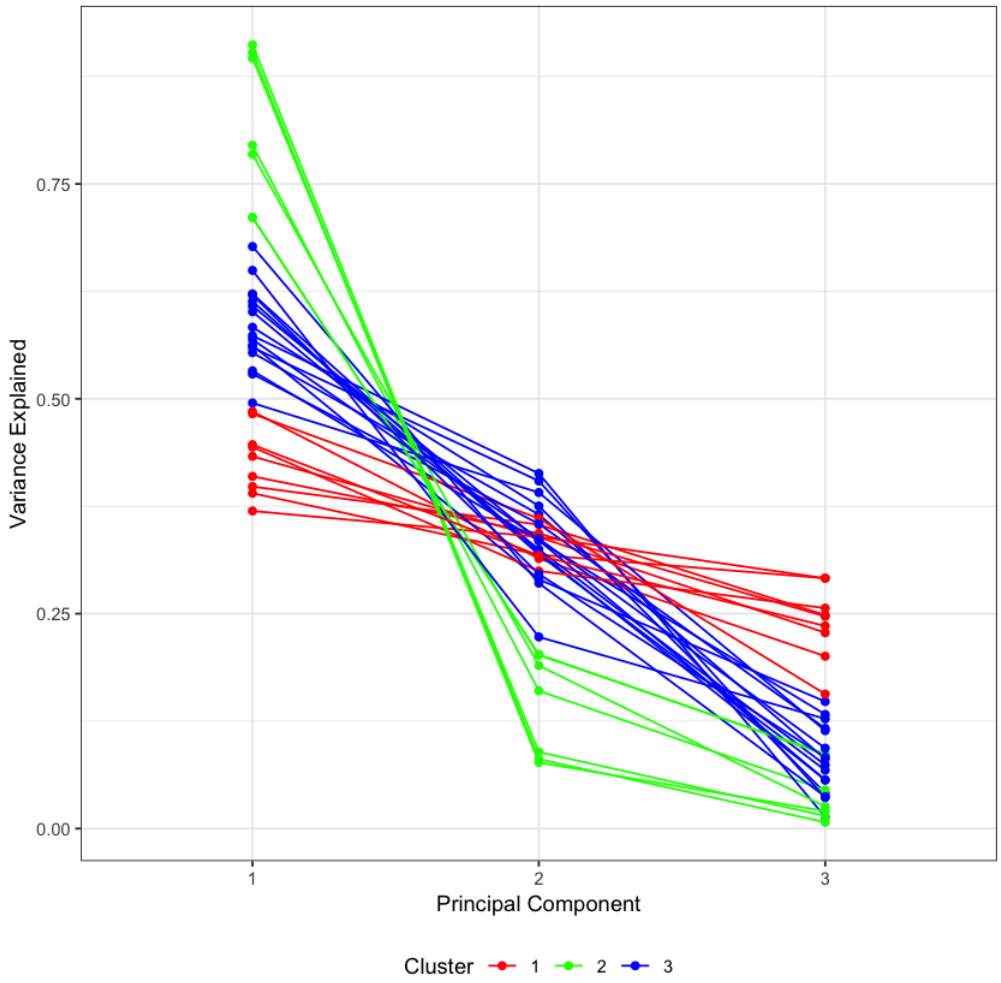
Agile12v2016 only


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

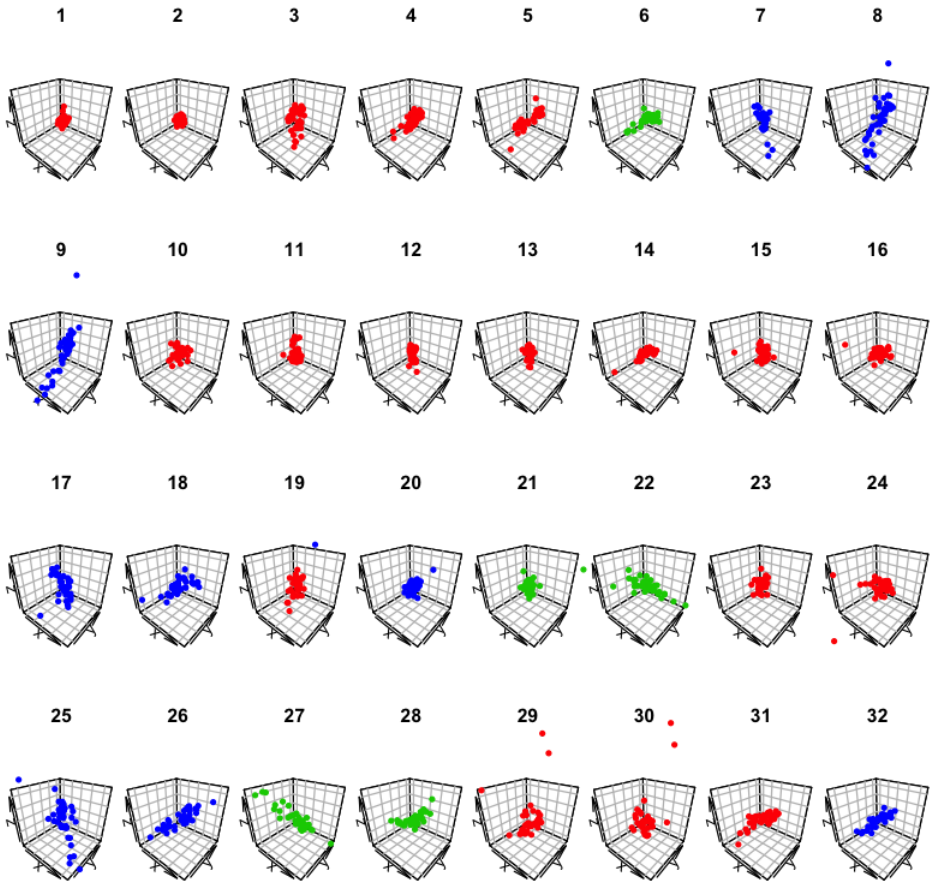


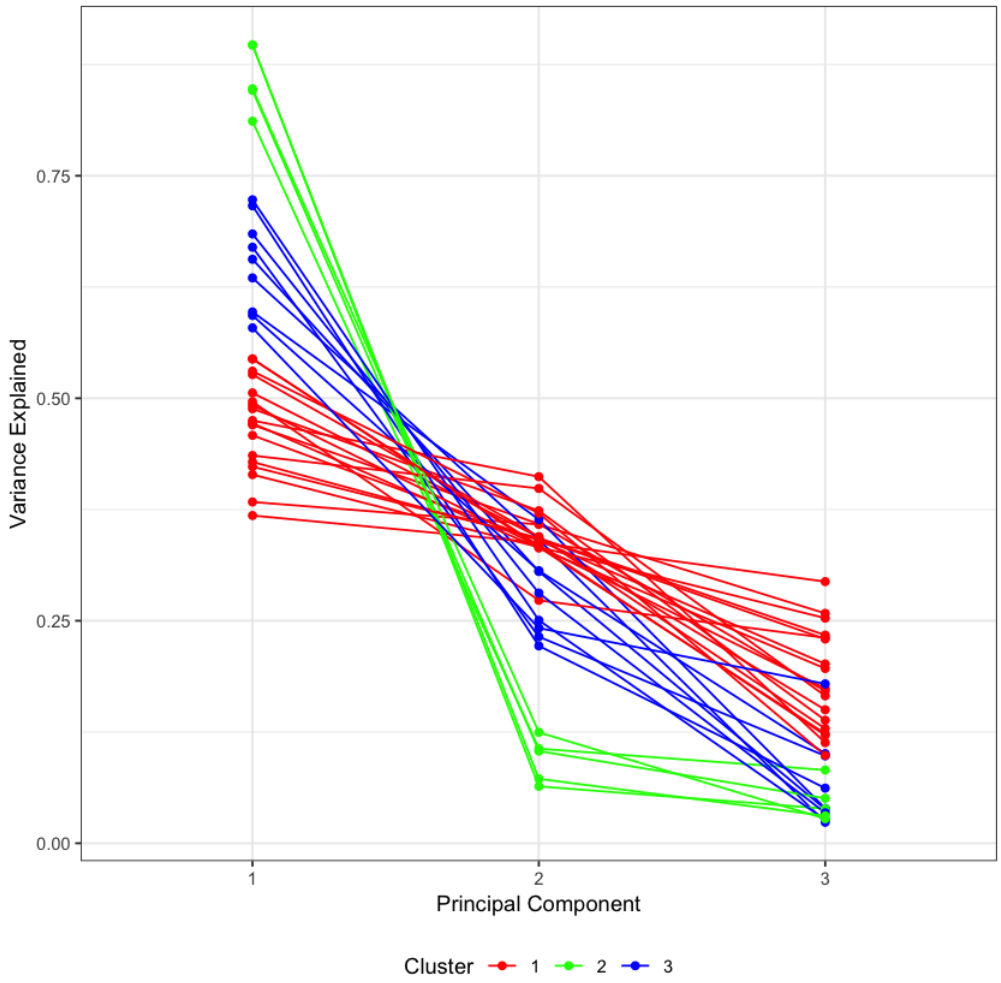
Colin27 only


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

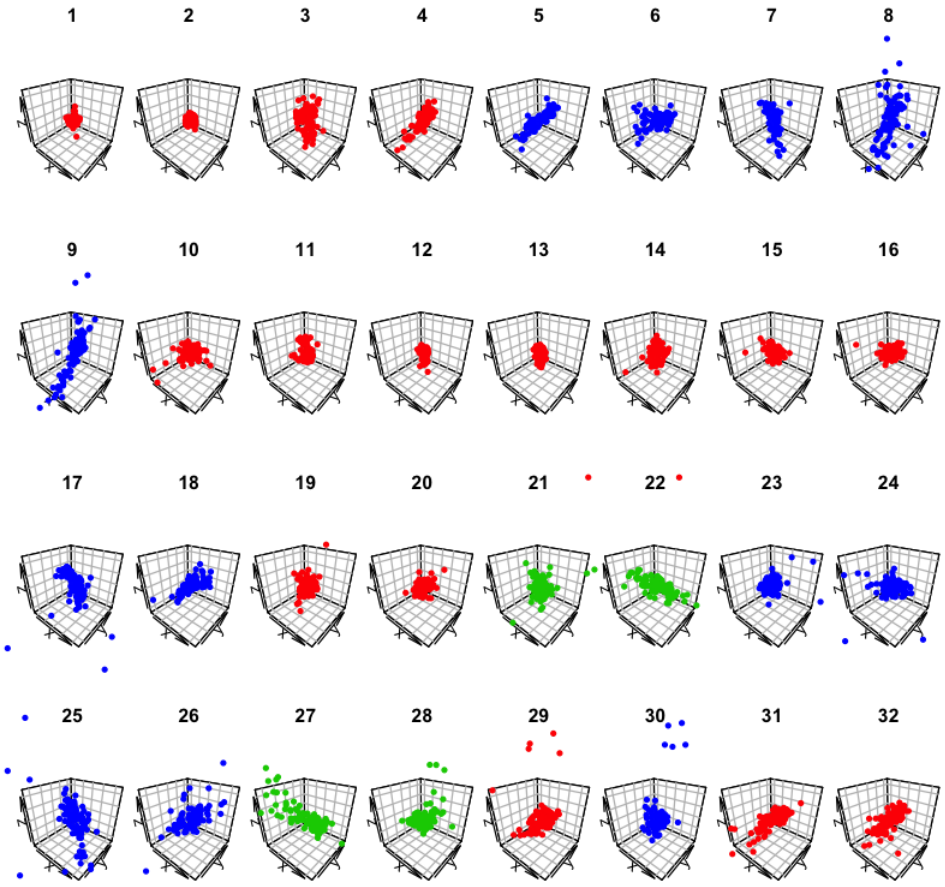


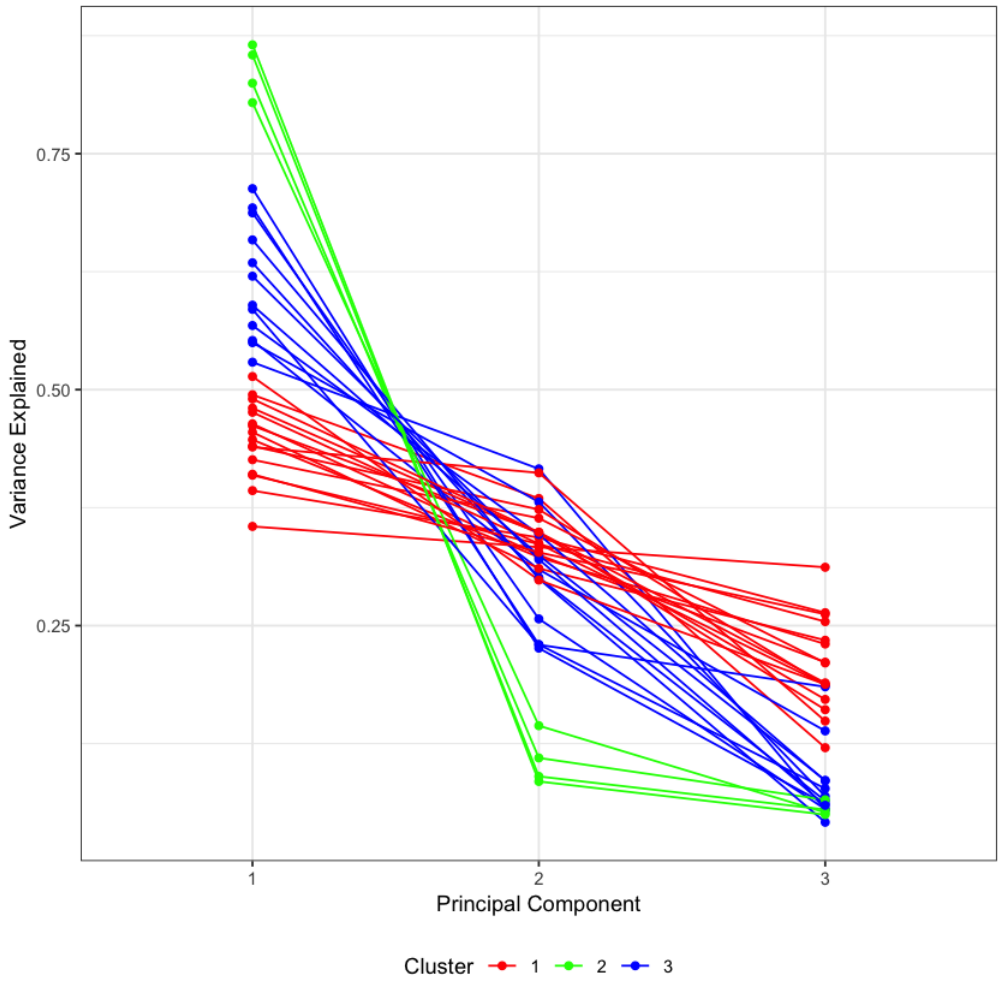
MNI152NLin2009bAsym Only


