Age-dependent contribution of domain-general networks to semantic cognition

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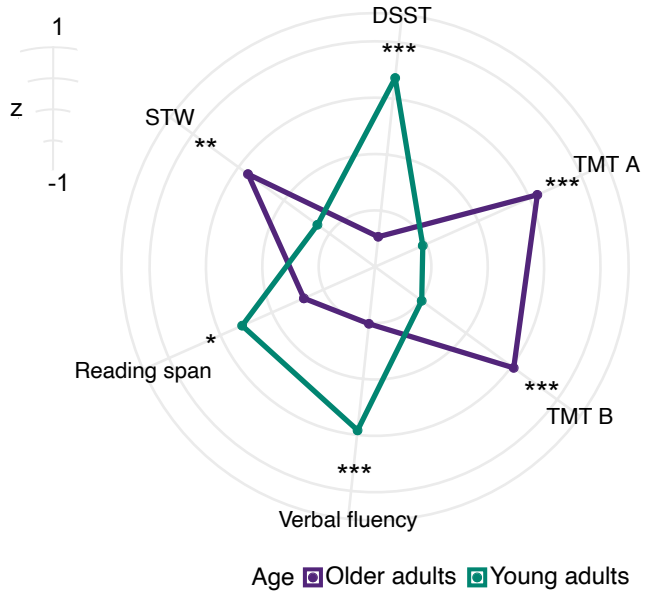
Supplementary Material

Materials and Methods



Supplementary Figure S1. Age differences in neuropsychological tests. STW = Spot-the-word test, DSST = Digit symbol substitution test, TMT A/B = Trail making test A/B. *** p < 0.001, ** p < 0.01, * p < 0.05.

Supplementary Results

Behavioral Result Tables

Regression tables were generated using RStudio (R Core Team, 2018) and the package sjPlot (Lüdecke, 2020).

Table S1. Results for mixed-effects models for accuracy and response time.

	Accuracy			**Response time**		
Coefficient	*Log-Odds*	*Conf. Int (95%)*	*p*	*Estimates*	*Conf. Int (95%)*	*p*
Intercept	6.28	5.28 – 7.28	**< 0.001**	6.45	6.41 – 6.49	**< 0.001**
Age	-3.82	-5.66 – -1.97	0.662	0.02	0.01 – 0.03	**< 0.001**
Condition	-6.47	-8.44 – -4.50	**< 0.001**	0.17	0.13 – 0.22	**< 0.001**
Difficulty	4.63	2.67 – 6.59	**< 0.001**	-0.06	-0.11 – -0.01	**< 0.001**
Age * Condition	7.26	3.57 – 10.94	0.162	0.08	0.06 – 0.09	**< 0.001**
Age * Difficulty	-7.99	-11.64 – -4.34	**0.002**	0.00	-0.01 – 0.02	0.7
Condition * Difficulty	-5.03	-8.94 – -1.11	0.049	-0.10	-0.19 – -0.00	0.056
Age * Condition * Difficulty	14.94	7.67 – 22.21	**0.002**	0.03	-0.00 – 0.07	0.091
Random Effects						
σ^2	3.29			0.10		
τ_{00}	0.19 $_{Subj}$			0.01 $_{Subj}$		
	0.22 $_{Category}$			0.00 $_{Category}$		
ICC	0.11			0.08		
N	58 $_{Subj}$			58 $_{Subj}$		
	22 $_{Category}$			22 $_{Category}$		
Observations	19710			19491		
Marginal R^2 / Conditional R^2	0.900 / 0.911			0.079 / 0.156		

Significant effects are marked in bold. Contrasts are sum coded. P-values were obtained via likelihood ratio tests. Conf. Int. Confidence interval.

Table S2. Results of post-hoc tests for three-way interaction Age x Condition x Difficulty for accuracy model. P-values are Bonferroni-corrected.

