*Supplement*

# Predicting Executive Functioning from Functional Brain Connectivity: Network Specificity and Age Effects

Marisa K. Heckner[1,2*], Edna C. Cieslik[1,2], Kaustubh R. Patil[1,2], Martin Gell[1,3], Simon B. Eickhoff[1,2], Felix Hoffstädter[1,2], & Robert Langner[1,2*].

[1]Institute of Neuroscience and Medicine (INM-7: Brain and Behaviour), Research Centre Jülich, Jülich, Germany

[2]Institute of Systems Neuroscience, Medical Faculty, Heinrich Heine University Düsseldorf, Düsseldorf, Germany

[3]Department of Psychiatry, Psychotherapy and Psychosomatics, Medical Faculty, RWTH Aachen University, Aachen, Germany

*Corresponding authors: Marisa Heckner or Robert Langner, Institute of Neuroscience and Medicine (INM-7), Research Centre Jülich, 52428 Jülich, Germany, tel.: +49 2461 61 96118, e-mail: m.heckner@fz-juelich.de (M.K.H.); r.langner@fz-juelich.de (R.L.)

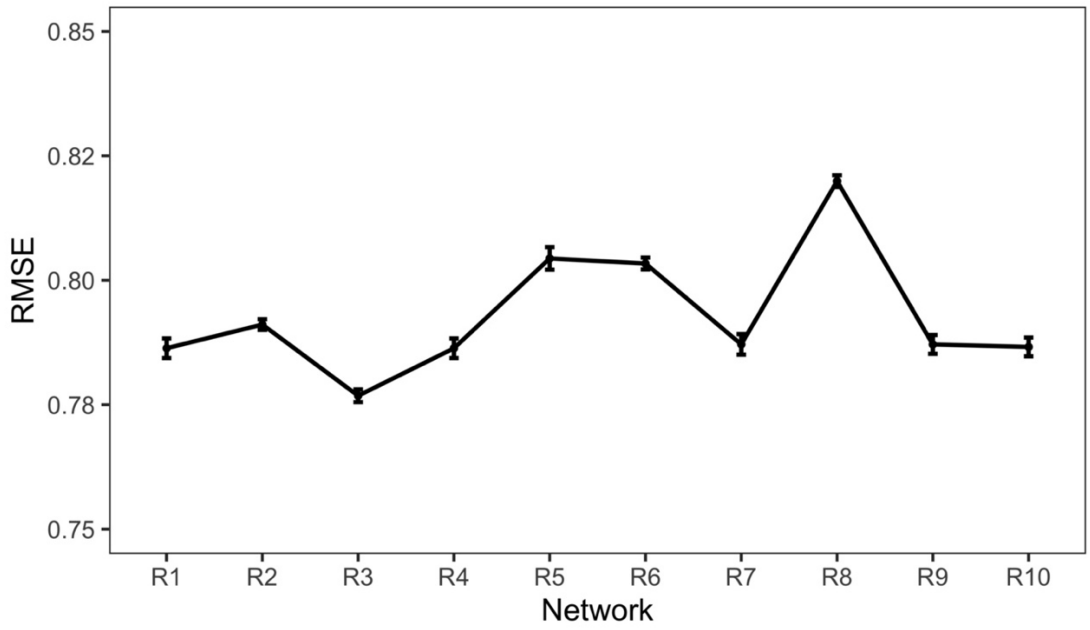


Figure S1. Prediction accuracy indicated by the root mean squared error (RMSE) for the 10 random networks (R1-R10) across task demand level and age groups.

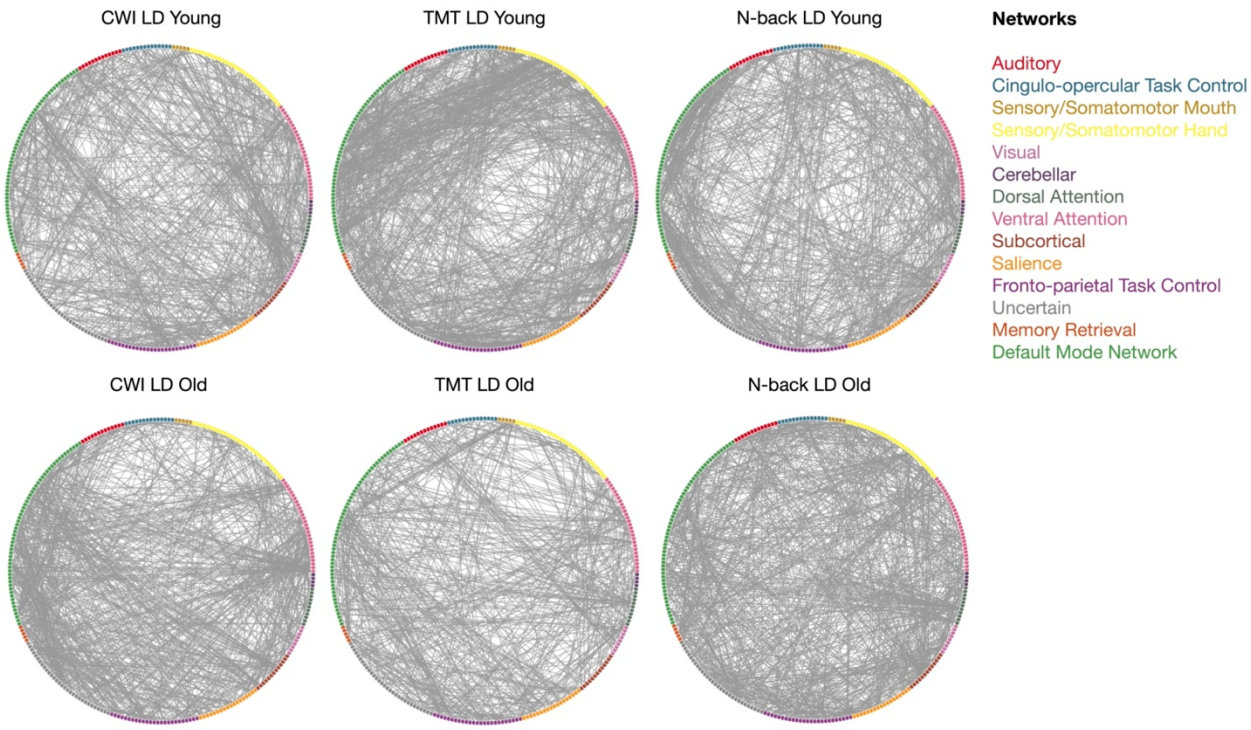


Figure S2. Features (i.e., resting-state functional connectivity edges), resulting from the data-driven feature selection approach that are significantly positively associated with the low demanding (LD) condition of each of the three executive function tests.

