

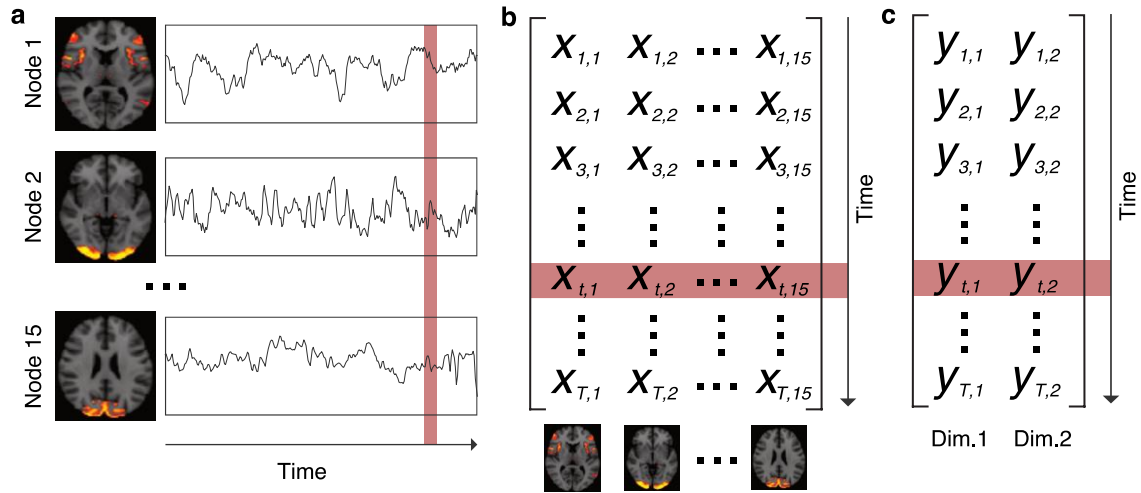
**Brain meta-state transitions demarcate thoughts across task contexts exposing  
the mental noise of trait neuroticism**