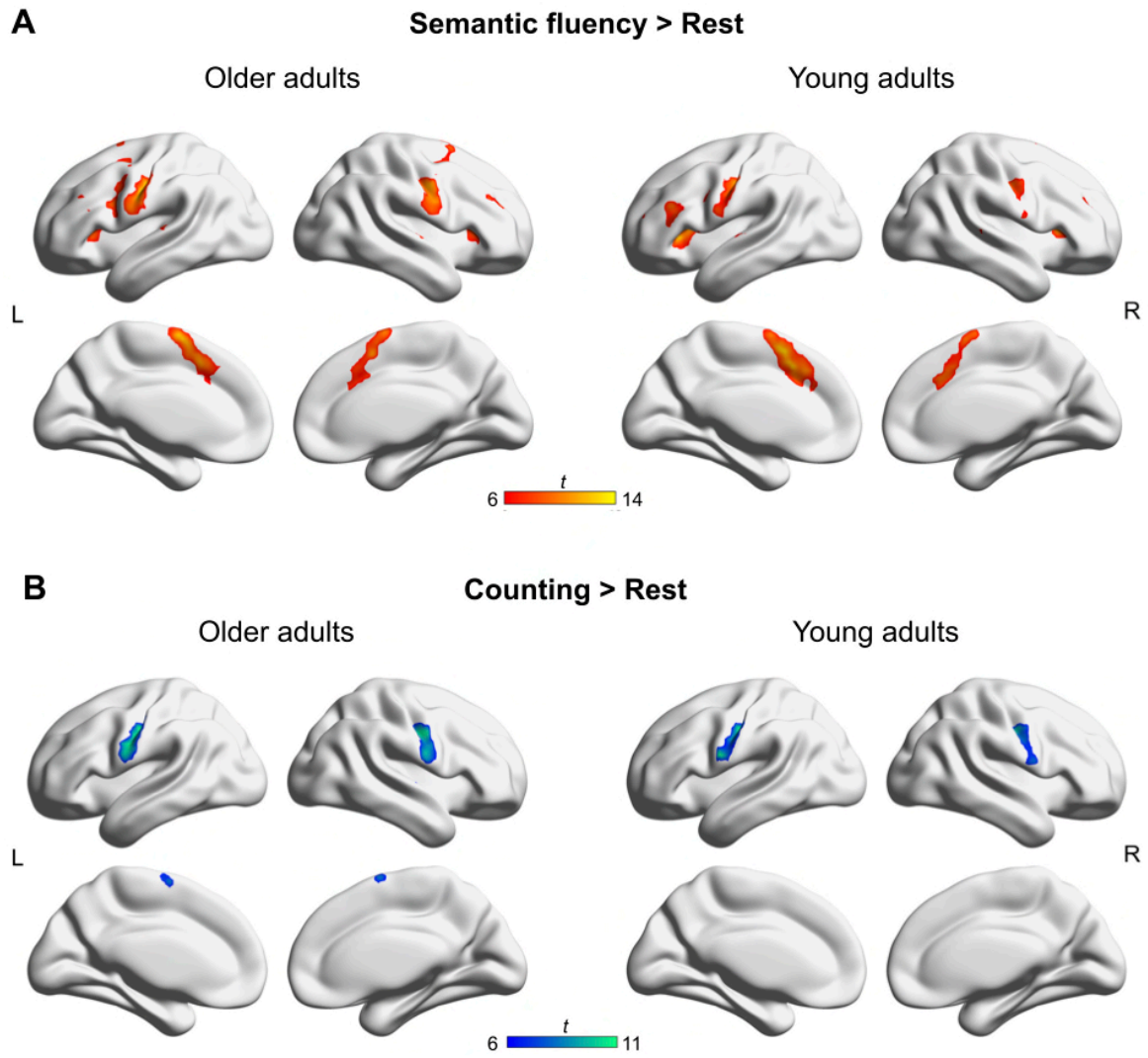
Contrast	Condition	*Odds ratio*	*SE*	*df*	*Conf. Int (95%)*	*z*	*p*
OA Easy / YA Easy	Categories	0.64	0.13	Inf	0.38 – 1.08	-2.26	0.145
OA Easy / OA Difficult	Categories	6.41	1.69	Inf	3.20 – 12.83	7.06	**< 0.001**
OA Easy / YA Difficult	Categories	6.91	1.81	Inf	3.46 –13.80	7.36	**< 0.001**
YA Easy / OA Difficult	Categories	10.02	2.76	Inf	4.85 – 20.71	8.38	**< 0.001**
YA Easy / YA Difficult	Categories	10.79	2.95	Inf	5.25 – 22.21	8.7	**< 0.001**
OA Difficult / YA Difficult	Categories	1.08	0.09	Inf	0.86 – 1.35	0.86	1
OA Easy / YA Easy	Counting	0.00	0.00	Inf	0.00 – 0.00	-4.1	**< 0.001**
OA Easy / OA Difficult	Counting	0.56	0.46	Inf	0.06 – 4.99	-0.71	1
OA Easy / YA Difficult	Counting	0.74	0.59	Inf	0.09 – 6.12	-0.38	1
YA Easy / OA Difficult	Counting	2167280.49	8196077.90	Inf	100.66 – 46660808797.59	3.86	**< 0.001**
YA Easy / YA Difficult	Counting	2884921.64	1082133 7.03	Inf	145.32 – 57273715280.44	3.97	**< 0.001**
OA Difficult / YA Difficult	Counting	1.33	0.69	Inf	0.34 – 5.21	0.55	1