CWI = color word interference, TMT = trail making test, LD = low demanding test condition.

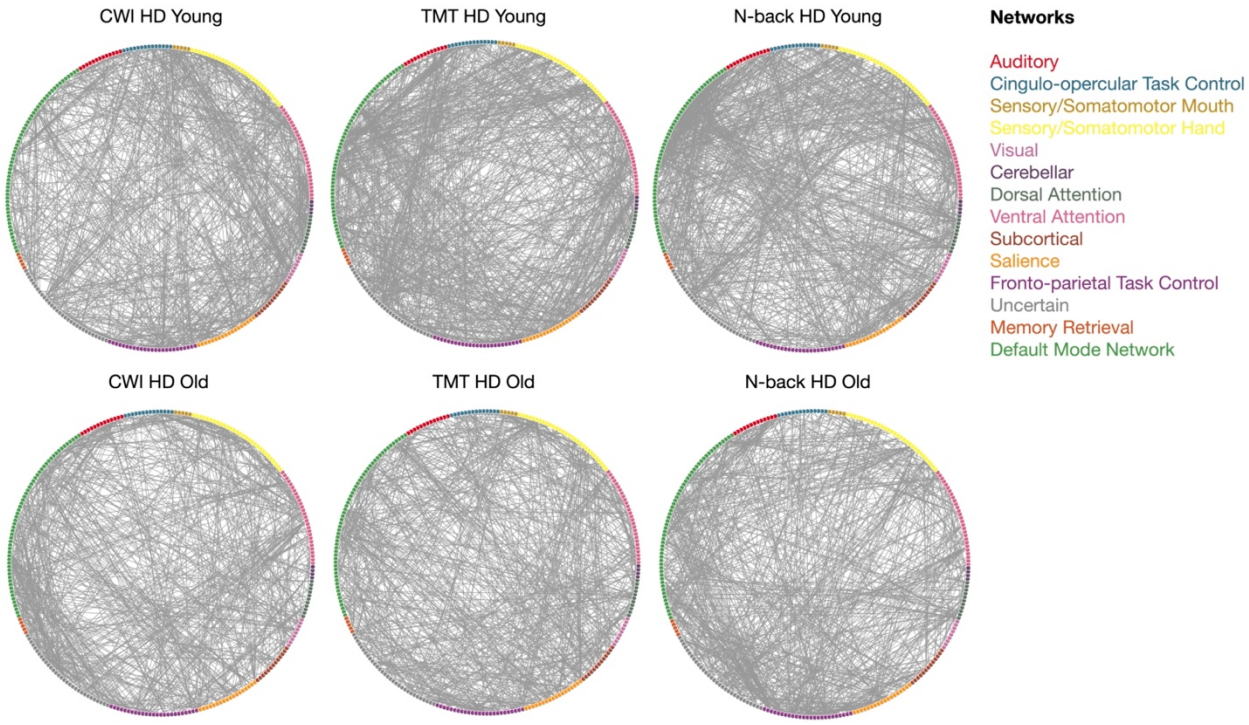


Figure S3. Features (i.e., resting-state functional connectivity edges), resulting from the data-driven feature selection approach that are significantly positively associated with the high demanding (HD) condition of each of the three executive function tests.

CWI = color word interference, TMT = trail making test.

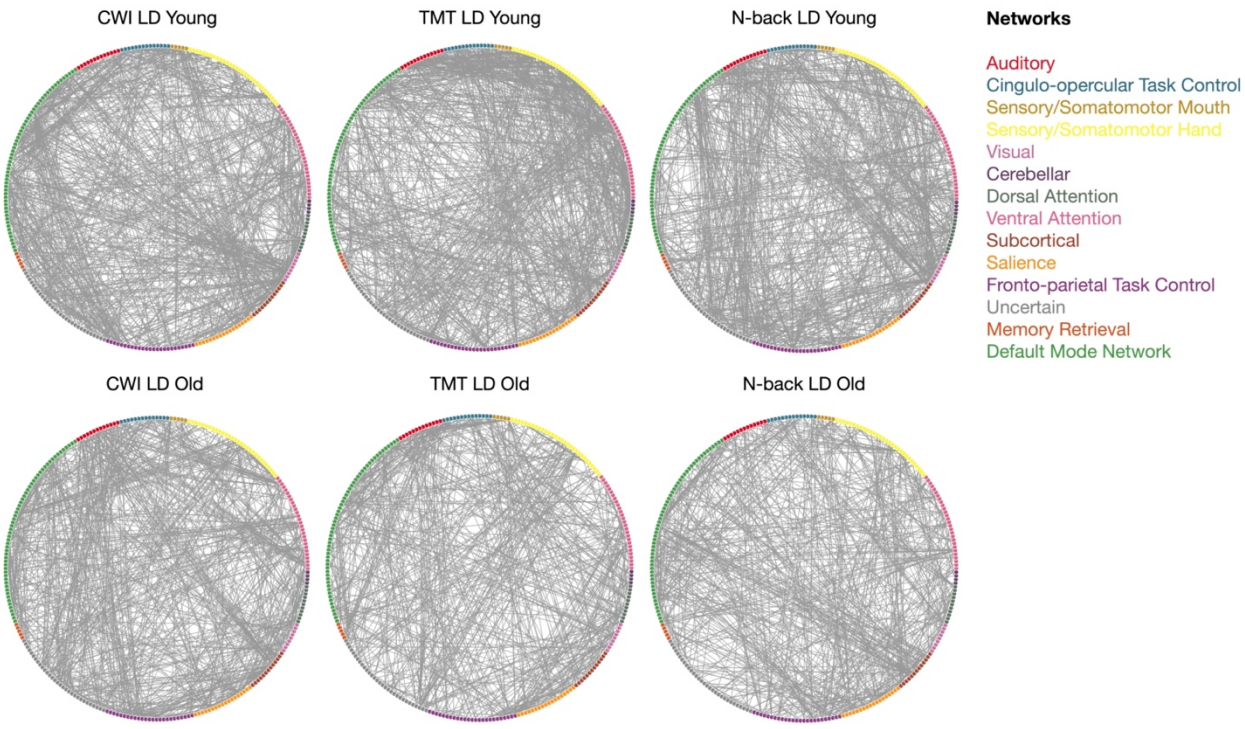


Figure S4. Features (i.e., resting-state functional connectivity edges), resulting from the data-driven feature selection approach that are significantly negatively associated with the low demanding (LD) condition of each of the three executive function tests.