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32



All templates combined


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32




```
R version 3.5.1 (2018-07-02)
Platform: x86_64-apple-darwin13.4.0 (64-bit)
Running under: macOS  10.14.1

Matrix products: default
BLAS/LAPACK: /anaconda3/lib/R/lib/libRblas.dylib

locale:
[1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

other attached packages:
[1] plot3D_1.1.1   ggplot2_3.0.0  reshape2_1.4.3 digest_0.6.15  plyr_1.8.4

loaded via a namespace (and not attached):
 [1] Rcpp_0.12.18     compiler_3.5.1   pillar_1.3.0     bindr_0.1.1
 [5] base64enc_0.1-3  tools_3.5.1      uuid_0.1-2       jsonlite_1.5
 [9] evaluate_0.11    tibble_1.4.2     gtable_0.2.0     pkgconfig_2.0.1
[13] rlang_0.2.1      IRdisplay_0.5.0  IRkernel_0.8.12  bindrcpp_0.2.2
[17] repr_0.15.0      withr_2.1.2      stringr_1.3.1    dplyr_0.7.6
[21] grid_3.5.1       tidyselect_0.2.4 glue_1.3.0       R6_2.2.2
[25] pbdZMQ_0.3-3     purrr_0.2.5      magrittr_1.5     scales_0.5.0
[29] htmltools_0.3.6  misc3d_0.8-4     assertthat_0.2.0 colorspace_1.3-2
[33] labeling_0.3     stringi_1.2.4    lazyeval_0.2.1   munsell_0.5.0
[37] crayon_1.3.4
```