Significant effects are marked in bold. SE standard error; df degrees of freedom; Conf. Int confidence interval.

Table S3. Results of post-hoc tests for three-way interaction Age x Condition x Difficulty for response time model. P-values are Bonferroni-corrected.

Contrast	**Condition**	***Ratio***	***SE***	***df***	***Conf. Int (95%)***	***z***	***p***
OA Easy / YA Easy	Categories	1.07	0.01	Inf	1.04 – 1.1	7.33	**< 0.001**
OA Easy / OA Difficult	Categories	0.91	0.02	Inf	0.87 – 0.95	-5.69	**< 0.001**
OA Easy / YA Difficult	Categories	0.95	0.02	Inf	0.91 – 0.99	-2.94	**0.019**
YA Easy / OA Difficult	Categories	0.85	0.01	Inf	0.81 – 0.89	-9.60	**< 0.001**
YA Easy / YA Difficult	Categories	0.89	0.02	Inf	0.85 – 0.93	-6.90	**< 0.001**
OA Difficult / YA Difficult	Categories	1.05	0.01	Inf	1.02 – 1.07	5.22	**< 0.001**
OA Easy / YA Easy	Counting	0.98	0.01	Inf	0.95 – 1	-2.61	0.054
OA Easy / OA Difficult	Counting	0.98	0.05	Inf	0.87 – 1.11	-0.32	1
OA Easy / YA Difficult	Counting	0.97	0.05	Inf	0.86 – 1.1	-0.58	1
YA Easy / OA Difficult	Counting	1.01	0.05	Inf	0.89 – 1.14	0.18	1
YA Easy / YA Difficult	Counting	1	0.05	Inf	0.88 – 1.13	-0.08	1
OA Difficult / YA Difficult	Counting	0.99	0.01	Inf	0.96 – 1.01	-1.32	1

Significant effects are marked in bold. SE standard error; df degrees of freedom; Conf. Int confidence interval.



Supplementary Figure S2. Functional MRI results for main effects of tasks from univariate analyses for each age group. Results are FWE-corrected at $p < 0.05$ at peak-level with a minimum cluster size = 20 voxel. Unthresholded statistical maps are available at https://neurovault.org/collections/9072/.