CWI = color word interference, TMT = trail making test.

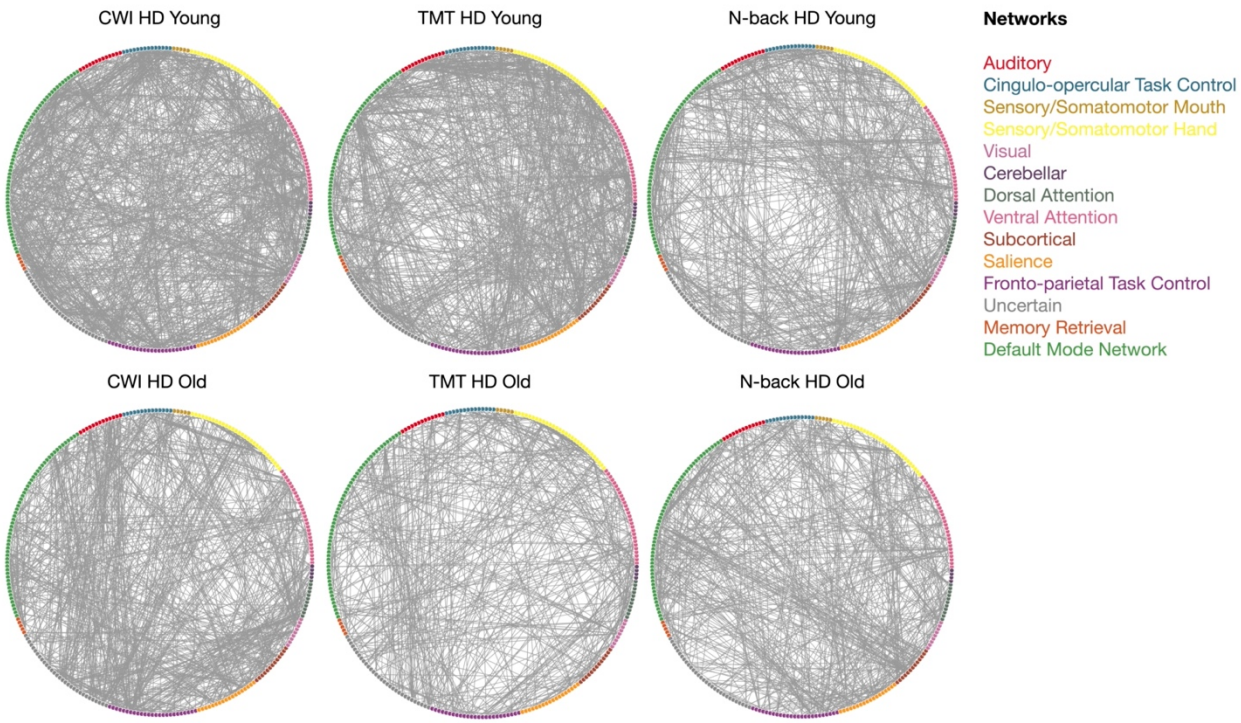


Figure S5. Features (i.e., resting-state functional connectivity edges), resulting from the data-driven feature selection approach that are significantly negatively associated with the high demanding (HD) condition of each of the three executive function tests.

CWI = color word interference, TMT = trail making test.

Table S1

*ANOVA Results from Resting-State Functional Connectivity without Global Signal Regression.*

| ANOVA Results | *F*-statistic | df | *p*-value | $\eta^2$ |
|---|---|---|---|---|
| *Main Effects* | | | | |
| Network | 2435.97 | 2.43, 481.15 | $1.42 \times 10^{-270}$ | .925 |
| Demand Level | 3638.82 | 1, 198 | $2.09 \times 10^{-129}$ | .948 |
| Age | 3370.75 | 1, 198 | $2.73 \times 10^{-126}$ | .945 |
| *Two-way Interactions* | | | | |
| Age × Network | 482.99 | 3, 594 | $1.89 \times 10^{-213}$ | .709 |
| Age × Demand Level | 26891.64 | 1, 198 | $1.79 \times 10^{-226}$ | .993 |
| Network × Demand Level | 3.16 | 2.40, 474.79 | .034 | .016 |
| *Three-way Interactions* | | | | |
| Age × Network × Demand Level | 63.72 | 3, 594 | $9.93 \times 10^{-36}$ | .243 |

Table S2

*Post-hoc Pairwise Comparisons of ANOVA Effects from Resting-State Functional Connectivity without Global Signal Regression.*

| Post-hoc Pairwise Comparisons | | | |
|---|---|---|---|
| Factor | Mean $(SE)_{group1}$ | Mean $(SE)_{group2}$ | *p*-value |
| Age | $.797\ (.0003)_{old}$ | $.820\ (.0003)_{young}$ | $2.73 \times 10^{-126}$ |
| Network | $.818\ (.0004)_{EF}$ | $.825\ (.0005)_{PercMot}$ | $1.77 \times 10^{-20}$ |
| | $.818\ (.0004)_{EF}$ | $.783\ (.0003)_{Power}$ | $1.17 \times 10^{-132}$ |
| | $.818\ (.0004)_{EF}$ | $.808\ (.0001)_{Random}$ | $5.69 \times 10^{-54}$ |

| | | | |
|---|---|---|---|
| | .825 (.0005)$_{PercMot}$ | .783 (.0003)$_{Power}$ | $2.55 \times 10^{-146}$ |
| | .825 (.0005)$_{PercMot}$ | .808 (.0001)$_{Random}$ | $8.12 \times 10^{-80}$ |
| | .783 (.0003)$_{Power}$ | .808 (.0001)$_{Random}$ | $1.48 \times 10^{-144}$ |
| Demand Level | .798 (.0002)$_{HD}$ | .819 (.0003)$_{LD}$ | $2.09 \times 10^{-129}$ |

*Note.* EF = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, Random = average of 10 randomly computed brain networks, HD = high-demand, LD = low-demand, SE = standard error.