Tseng & Poppenk

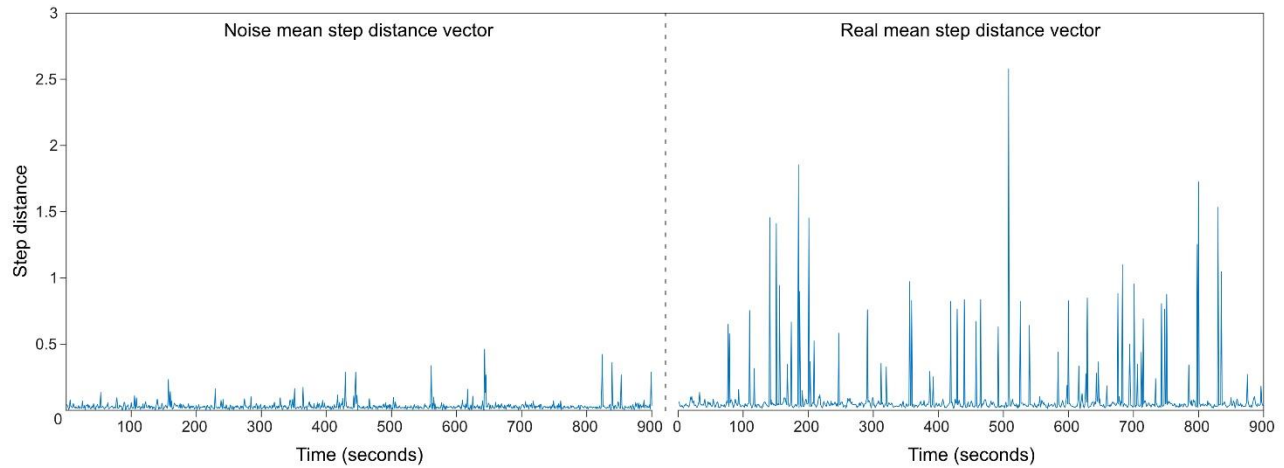
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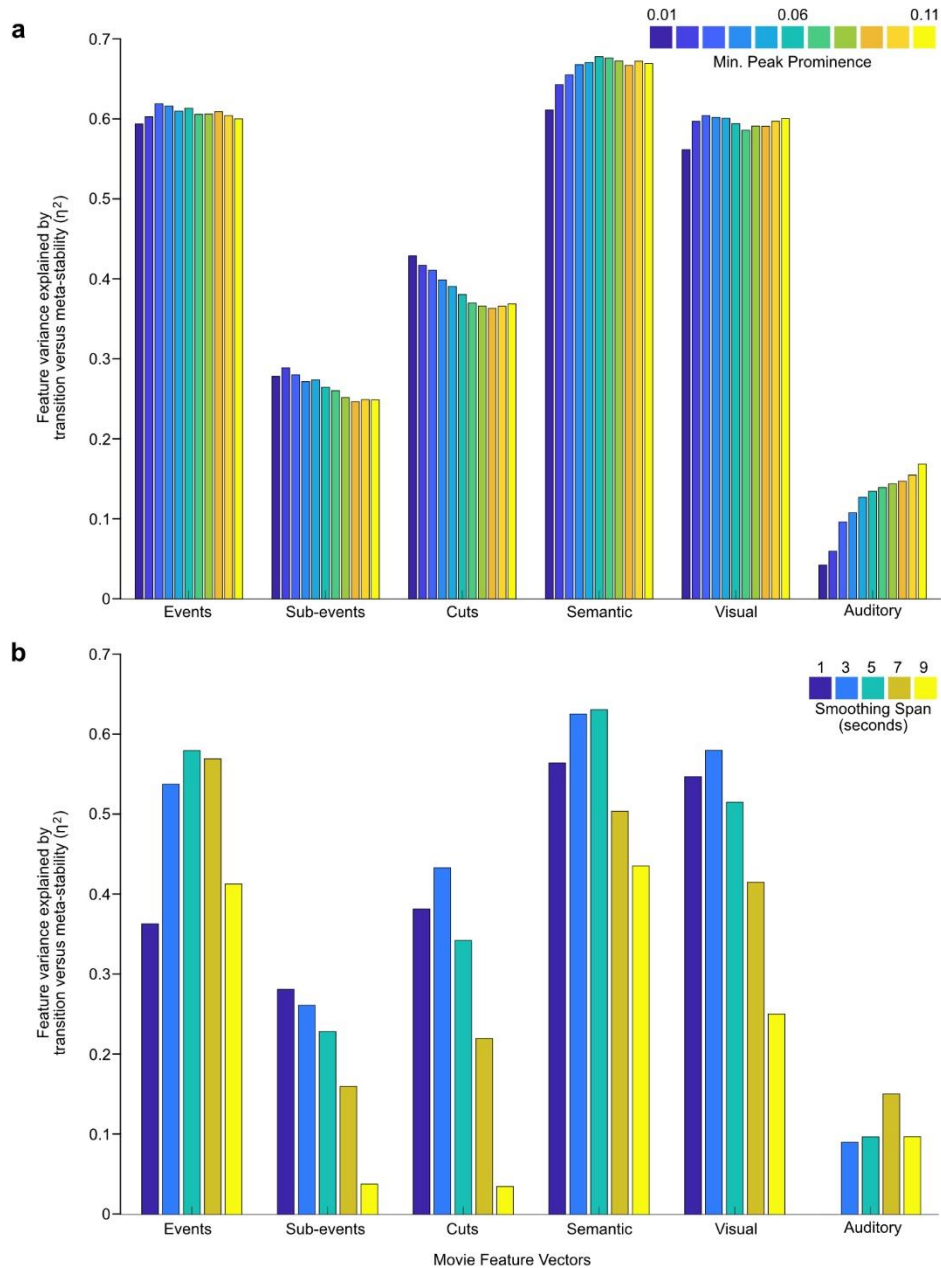
## Supplementary Figures