Functional MRI Activation Tables – within-group comparisons

All X, Y, and Z coordinates are in Montreal Neurological Institute (MNI) atlas space. Cluster size (k) is given in mm^3.

Table S4. Older adults: Semantic fluency > Rest.

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Postcentral gyrus	**L**	**899**	**14.26**	**-46**	**-10**	**35**
Postcentral gyrus	L		12.75	-56	-8	29
Postcentral gyrus	L		12.01	-51	-13	46
Postcentral gyrus	L		11.13	-61	0	24
Cerebellum	**L**	**407**	**13.28**	**-34**	**-57**	**-26**
Cerebellum	L		11.9	-16	-62	-15
Cerebellum	L		9.27	-14	-60	-23
Cerebellum	L		9	-16	-75	-20
Supplementary motor cortex	**L**	**878**	**13.11**	**-4**	**2**	**62**
Supplementary motor cortex	R		12.98	4	0	68
Supplementary motor cortex	L		11.61	-9	7	57
Superior frontal gyrus	R		11.5	11	5	62
Postcentral gyrus	**R**	**370**	**12**	**53**	**-5**	**26**
Precentral gyrus	R		11.77	51	-5	35
Postcentral gyrus	R		8.46	66	-3	18
Caudate nucleus	**R**	**86**	**11.63**	**18**	**2**	**24**
Caudate nucleus	R		9.59	16	-8	21
Caudate nucleus	R		8.72	11	0	10
Cerebellum	**R**	**571**	**11.58**	**31**	**-65**	**-26**
Cerebellum	R		9.98	28	-67	-56
Cerebellum	R		9.14	21	-72	-53
Cerebellum	R		8.97	36	-55	-50
Middle frontal gyrus	**R**	**163**	**11.36**	**36**	**47**	**26**
Middle frontal gyrus	R		9.23	41	35	29
Middle frontal gyrus	R		7.43	26	35	26
Middle frontal gyrus	R		7.28	36	42	18
Insula	**L**	**122**	**9.92**	**-31**	**27**	**4**
Insula	L		8.09	-31	15	7
Inferior frontal gyrus, pars orbitalis	L		7.92	-44	37	-9
Insula	**R**	**148**	**9.91**	**31**	**27**	**2**
Insula	R		8.77	43	20	2
Inferior frontal gyrus, pars orbitalis	R		6.47	38	32	-6
Superior temporal gyrus	**R**	**78**	**9.76**	**63**	**-3**	**2**
Superior temporal gyrus	R		8.24	56	-13	2
Superior temporal gyrus	R		7.49	68	-15	2

Superior temporal gyrus	R		7.06	51	-18	7
Caudate nucleus	**L**	**45**	**9.56**	**-16**	**-10**	**24**
Caudate nucleus	L		9.11	-14	-5	16
Superior parietal lobe	**L**	**98**	**9.33**	**-19**	**-60**	**48**
Inferior parietal sulcus	L		8.5	-26	-45	38
Inferior parietal lobe	L		7.99	-26	-55	38
Inferior parietal lobe	L		7.77	-41	-40	38
Superior temporal gyrus	**L**	**54**	**8.72**	**-51**	**-28**	**10**
Superior temporal gyrus	L		7.68	-66	-23	10
Superior temporal gyrus	L		6.7	-41	-32	10
Inferior frontal gyrus, pars triangularis	**L**	**20**	**8.71**	**-36**	**40**	**4**
Superior temporal gyrus	**L**	**21**	**8.09**	**-64**	**-10**	**4**

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S5. Young adults: Semantic fluency > Rest.