Table S3

*ANOVA Results from Resting-State Functional Connectivity with Correction for 24 Movement Parameters.*

| ANOVA Results | *F*-statistic | df | *p*-value | $\eta^2$ |
|---|---|---|---|---|
| *Main Effects* | | | | |
| Network | 1777.60 | 2.07, 409.19 | $4.87 \times 10^{-205}$ | .900 |
| Demand Level | 2320.46 | 1, 198 | $2.68 \times 10^{-111}$ | .921 |
| Age | 1759.89 | 1, 198 | $1.81 \times 10^{-100}$ | .899 |
| *Two-way Interactions* | | | | |
| Age × Network | 766.48 | 3, 594 | $1.03 \times 10^{-203}$ | .795 |
| Age × Demand Level | 47411.88 | 1, 198 | $1.08 \times 10^{-237}$ | .996 |
| Network × Demand Level | 27.65 | 2.40, 476.06 | $6.67 \times 10^{-14}$ | .123 |
| *Three-way Interactions* | | | | |
| Age × Network × Demand Level | 179.95 | 3, 594 | $5.49 \times 10^{-83}$ | .476 |

Table S4

*Post-hoc Pairwise Comparisons of ANOVA Effects from Resting-State Functional Connectivity with Correction for 24 Movement Parameters.*

| Post-hoc Pairwise Comparisons | | | |
|---|---|---|---|
| Factor | Mean $(SE)_{group1}$ | Mean $(SE)_{group2}$ | *p*-value |
| Age | $.797\ (.0002)_{old}$ | $.785\ (.0002)_{young}$ | $1.81 \times 10^{-100}$ |
| Network | $.809\ (.0004)_{EF}$ | $.792\ (.0004)_{PercMot}$ | $3.52 \times 10^{-68}$ |
| | $.809\ (.0004)_{EF}$ | $.776\ (.0002)_{Power}$ | $1.82 \times 10^{-135}$ |
| | $.809\ (.0004)_{EF}$ | $.788\ (.0001)_{Random}$ | $3.54 \times 10^{-108}$ |
| | $.792\ (.0004)_{PercMot}$ | $.776\ (.0002)_{Power}$ | $2.43 \times 10^{-89}$ |
| | $.792\ (.0004)_{PercMot}$ | $.788\ (.0001)_{Random}$ | $8.25 \times 10^{-22}$ |
| | $.776\ (.0002)_{Power}$ | $.788\ (.0001)_{Random}$ | $5.93 \times 10^{-107}$ |
| Demand Level | $.784\ (.0002)_{HD}$ | $.798\ (.0002)_{LD}$ | $2.68 \times 10^{-111}$ |

*Note.* EF = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, Random = average of 10 randomly computed brain networks, HD = high-demand, LD = low-demand, SE = standard error.

Table S5

*Results of Machine Learning Adjusted t-Tests, Corroborating the Main Effects of Age, Network, and Task Demand Level.*

| Factor | Contrast | t-statistic |
|---|---|---|
| Age | Old vs. Young | 6.88** |
| Network | EF vs. PercMot | 2.78* |
| | EF vs. Power | 11.10** |
| | EF vs. Random | 7.23** |
| | PercMot vs. Power | 17.69** |
| | PercMot vs. Random | 2.56* |
| | Power vs. Random | 14.30** |
| Demand Level | High vs. Low | 0.70 |

*Note.* EF = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, Random = average of 10 randomly computed brain networks.

**significant at $p < .001$

*significant at $p < .05$

Table S6

*ANOVA Interaction Effects.*

| Age x Network | | |
|---|---|---|
| Age | Network | Mean (SE) |
| Old | EFN | .811 (.0006) |
| | PercMot | .808 (.0006) |
| | Power | .767 (.0004) |
| | Random | .783 (.0002) |
| Young | EFN | .829 (.0006) |
| | PercMot | .811 (.0006) |
| | Power | .767 (.0004) |
| | Random | .802 (.0002) |
| **Age x Demand** | | |
| Age | Demand | Mean (SE) |
| Old | LD | .771 (.0003) |
| | HD | .814 (.0004) |
| Young | LD | .834 (.0003) |
| | HD | .771 (.0004) |
| **Network x Demand** | | |
| Network | Demand | Mean (SE) |
| 1 | LD | .822 (.0006) |
| | HD | .818 (.0007) |
| | LD | .817 (.0005) |

| | | |
|---|---|---|
| 2 | HD | .801 (.0006) |
| 3 | LD | .770 (.0004) |
| | HD | .765 (.0004) |
| 4 | LD | .800 (.0002) |
| | HD | .786 (.0002) |

*Note.* EFN = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, Random = average of 10 randomly computed brain networks, HD = high-demand, LD = low-demand, SE = standard error.

Table S7

*Prediction Accuracies Displayed as Pearson's r, Mean Absolute Error and Root Mean Squared Error for Both Age Groups from Prediction within the Executive Function-related, the Perceptuo-motor Brain Network and the Full Connectome (i.e., Power et al.'s Graph of Putative Functional Areas) using Random Forest*

| | $r_{old}$ | $r_{young}$ | $MAE_{old}$ | $MAE_{young}$ | $RMSE_{old}$ | $RMSE_{young}$ |
|---|---|---|---|---|---|---|
| *EFN* | | | | | | |
| 0-back | .07 | -.11 | .49 | .72 | .62 | .91 |
| 1-back | -.03 | -.10 | .54 | .70 | .68 | .91 |
| CWI_con | -.07 | -.14 | .72 | .75 | .94 | .93 |
| CWI_inc | -.03 | -.01 | .66 | .52 | .85 | .63 |
| TMT_con | -.01 | .09 | .53 | .44 | .68 | .55 |
| TMT_switch | .08 | -.17 | .59 | .52 | .77 | .66 |
| *PercMot* | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0-back | .19 | -.09 | .48 | .71 | .61 | .91 |
| 1-back | .16 | -.01 | .52 | .69 | .67 | .89 |
| CWI_con | .03 | -.07 | .71 | .74 | .92 | .91 |
| CWI_inc | -.08 | -.12 | .66 | .53 | .86 | .64 |
| TMT_con | -.08 | .08 | .55 | .43 | .68 | .54 |
| TMT_switch | -.07 | -.18 | .62 | .52 | .80 | .66 |
| *Power* | | | | | | |
| 0-back | -.16 | -.13 | .50 | .71 | .63 | .91 |
| 1-back | .04 | -.12 | .54 | .70 | .68 | .90 |
| CWI_con | .03 | .23 | .71 | .72 | .92 | .88 |
| CWI_inc | .13 | .08 | .65 | .51 | .84 | .62 |
| TMT_con | .08 | .10 | .52 | .42 | .67 | .54 |
| TMT_switch | .01 | -.07 | .60 | .51 | .79 | .65 |