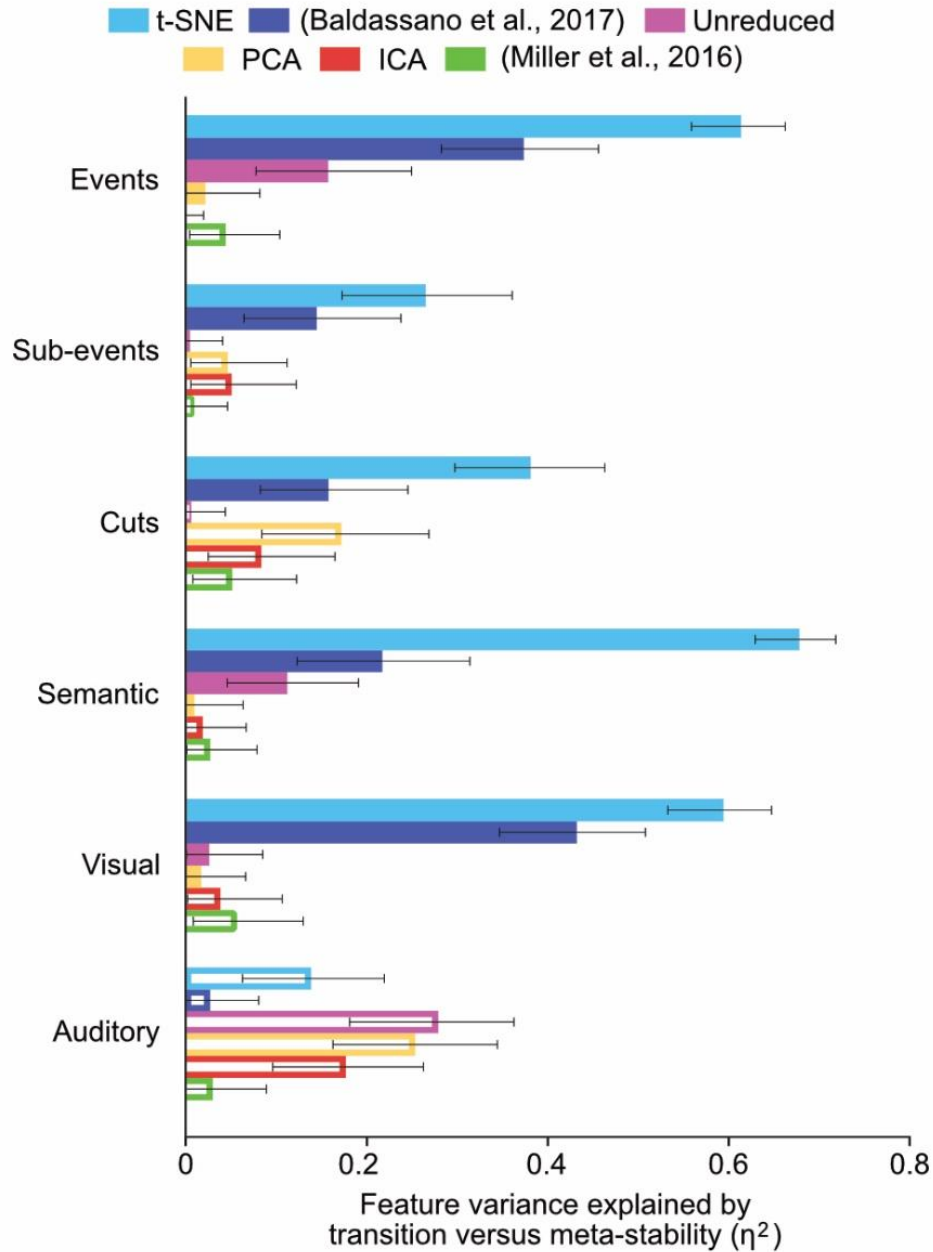
**Supplementary Figure 1. Expression of brain network activity.** (a) Each fMRI run of each participant was characterized as the activation of 15 brain networks over time. (b) Representation of  $A$  as a two-dimensional matrix of (time x network). (c) Reduced representation obtained after applying t-SNE algorithm. (a-c) Red bar defining a specific TR across all three representations.