Anatomical structure	**Hemi**	***k***	***t***	***x***	***y***	***z***
Presupplementary motor cortex	**L**	**767**	**15.05**	**-4**	**12**	**51**
Supplementary motor cortex	L		13.89	-6	17	43
Supplementary motor cortex	R		12.54	4	7	62
Middle cingulate cortex	R		11.17	11	20	38
Insula	**L**	**280**	**13.95**	**-34**	**27**	**2**
Insula	L		11.74	-31	20	7
Inferior frontal gyrus, pars opercularis	L		8.61	-46	10	7
Inferior frontal gyrus, pars opercularis	L		7.01	-49	17	-4
Cerebellum	**R**	**683**	**13.82**	**33**	**-55**	**-31**
Cerebellum	R		13.01	43	-60	-28
Cerebellum	R		11.51	33	-62	-50
Cerebellum	R		11.24	26	-67	-48
Postcentral gyrus	**L**	**331**	**13.74**	**-49**	**-15**	**40**
Postcentral gyrus	L		10.89	-56	-13	46
Postcentral gyrus	L		9.93	-61	0	21
Precentral gyrus	L		8.04	-54	0	46
Cerebellum	**L**	**377**	**13.18**	**-26**	**-60**	**-26**
Cerebellum	L		12.1	-46	-62	-28
Insula	**R**	**130**	**12.01**	**33**	**22**	**7**
Inferior frontal gyrus, pars opercularis	R		9.4	46	15	4
Insula	R		9.05	41	20	-1
Cerebellum	**R**	**40**	**10.86**	**1**	**-47**	**-23**

Cerebellum	**L**	**68**	**10.41**	**-36**	**-60**	**-50**
Precentral gyrus	**R**	**208**	**10.23**	**56**	**-3**	**46**
Precentral gyrus	R		10.09	46	-10	38
Postcentral gyrus	R		8.94	56	-5	35
Rolandic operculum	R		7.71	61	-3	16
Inferior frontal gyrus, pars triangularis	**L**	**208**	**9.99**	**-44**	**32**	**24**
Inferior frontal gyrus, pars triangularis	L		8.29	-51	30	21
Inferior frontal gyrus, pars triangularis	L		8.13	-39	35	7
Inferior frontal gyrus, pars triangularis	L		7.96	-51	35	10
Thalamus	**L**	**57**	**9.31**	**-11**	**-5**	**13**
Caudate nucleus	L		9.2	-16	-3	21
Inferior frontal gyrus, pars opercularis	**L**	**98**	**8.33**	**-39**	**2**	**26**
Precentral gyrus	L		7.6	-46	10	32
Precentral gyrus	L		7.16	-41	0	38
Inferior frontal gyrus, pars triangularis	L		6.5	-46	15	24
Middle frontal gyrus	**R**	**81**	**8.1**	**33**	**47**	**32**
Middle frontal gyrus	R		7.08	31	47	24
Caudate nucleus	**R**	**43**	**8.09**	**18**	**5**	**21**
Caudate nucleus	R		7.75	16	-3	24
Caudate nucleus	R		7.73	18	12	16
Middle frontal gyrus	**L**	**26**	**7.57**	**-34**	**55**	**21**
Superior temporal gyrus	**R**	**21**	**7.5**	**66**	**-30**	**7**
Superior temporal gyrus	R		6.7	56	-30	4
Superior temporal gyrus	**L**	**20**	**6.74**	**-59**	**-15**	**4**

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S6. Older adults: Counting > Rest.

Anatomical structure	**Hemi**	***k***	***t***	***x***	***y***	***z***
Postcentral gyrus	**L**	**347**	**11.69**	**-46**	**-13**	**38**
Postcentral gyrus	L		11.56	-61	-3	24
Postcentral gyrus	L		11.52	-51	-13	46
Postcentral gyrus	L		11.05	-56	-8	29
Postcentral gyrus	**R**	**342**	**11.43**	**48**	**-8**	**35**
Postcentral gyrus	R		10.71	53	-3	24
Postcentral gyrus	R		9.39	63	-3	18
Supplementary motor cortex	**L**	**57**	**10.16**	**-4**	**-5**	**70**
Supplementary motor cortex	**R**	**59**	**9.96**	**4**	**0**	**68**