*Note.* MAE = mean absolute error, RMSE = root mean squared error, EFN = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, CWI_con = congruent condition of color word interference test, CWI_inc = incongruent condition of color word interference test, TMT_con = consecutive condition of trail making test, TMT_switch = switching condition of trail making test.

Table S8

*Prediction Accuracies Displayed as Pearson's r, Mean Absolute Error and Root Mean Squared Error for Both Age Groups from Prediction within Power et al.'s (2012) Graph of Putative Functional Areas Using the Data-driven Feature Selection Algorithm Connectome-based Predictive Modeling*

| | $r_{old}$ | $r_{young}$ | $MAE_{old}$ | $MAE_{young}$ | $RMSE_{old}$ | $RMSE_{young}$ |
|---|---|---|---|---|---|---|
| 0-back | -.05 | -.07 | .52 | .75 | .64 | .96 |
| 1-back | .06 | .02 | .56 | .72 | .69 | .93 |
| CWI_con | .11 | .14 | .73 | .75 | .93 | .92 |
| CWI_inc | .03 | .03 | .68 | .53 | .87 | .64 |
| TMT_con | .01 | .08 | .55 | .44 | .69 | .55 |
| TMT_switch | -.02 | -.07 | .61 | .53 | .81 | .67 |

*Note.* MAE = mean absolute error, RMSE = root mean squared error, EFN = executive-function-related network, PercMot = perceptuo-motor-related network, Power = Power et al.'s (2011) graph of putative functional areas, CWI_con = congruent condition of color word interference test, CWI_inc = incongruent condition of color word interference test, TMT_con = consecutive condition of trail making test, TMT_switch = switching condition of trail making test.

Table S9

*Features (i.e., Resting-state Functional Connectivity Edges), Resulting from the Data-driven Feature Selection Approach that are Significantly Positively Associated with the High and Low Demanding Test Condition of the three Executive Function Tests Applied.*

| | Network # | Assigned Name | Absolute # Edges | Relative # Edges (%) |
|---|---|---|---|---|
| CWI_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 4.35 |
| | 1 | Sensory/Somatomotor Hand | 111 | 2.81 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 5.63 |
| | 3 | Cingulo-opercular Task Control | 76 | 4.13 |
| | 4 | Auditory | 68 | 3.98 |
| | 5 | Default Mode Network | 335 | 4.39 |
| | 6 | Memory Retrieval | 25 | 3.80 |
| | 7 | Visual | 147 | 3.60 |
| | 8 | Fronto-parietal Task Control | 134 | 4.08 |
| | 9 | Salience | 163 | 6.89 |
| | 10 | Subcortical | 61 | 3.57 |
| | 11 | Ventral Attention | 91 | 7.69 |
| | 12 | Dorsal Attention | 58 | 4.01 |
| | 13 | Cerebellar | 18 | 3.42 |
| *Old* | -1 | Uncertain | 242 | 6.57 |
| | 1 | Sensory/Somatomotor Hand | 107 | 2.71 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.65 |

| | | | | |
|---|---|---|---|---|
| | 3 | Cingulo-opercular Task Control | 69 | 3.75 |
| | 4 | Auditory | 71 | 4.15 |
| | 5 | Default Mode Network | 470 | 6.16 |
| | 6 | Memory Retrieval | 18 | 2.74 |
| | 7 | Visual | 189 | 4.64 |
| | 8 | Fronto-parietal Task Control | 141 | 4.29 |
| | 9 | Salience | 136 | 5.75 |
| | 10 | Subcortical | 43 | 2.52 |
| | 11 | Ventral Attention | 45 | 3.80 |
| | 12 | Dorsal Attention | 65 | 4.49 |
| | 13 | Cerebellar | 16 | 3.04 |
| CWI_HD | | | | |
| *Young* | -1 | Uncertain | 160 | 5.11 |
| | 1 | Sensory/Somatomotor Hand | 111 | 3.98 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 7.60 |
| | 3 | Cingulo-opercular Task Control | 76 | 2.88 |
| | 4 | Auditory | 68 | 3.69 |
| | 5 | Default Mode Network | 335 | 3.85 |
| | 6 | Memory Retrieval | 25 | 7.30 |
| | 7 | Visual | 147 | 4.93 |
| | 8 | Fronto-parietal Task Control | 134 | 5.35 |
| | 9 | Salience | 163 | 5.28 |
| | 10 | Subcortical | 61 | 8.72 |

| | | | | |
|---|---|---|---|---|
| | 11 | Ventral Attention | 91 | 7.10 |
| | 12 | Dorsal Attention | 58 | 4.84 |
| | 13 | Cerebellar | 18 | 7.79 |
| *Old* | -1 | Uncertain | 242 | 3.88 |
| | 1 | Sensory/Somatomotor Hand | 107 | 3.85 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.04 |
| | 3 | Cingulo-opercular Task Control | 69 | 3.37 |
| | 4 | Auditory | 71 | 4.74 |
| | 5 | Default Mode Network | 470 | 4.65 |
| | 6 | Memory Retrieval | 18 | 5.93 |
| | 7 | Visual | 189 | 3.97 |
| | 8 | Fronto-parietal Task Control | 141 | 3.65 |
| | 9 | Salience | 136 | 3.21 |
| | 10 | Subcortical | 43 | 4.04 |
| | 11 | Ventral Attention | 45 | 4.48 |
| | 12 | Dorsal Attention | 65 | 2.83 |
| | 13 | Cerebellar | 16 | 2.66 |
| TMT_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 5.81 |
| | 1 | Sensory/Somatomotor Hand | 111 | 6.87 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 4.71 |
| | 3 | Cingulo-opercular Task Control | 76 | 3.31 |
| | 4 | Auditory | 68 | 3.28 |