**Supplementary Figure 2. Comparison of noise and real mean step distance vectors.** A noise dataset was generated by phase randomizing in a voxel-wise fashion each participant's Movie 1 fMRI run. The same procedure (dual regression, 100 iterations of the t-SNE algorithm, Mahalanobis distance calculation) was carried out to obtain mean noise step distance vectors. One participant's noise vs. real step distance vector is shown above, revealing that t-SNE space representations of noise data do not jump at consistent timepoints across repeated iterations, resulting in smaller transition amplitudes than in the real step distance vector.

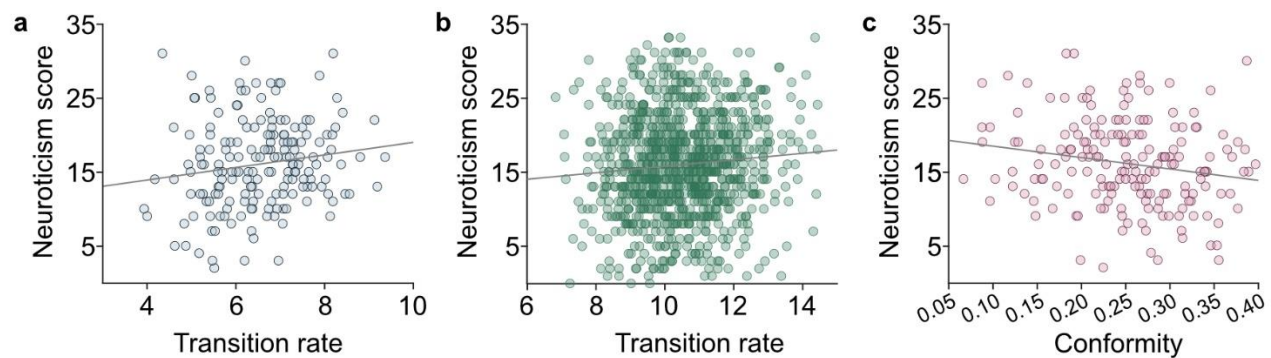


**Supplementary Figure 3. Effects of varying peak threshold and smoothing spans.** Eta-squared values describing the proportion of variance in movie features explained by alignment to transition vs. meta-stable timepoints. The colour scale from blue to yellow denotes increasing parameter values. Note that all auditory feature results showed stronger association to meta-stable rather than transition timepoints. **(a)** Comparison of eta-squared results for varying minimum peak prominence. **(b)** Comparison of eta-squared results for varying temporal smoothing spans.