Cerebellum	**L**	**52**	**9.35**	**-29**	**-62**	**-23**
Cerebellum	L		7.84	-16	-65	-18
Superior temporal gyrus	**R**	**49**	**8.44**	**66**	**-10**	**2**
Superior temporal gyrus	R		7.71	63	2	-1
Superior temporal gyrus	R		6.96	68	-18	4
Superior temporal gyrus	R		6.76	53	-15	4
Superior temporal gyrus	**L**	**46**	**8.4**	**-46**	**-42**	**21**
Superior temporal gyrus	L		6.54	-46	-37	13
Superior temporal gyrus	L		6.19	-51	-28	10
Cerebellum	**R**	**26**	**6.96**	**21**	**-60**	**-23**
Cerebellum	R		6.9	11	-60	-23

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S7. Young adults: Counting > Rest.

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Postcentral gyrus	**L**	**317**	**11.47**	**-61**	**0**	**21**
Postcentral gyrus	L		11.3	-49	-15	40
Postcentral gyrus	L		9.28	-56	-13	46
Postcentral gyrus	L		6.99	-59	-8	16
Precentral gyrus	**R**	**247**	**10.42**	**46**	**-10**	**38**
Precentral gyrus	R		9.44	56	-3	46
Rolandic operculum	R		9.35	61	2	16
Postcentral gyrus	R		8.25	56	-8	35
Cerebellum	**R**	**37**	**8.3**	**13**	**-60**	**-20**
Cerebellum	**L**	**25**	**7.37**	**-16**	**-60**	**-23**

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S8. Older adults: Semantic fluency > Counting.

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Cerebellum	**L**	**1844**	**12.99**	**-36**	**-62**	**-26**
Cerebellum	R		12.59	28	-62	-26
Cerebellum	L		12.03	-29	-67	-26
Cerebellum	R		11.08	6	-80	-31
Middle frontal gyrus	**L**	**578**	**12.9**	**-44**	**5**	**35**
Inferior frontal gyrus, pars opercularis	L		11.2	-41	15	21
Precentral gyrus	L		10.7	-39	2	24
Middle frontal gyrus	L		8.94	-46	7	46
Superior frontal gyrus (preSMA)	**L**	**661**	**12.02**	**-9**	**15**	**51**
Presupplementary motor cortex	L		11.62	-9	20	43
Superior frontal gyrus	L		10.34	-1	10	60

Superior frontal gyrus	R		9.34	8	15	48
Insula	**L**	**269**	**10.98**	**-31**	**25**	**4**
Caudate nucleus	L		10.84	-16	0	16
Caudate nucleus	L		9.52	-16	-10	21
Superior frontal gyrus	L		8.74	-19	10	4
Insula	**R**	**113**	**10.95**	**31**	**27**	**2**
Inferior frontal gyrus. pars triangularis	R		7.25	48	22	-4
Frontal operculum	R		7.08	43	20	4
Caudate nucleus	**R**	**106**	**9.96**	**18**	**15**	**18**
Caudate nucleus	R		9.53	18	-8	21
Caudate nucleus	R		8.67	16	0	18
Thalamus	R		8.22	11	0	10
Middle frontal gyrus	**R**	**36**	**9.79**	**43**	**35**	**32**
Superior frontal gyrus	**L**	**100**	**9.12**	**-21**	**12**	**54**
Middle frontal gyrus	L		6.82	-21	-3	60
Middle frontal gyrus	L		6.57	-24	20	51
Intracalcarine cortex	**R**	**43**	**9.01**	**18**	**-80**	**7**
Occipital pole	R		7.93	13	-95	10
Intracalcarine cortex	R		6.77	13	-77	16
Angular gyrus	**L**	**27**	**8.1**	**-34**	**-72**	**43**
Middle frontal gyrus	**L**	**24**	**8.07**	**-34**	**0**	**57**
Superior parietal lobe	**L**	**61**	**7.65**	**-14**	**-65**	**51**
Superior parietal lobe	L		7.31	-21	-65	60
Angular gyrus	L		6.65	-29	-62	46
Intracalcarine cortex	**L**	**71**	**7.52**	**-11**	**-72**	**10**
Intracalcarine cortex	L		7.24	-6	-87	2
Intracalcarine cortex	L		6.96	-4	-82	10
Middle frontal gyrus	**R**	**21**	**7.39**	**23**	**60**	**-4**
Middle frontal gyrus	R		7.05	31	57	-9
Thalamus	**L**	**21**	**6.99**	**-4**	**-5**	**10**