| | | | | |
|---|---|---|---|---|
| | 5 | Default Mode Network | 335 | 6.52 |
| | 6 | Memory Retrieval | 25 | 6.24 |
| | 7 | Visual | 147 | 5.94 |
| | 8 | Fronto-parietal Task Control | 134 | 5.41 |
| | 9 | Salience | 163 | 4.82 |
| | 10 | Subcortical | 61 | 5.50 |
| | 11 | Ventral Attention | 91 | 5.15 |
| | 12 | Dorsal Attention | 58 | 4.08 |
| | 13 | Cerebellar | 18 | 3.61 |
| *Old* | -1 | Uncertain | 242 | 3.91 |
| | 1 | Sensory/Somatomotor Hand | 107 | 1.75 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 1.67 |
| | 3 | Cingulo-opercular Task Control | 69 | 3.10 |
| | 4 | Auditory | 71 | 2.75 |
| | 5 | Default Mode Network | 470 | 4.33 |
| | 6 | Memory Retrieval | 18 | 2.74 |
| | 7 | Visual | 189 | 3.46 |
| | 8 | Fronto-parietal Task Control | 141 | 3.92 |
| | 9 | Salience | 136 | 2.41 |
| | 10 | Subcortical | 43 | 3.63 |
| | 11 | Ventral Attention | 45 | 4.06 |
| | 12 | Dorsal Attention | 65 | 5.74 |
| | 13 | Cerebellar | 16 | 1.71 |

| TMT_HD | | | | |
|---|---|---|---|---|
| *Young* | -1 | Uncertain | 160 | 5.73 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.92 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 7.15 |
| | 3 | Cingulo-opercular Task Control | 76 | 4.07 |
| | 4 | Auditory | 68 | 2.28 |
| | 5 | Default Mode Network | 335 | 6.12 |
| | 6 | Memory Retrieval | 25 | 9.73 |
| | 7 | Visual | 147 | 6.01 |
| | 8 | Fronto-parietal Task Control | 134 | 6.27 |
| | 9 | Salience | 163 | 3.80 |
| | 10 | Subcortical | 61 | 4.04 |
| | 11 | Ventral Attention | 91 | 3.89 |
| | 12 | Dorsal Attention | 58 | 4.42 |
| | 13 | Cerebellar | 18 | 4.56 |
| *Old* | -1 | Uncertain | 242 | 3.45 |
| | 1 | Sensory/Somatomotor Hand | 107 | 3.88 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 4.56 |
| | 3 | Cingulo-opercular Task Control | 69 | 3.15 |
| | 4 | Auditory | 71 | 5.32 |
| | 5 | Default Mode Network | 470 | 3.88 |
| | 6 | Memory Retrieval | 18 | 3.95 |
| | 7 | Visual | 189 | 3.19 |

| | | | | |
|---|---|---|---|---|
| | 8 | Fronto-parietal Task Control | 141 | 4.78 |
| | 9 | Salience | 136 | 4.94 |
| | 10 | Subcortical | 43 | 3.98 |
| | 11 | Ventral Attention | 45 | 3.46 |
| | 12 | Dorsal Attention | 65 | 4.84 |
| | 13 | Cerebellar | 16 | 3.61 |
| N-back_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 4.62 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.11 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 3.80 |
| | 3 | Cingulo-opercular Task Control | 76 | 4.51 |
| | 4 | Auditory | 68 | 5.56 |
| | 5 | Default Mode Network | 335 | 5.15 |
| | 6 | Memory Retrieval | 25 | 4.11 |
| | 7 | Visual | 147 | 5.72 |
| | 8 | Fronto-parietal Task Control | 134 | 4.65 |
| | 9 | Salience | 163 | 3.51 |
| | 10 | Subcortical | 61 | 5.03 |
| | 11 | Ventral Attention | 91 | 5.75 |
| | 12 | Dorsal Attention | 58 | 4.98 |
| | 13 | Cerebellar | 18 | 3.42 |
| *Old* | -1 | Uncertain | 242 | 5.13 |
| | 1 | Sensory/Somatomotor Hand | 107 | 5.12 |

| | | | | |
|---|---|---|---|---|
| | 2 | Sensory/Somatomotor Mouth | 24 | 4.56 |
| | 3 | Cingulo-opercular Task Control | 69 | 5.70 |
| | 4 | Auditory | 71 | 5.79 |
| | 5 | Default Mode Network | 470 | 4.88 |
| | 6 | Memory Retrieval | 18 | 4.71 |
| | 7 | Visual | 189 | 5.59 |
| | 8 | Fronto-parietal Task Control | 141 | 4.96 |
| | 9 | Salience | 136 | 6.29 |
| | 10 | Subcortical | 43 | 6.14 |
| | 11 | Ventral Attention | 45 | 4.65 |
| | 12 | Dorsal Attention | 65 | 7.40 |
| | 13 | Cerebellar | 16 | 4.56 |
| N-back_HD | | | | |
| *Young* | -1 | Uncertain | 160 | 5.02 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.64 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 4.41 |
| | 3 | Cingulo-opercular Task Control | 76 | 6.03 |
| | 4 | Auditory | 68 | 6.79 |
| | 5 | Default Mode Network | 335 | 6.24 |
| | 6 | Memory Retrieval | 25 | 7.30 |
| | 7 | Visual | 147 | 2.77 |
| | 8 | Fronto-parietal Task Control | 134 | 4.41 |
| | 9 | Salience | 163 | 3.21 |

| | | | | |
|---|---|---|---|---|
| | 10 | Subcortical | 61 | 3.57 |
| | 11 | Ventral Attention | 91 | 4.22 |
| | 12 | Dorsal Attention | 58 | 6.84 |
| | 13 | Cerebellar | 18 | 2.85 |
| *Old* | -1 | Uncertain | 242 | 3.39 |
| | 1 | Sensory/Somatomotor Hand | 107 | 3.80 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 4.11 |
| | 3 | Cingulo-opercular Task Control | 69 | 3.04 |
| | 4 | Auditory | 71 | 4.21 |
| | 5 | Default Mode Network | 470 | 4.13 |
| | 6 | Memory Retrieval | 18 | 2.13 |
| | 7 | Visual | 189 | 5.96 |
| | 8 | Fronto-parietal Task Control | 141 | 4.68 |
| | 9 | Salience | 136 | 2.83 |
| | 10 | Subcortical | 43 | 2.46 |
| | 11 | Ventral Attention | 45 | 1.44 |
| | 12 | Dorsal Attention | 65 | 4.70 |
| | 13 | Cerebellar | 16 | 3.42 |

*Note.* # = number, CWI = color-word interference test, TMT = trail making test, LD = low demanding test condition, HD = high demanding test condition.