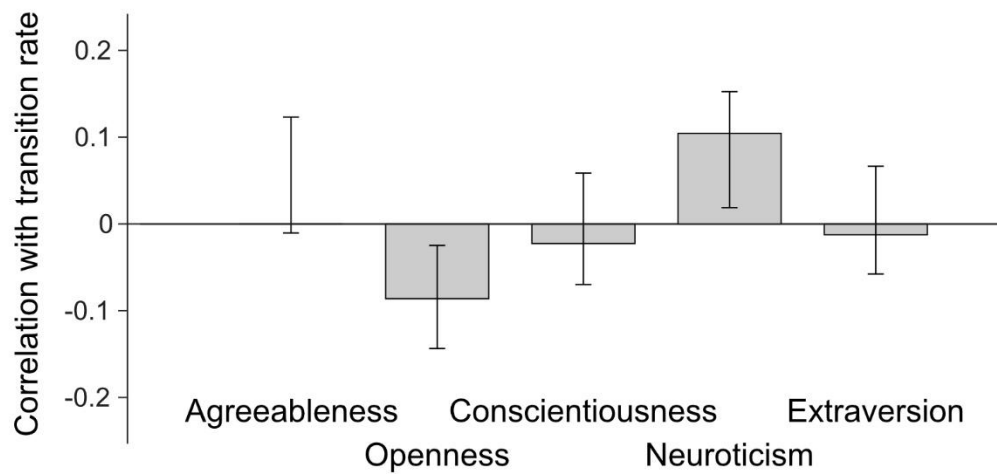


**Supplementary Figure 4. Impact of embedding approach on transitions' movie feature alignment.**

Data are presented as eta-squared values describing the proportion of variance in movie features explained by alignment to transition vs. meta-stable timepoints. See Figure 3 for a description of the calculation procedure ( $n = 184$ ). Colours indicate the method used to identify transition and meta-stable timepoints. Filled bars denote features that are aligned to transitions, whereas empty bars denote stronger alignment to meta-stability. Error bars designate eta-squared values corresponding to 95% percentile bootstrap confidence intervals of the transition-meta-stable feature value difference.



**Supplementary Figure 5. Higher transition rate correlated to higher trait neuroticism.** Transition rate is calculated as the total number of transitions divided by the time in minutes. Neuroticism scores are obtained from the NEO Five Factor Inventory administered to HCP participants. **(a)** Correlation between transition rate and neuroticism in the 7T dataset. **(b)** Correlation between transition rate and neuroticism in the larger 3T dataset. **(c)** Correlation between conformity and neuroticism in the 7T dataset.



**Supplementary Figure 6. Correlations between 3T transition rate and personality.** Exploratory results here are presented as correlation values between resting state transition rate and personality traits, obtained through bootstrapping procedures with 1,000 samples ( $n = 1003$ ). Error bars designate 95% percentile bootstrap confidence intervals.

**Supplementary Table 1.** Voxel clusters in which activation reliability distinguished transition from meta-stable timepoints specifically during movie-viewing fMRI.

| Region                                                                       | BA      | Hemi. | Peak MNI coordinates |     |     | Peak z estimate | Spatial extent (mm³) |
|------------------------------------------------------------------------------|---------|-------|----------------------|-----|-----|-----------------|----------------------|
|                                                                              |         |       | X                    | Y   | Z   |                 |                      |
| <b>Movie: Transition &gt; Meta-stable</b>                                    |         |       |                      |     |     |                 |                      |
| <i>Frontal lobe</i>                                                          |         |       |                      |     |     |                 |                      |
| Ventromedial prefrontal ctx.                                                 | 11      | L/R   | -11                  | 64  | -19 | 4.50            | 3531                 |
|                                                                              | 11      | L/R   | 0                    | 22  | -29 | 3.99            | 1802                 |
| Dorsal anterior cingulate                                                    | 32      | L/R   | -2                   | 26  | 27  | 6.53            | 3998                 |
| <i>Insular lobe</i>                                                          |         |       |                      |     |     |                 |                      |
| Insula                                                                       | 13      | L     | -35                  | 11  | 11  | 5.21            | 1331                 |
| <i>Parietal lobe</i>                                                         |         |       |                      |     |     |                 |                      |
| Posterior cingulate                                                          | 23      | L/R   | -2                   | -38 | 22  | 7.84            | 2679                 |
| Dorsal posterior cingulate                                                   | 31      | L/R   | 11                   | -38 | 51  | 7.72            | 3596                 |
| <i>Temporal lobe</i>                                                         |         |       |                      |     |     |                 |                      |
| Middle temporal g.                                                           | 20/21   | R     | 48                   | -16 | -29 | 4.35            | 2281                 |
| <i>Visual lobe</i>                                                           |         |       |                      |     |     |                 |                      |
| Visual assoc. area.                                                          | 17/18   | L/R   | 0                    | -80 | 32  | 7.87            | 13431                |
| <i>Cerebellum</i>                                                            |         |       |                      |     |     |                 |                      |
| Cerebellum                                                                   | -       | L/R   | -2                   | -78 | -34 | 4.83            | 11788                |
| <b>Movie: Meta-stable &gt; Transition</b>                                    |         |       |                      |     |     |                 |                      |
| <i>Frontal lobe</i>                                                          |         |       |                      |     |     |                 |                      |
| Lateral prefrontal ctx.                                                      | 46      | L     | -46                  | 45  | 2   | -5.48           | 2044                 |
|                                                                              | 47      | R     | 45                   | 42  | -5  | -6.41           | 4461                 |
| Dorsomedial prefrontal ctx.                                                  | 8/9/10  | L/R   | -2                   | 32  | 46  | -7.68           | 4784                 |
|                                                                              | 6/44    | L     | -48                  | 22  | 24  | -5.97           | 4923                 |
|                                                                              | 8       | R     | 42                   | 22  | 40  | -5.18           | 1200                 |
|                                                                              | 6/8     | L     | 26                   | 16  | 51  | -5.40           | 1241                 |
| Dorsolateral prefrontal ctx.                                                 | 6/44/46 | R     | 51                   | 10  | 19  | -5.95           | 6222                 |
| <i>Temporal lobe</i>                                                         |         |       |                      |     |     |                 |                      |
| Temporal pole / posterior ventromedial prefrontal ctx. / amygdala / thalamus | 38      | L/R   | 35                   | 16  | -21 | -5.67           | 15462                |
| <i>Parietal lobe</i>                                                         |         |       |                      |     |     |                 |                      |
| Precuneus                                                                    | 7       | L     | -43                  | -43 | 48  | -4.95           | 1368                 |
| Supramarginal g.                                                             | 40      | R     | 48                   | -34 | 50  | -5.26           | 2621                 |
| Angular g.                                                                   | 39      | R     | 54                   | -53 | 38  | -4.87           | 3011                 |
|                                                                              | 39      | L     | -54                  | -58 | 29  | -5.82           | 4055                 |
| <i>Visual lobe</i>                                                           |         |       |                      |     |     |                 |                      |
| Visual assoc. area                                                           | 18      | R     | 11                   | -91 | -2  | -6.01           | 6328                 |

**Supplementary Table 2.** Voxel clusters in which activation reliability distinguished transition from meta-stable timepoints specifically during resting state fMRI.

| Region                         | BA      | Hemi. | Peak MNI coordinates |     |     | Peak z estimate | Spatial extent (mm <sup>3</sup> ) |
|--------------------------------|---------|-------|----------------------|-----|-----|-----------------|-----------------------------------|
|                                |         |       | X                    | Y   | Z   |                 |                                   |
| Rest: Transition > Meta-stable |         |       |                      |     |     |                 |                                   |
| Frontal / parietal lobe        |         |       |                      |     |     |                 |                                   |
| Cingulate ctx.                 | 7/23/32 | L/R   | 2                    | -29 | 27  | 11.02           | 33243                             |
| Somatosensory ctx.             | 1       | R     | 30                   | -30 | 62  | 5.06            | 1671                              |
| Supramarginal g.               | 40      | R     | 54                   | -32 | 29  | 7.58            | 6644                              |
| Insular lobe                   |         |       |                      |     |     |                 |                                   |
| Insula                         | 13      | R     | 46                   | 13  | -3  | 7.24            | 1548                              |
| Visual lobe                    |         |       |                      |     |     |                 |                                   |
| Visual assoc ctx.              | 7/17/18 | L/R   | -10                  | -77 | 37  | 13.03           | 39973                             |
| Subcortical                    |         |       |                      |     |     |                 |                                   |
| Cerebellum                     | -       | L     | -32                  | -51 | -26 | 4.58            | 1200                              |
| Rest: Meta-stable > Transition |         |       |                      |     |     |                 |                                   |
| Frontal lobe                   |         |       |                      |     |     |                 |                                   |
| Lateral prefrontal ctx.        | 47      | L     | -43                  | 45  | -5  | -5.08           | 1110                              |
|                                | 44      | L     | -51                  | 21  | 6   | -6.86           | 2765                              |
| Dorsolateral prefrontal ctx.   | 6       | L     | -24                  | 18  | 53  | -6.24           | 11010                             |
|                                | 6       | R     | 32                   | 24  | 58  | -6.13           | 2585                              |
| Temporal lobe                  |         |       |                      |     |     |                 |                                   |
| Middle temporal g.             | 20      | R     | 54                   | 0   | -34 | -4.64           | 1253                              |
| Parietal lobe                  |         |       |                      |     |     |                 |                                   |
| Supramarginal g.               | 40      | L     | -46                  | -43 | 48  | -6.29           | 6250                              |