Table S10

*Features (i.e., Resting-state Functional Connectivity Edges), Resulting from the Data-driven Feature Selection Approach that are Significantly Negatively Associated with the High and Low Demanding Test Condition of the three Executive Function Tests Applied.*

| | Network # | Assigned Name | Absolute # Edges | Relative # Edges (%) |
|---|---|---|---|---|
| CWI_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 4.51 |
| | 1 | Sensory/Somatomotor Hand | 111 | 3.70 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 5.78 |
| | 3 | Cingulo-opercular Task Control | 76 | 4.67 |
| | 4 | Auditory | 68 | 4.50 |
| | 5 | Default Mode Network | 335 | 5.40 |
| | 6 | Memory Retrieval | 25 | 5.78 |
| | 7 | Visual | 147 | 4.27 |
| | 8 | Fronto-parietal Task Control | 134 | 4.08 |
| | 9 | Salience | 163 | 6.55 |
| | 10 | Subcortical | 61 | 5.32 |
| | 11 | Ventral Attention | 91 | 8.37 |
| | 12 | Dorsal Attention | 58 | 4.29 |
| | 13 | Cerebellar | 18 | 3.04 |
| *Old* | -1 | Uncertain | 242 | 6.19 |
| | 1 | Sensory/Somatomotor Hand | 107 | 3.04 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.50 |

| | | | | |
|---|---|---|---|---|
| | 3 | Cingulo-opercular Task Control | 69 | 6.63 |
| | 4 | Auditory | 71 | 4.86 |
| | 5 | Default Mode Network | 470 | 4.14 |
| | 6 | Memory Retrieval | 18 | 7.15 |
| | 7 | Visual | 189 | 5.81 |
| | 8 | Fronto-parietal Task Control | 141 | 4.26 |
| | 9 | Salience | 136 | 7.27 |
| | 10 | Subcortical | 43 | 4.04 |
| | 11 | Ventral Attention | 45 | 3.30 |
| | 12 | Dorsal Attention | 65 | 3.18 |
| | 13 | Cerebellar | 16 | 2.85 |
| CWI_HD | | | | |
| *Young* | -1 | Uncertain | 160 | 6.22 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.71 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 9.13 |
| | 3 | Cingulo-opercular Task Control | 76 | 3.37 |
| | 4 | Auditory | 68 | 6.08 |
| | 5 | Default Mode Network | 335 | 5.83 |
| | 6 | Memory Retrieval | 25 | 4.56 |
| | 7 | Visual | 147 | 5.64 |
| | 8 | Fronto-parietal Task Control | 134 | 5.54 |
| | 9 | Salience | 163 | 4.73 |
| | 10 | Subcortical | 61 | 7.08 |

| | | | | |
|---|---|---|---|---|
| | 11 | Ventral Attention | 91 | 9.80 |
| | 12 | Dorsal Attention | 58 | 3.80 |
| | 13 | Cerebellar | 18 | 6.46 |
| *Old* | -1 | Uncertain | 242 | 3.53 |
| | 1 | Sensory/Somatomotor Hand | 107 | 4.49 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.80 |
| | 3 | Cingulo-opercular Task Control | 69 | 5.32 |
| | 4 | Auditory | 71 | 4.04 |
| | 5 | Default Mode Network | 470 | 3.68 |
| | 6 | Memory Retrieval | 18 | 7.45 |
| | 7 | Visual | 189 | 6.82 |
| | 8 | Fronto-parietal Task Control | 141 | 4.05 |
| | 9 | Salience | 136 | 4.86 |
| | 10 | Subcortical | 43 | 4.27 |
| | 11 | Ventral Attention | 45 | 4.82 |
| | 12 | Dorsal Attention | 65 | 4.63 |
| | 13 | Cerebellar | 16 | 3.80 |
| TMT_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 6.95 |
| | 1 | Sensory/Somatomotor Hand | 111 | 7.20 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 7.00 |
| | 3 | Cingulo-opercular Task Control | 76 | 7.17 |
| | 4 | Auditory | 68 | 6.08 |

| | | | | |
|---|---|---|---|---|
| | 5 | Default Mode Network | 335 | 4.06 |
| | 6 | Memory Retrieval | 25 | 1.98 |
| | 7 | Visual | 147 | 5.32 |
| | 8 | Fronto-parietal Task Control | 134 | 4.62 |
| | 9 | Salience | 163 | 6.21 |
| | 10 | Subcortical | 61 | 4.45 |
| | 11 | Ventral Attention | 91 | 6.42 |
| | 12 | Dorsal Attention | 58 | 4.56 |
| | 13 | Cerebellar | 18 | 4.75 |
| *Old* | -1 | Uncertain | 242 | 2.85 |
| | 1 | Sensory/Somatomotor Hand | 107 | 3.02 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.04 |
| | 3 | Cingulo-opercular Task Control | 69 | 5.11 |
| | 4 | Auditory | 71 | 3.33 |
| | 5 | Default Mode Network | 470 | 3.47 |
| | 6 | Memory Retrieval | 18 | 3.04 |
| | 7 | Visual | 189 | 3.19 |
| | 8 | Fronto-parietal Task Control | 141 | 3.92 |
| | 9 | Salience | 136 | 3.55 |
| | 10 | Subcortical | 43 | 5.03 |
| | 11 | Ventral Attention | 45 | 4.39 |
| | 12 | Dorsal Attention | 65 | 4.22 |
| | 13 | Cerebellar | 16 | 1.71 |