**Supplementary Table 3.** Voxel clusters in which activation reliability distinguished transition from meta-stable timepoints in both movie-viewing and resting state fMRI.

| Region                         | BA      | Hemi | Peak MNI coordinates |     |     | Peak z estimate | Peak z (rest) | Peak z (movie) | Spatial extent (mm³) |
|--------------------------------|---------|------|----------------------|-----|-----|-----------------|---------------|----------------|----------------------|
|                                |         |      | X                    | Y   | Z   |                 |               |                |                      |
| Transition > Meta-stable       |         |      |                      |     |     |                 |               |                |                      |
| Frontal lobe                   |         |      |                      |     |     |                 |               |                |                      |
| Dorsal anterior cingulate ctx. | 32      | L/R  | -2                   | 18  | 38  | 9.11            | 7.81          | 4.35           | 8327                 |
| Insular lobe                   |         |      |                      |     |     |                 |               |                |                      |
| Insula                         | 13      | L    | -35                  | 10  | 11  | 6.76            | 4.08          | 5.11           | 2208                 |
|                                | 13      | R    | 45                   | 13  | -3  | 9.28            | 7.22          | 5.52           | 2556                 |
| Parietal lobe                  |         |      |                      |     |     |                 |               |                |                      |
| Supramarginal g.               | 40      | R    | 54                   | -30 | 32  | 7.81            | 7.20          | 2.59           | 1028                 |
| Posterior cingulate ctx.       | 23      | L/R  | 0                    | -37 | 24  | 11.17           | 7.99          | 7.55           | 3858                 |
| Precuneus                      | 7       | L/R  | 11                   | -38 | 51  | 9.38            | 5.00          | 7.72           | 10572                |
| Visual lobe                    |         |      |                      |     |     |                 |               |                |                      |
| Visual assoc. ctx.             | 7/18/19 | L/R  | 0                    | -80 | 32  | 11.54           | 8.19          | 7.87           | 24965                |
| Subcortical                    |         |      |                      |     |     |                 |               |                |                      |
| Cerebellum                     | -       | L/R  | -5                   | -74 | -13 | 6.10            | 3.44          | 4.77           | 1995                 |
| Meta-stable > Transition       |         |      |                      |     |     |                 |               |                |                      |
| Frontal lobe                   |         |      |                      |     |     |                 |               |                |                      |
| Lateral prefrontal ctx.        | 47      | L    | -43                  | 45  | -3  | -6.33           | -4.90         | -3.65          | 1712                 |
|                                | 44      | L    | -45                  | 11  | 32  | -7.46           | -4.96         | -5.29          | 5272                 |
|                                | 8       | R    | 40                   | 24  | 38  | -6.47           | -4.12         | -4.71          | 1651                 |
| Dorsomedial prefrontal ctx.    | 8       | L/R  | -2                   | 32  | 45  | -7.84           | -2.60         | -7.23          | 1716                 |
| Dorsal prefrontal ctx.         | 6/8     | L    | -24                  | 18  | 51  | -6.68           | -5.95         | -2.61          | 1499                 |
|                                | 6/8     | R    | 26                   | 16  | 51  | -7.42           | -4.79         | -5.40          | 2830                 |
| Parietal lobe                  |         |      |                      |     |     |                 |               |                |                      |
| Superior parietal l.           | 7       | L    | -45                  | -43 | 48  | -7.93           | -6.09         | -4.76          | 8897                 |
| Angular g.                     | 39      | R    | 46                   | -59 | 32  | -6.39           | -5.62         | -2.61          | 1098                 |