| TMT_HD | | | | |
|---|---|---|---|---|
| *Young* | -1 | Uncertain | 160 | 5.19 |
| | 1 | Sensory/Somatomotor Hand | 111 | 7.40 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 7.45 |
| | 3 | Cingulo-opercular Task Control | 76 | 5.76 |
| | 4 | Auditory | 68 | 5.15 |
| | 5 | Default Mode Network | 335 | 4.86 |
| | 6 | Memory Retrieval | 25 | 2.89 |
| | 7 | Visual | 147 | 4.07 |
| | 8 | Fronto-parietal Task Control | 134 | 5.90 |
| | 9 | Salience | 163 | 5.49 |
| | 10 | Subcortical | 61 | 3.74 |
| | 11 | Ventral Attention | 91 | 6.59 |
| | 12 | Dorsal Attention | 58 | 4.36 |
| | 13 | Cerebellar | 18 | 5.70 |
| *Old* | -1 | Uncertain | 242 | 3.37 |
| | 1 | Sensory/Somatomotor Hand | 107 | 4.46 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 2.43 |
| | 3 | Cingulo-opercular Task Control | 69 | 2.61 |
| | 4 | Auditory | 71 | 3.33 |
| | 5 | Default Mode Network | 470 | 3.07 |
| | 6 | Memory Retrieval | 18 | 2.43 |
| | 7 | Visual | 189 | 3.70 |

| | | | | |
|---|---|---|---|---|
| | 8 | Fronto-parietal Task Control | 141 | 3.89 |
| | 9 | Salience | 136 | 2.45 |
| | 10 | Subcortical | 43 | 3.86 |
| | 11 | Ventral Attention | 45 | 3.55 |
| | 12 | Dorsal Attention | 65 | 2.97 |
| | 13 | Cerebellar | 16 | 2.09 |
| N-back_LD | | | | |
| *Young* | -1 | Uncertain | 160 | 3.50 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.64 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 7.00 |
| | 3 | Cingulo-opercular Task Control | 76 | 7.50 |
| | 4 | Auditory | 68 | 6.84 |
| | 5 | Default Mode Network | 335 | 3.23 |
| | 6 | Memory Retrieval | 25 | 2.89 |
| | 7 | Visual | 147 | 6.30 |
| | 8 | Fronto-parietal Task Control | 134 | 4.26 |
| | 9 | Salience | 163 | 4.10 |
| | 10 | Subcortical | 61 | 3.39 |
| | 11 | Ventral Attention | 91 | 8.03 |
| | 12 | Dorsal Attention | 58 | 5.95 |
| | 13 | Cerebellar | 18 | 3.23 |
| *Old* | -1 | Uncertain | 242 | 5.24 |
| | 1 | Sensory/Somatomotor Hand | 107 | 4.94 |

| | | | | |
|---|---|---|---|---|
| | 2 | Sensory/Somatomotor Mouth | 24 | 3.65 |
| | 3 | Cingulo-opercular Task Control | 69 | 4.45 |
| | 4 | Auditory | 71 | 5.26 |
| | 5 | Default Mode Network | 470 | 5.51 |
| | 6 | Memory Retrieval | 18 | 5.32 |
| | 7 | Visual | 189 | 4.22 |
| | 8 | Fronto-parietal Task Control | 141 | 5.05 |
| | 9 | Salience | 136 | 4.35 |
| | 10 | Subcortical | 43 | 5.15 |
| | 11 | Ventral Attention | 45 | 4.31 |
| | 12 | Dorsal Attention | 65 | 4.42 |
| | 13 | Cerebellar | 16 | 4.75 |
| N-back_HD | | | | |
| *Young* | -1 | Uncertain | 160 | 3.45 |
| | 1 | Sensory/Somatomotor Hand | 111 | 4.18 |
| | 2 | Sensory/Somatomotor Mouth | 37 | 4.87 |
| | 3 | Cingulo-opercular Task Control | 76 | 5.98 |
| | 4 | Auditory | 68 | 5.50 |
| | 5 | Default Mode Network | 335 | 4.94 |
| | 6 | Memory Retrieval | 25 | 4.11 |
| | 7 | Visual | 147 | 3.19 |
| | 8 | Fronto-parietal Task Control | 134 | 3.98 |
| | 9 | Salience | 163 | 5.24 |

| | | | | |
|---|---|---|---|---|
| | 10 | Subcortical | 61 | 4.74 |
| | 11 | Ventral Attention | 91 | 4.48 |
| | 12 | Dorsal Attention | 58 | 5.05 |
| | 13 | Cerebellar | 18 | 2.28 |
| *Old* | -1 | Uncertain | 242 | 3.07 |
| | 1 | Sensory/Somatomotor Hand | 107 | 2.66 |
| | 2 | Sensory/Somatomotor Mouth | 24 | 2.43 |
| | 3 | Cingulo-opercular Task Control | 69 | 3.69 |
| | 4 | Auditory | 71 | 2.69 |
| | 5 | Default Mode Network | 470 | 4.50 |
| | 6 | Memory Retrieval | 18 | 2.59 |
| | 7 | Visual | 189 | 3.43 |
| | 8 | Fronto-parietal Task Control | 141 | 4.87 |
| | 9 | Salience | 136 | 5.37 |
| | 10 | Subcortical | 43 | 3.80 |
| | 11 | Ventral Attention | 45 | 2.62 |
| | 12 | Dorsal Attention | 65 | 3.25 |
| | 13 | Cerebellar | 16 | 2.47 |

*Note.* # = number, CWI = color-word interference test, TMT = trail making test, LD = low demanding test condition, HD = high demanding test condition.

Table S11

*Variance in the Low- and High-Demand Test Conditions of the Three Executive Function Tests Investigated per Age Group.*

| Behavioral Score | Age Group | Variance |
|---|---|---|
| 0-back | Old | .39 |
| | Young | .79 |
| 1-back | Old | .46 |
| | Young | .77 |
| CWI_con | Old | .83 |
| | Young | .82 |
| CWI_inc | Old | .70 |
| | Young | .39 |
| TMT_con | Old | .45 |
| | Young | .29 |
| TMT_switch | Old | .59 |
| | Young | .41 |

*Note.* CWI_con = congruent condition of color word interference test, CWI_inc = incongruent condition of color word interference test, TMT_con = consecutive condition of trail making test, TMT_switch = switching condition of trail making test.