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S9. Young adults: Semantic fluency > Counting.

Anatomical structure	**Hemi**	***k***	***t***	***x***	***y***	***z***
Insula	**L**	**3112**	**20.03**	**-31**	**25**	**2**
Presupplementary motor cortex	L		16.85	-4	25	40
Presupplementary motor cortex	L		16.33	-6	12	51
Presupplementary motor cortex	R		14.72	13	27	29
Cerebellum	**R**	**2970**	**19.11**	**33**	**-57**	**-31**
Cerebellum	R		16.12	31	-65	-28
Cerebellum	R		13.89	28	-70	-50
Cerebellum	R		12.66	41	-60	-28

Anterior cingulate gyrus	**L**	**90**	**14.15**	**-4**	**2**	**29**
Anterior cingulate gyrus	L		9.12	-1	12	24
Anterior cingulate gyrus	R		8.89	6	7	26
Insula	**R**	**315**	**13.32**	**31**	**27**	**2**
Insula	R		12.64	38	20	-4
Caudate nucleus	**L**	**235**	**12.81**	**-9**	**5**	**2**
Caudate nucleus	L		12.02	-16	-3	21
Thalamus	L		11.32	-11	-5	13
Caudate nucleus	L		10.63	-16	7	16
Brain stem	**L**	**296**	**12.46**	**-6**	**-23**	**-18**
Thalamus	L		11.94	-9	-18	16
Thalamus	L		11.85	-4	-23	10
Thalamus	L		10.36	-4	-13	10
Superior parietal lobe	**L**	**224**	**10.49**	**-29**	**-65**	**51**
Angular gyrus	L		10.21	-29	-72	43
Inferior parietal lobe	L		8.84	-34	-57	40
Middle occipital gyrus	L		6.47	-31	-80	38
Caudate nucleus	**R**	**215**	**10.45**	**18**	**10**	**18**
Caudate nucleus	R		10.38	8	7	2
Caudate nucleus	R		9.57	13	7	10
Caudate nucleus	R		9.16	18	-3	21
Superior temporal gyrus	**L**	**54**	**9.62**	**-61**	**-30**	**7**
Planum temporale	L		6.97	-61	-15	4
Middle frontal gyrus	**R**	**176**	**8.3**	**36**	**42**	**32**
Middle frontal gyrus	R		7.56	31	55	26
Middle frontal gyrus	R		7.53	33	37	21
Middle frontal gyrus	R		7.17	41	35	40

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S10. Older adults: Counting > Semantic fluency.

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Temporal pole	**R**	**30**	**9.33**	**51**	**12**	**-31**
Precuneus	**R**	**45**	**7.72**	**6**	**-52**	**38**

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S11. Young adults: Counting > Semantic fluency (FWE-corrected).

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Temporal pole	**R**	**75**	**11.02**	**51**	**10**	**-31**
Temporal pole	R		6.93	43	20	-28
Precuneus	**R**	**312**	**9.7**	**8**	**-65**	**29**
Precuneus	R		9.59	11	-52	35
Precuneus	L		9.05	-9	-52	35

Insula	**L**	**46**	**8.62**	**-41**	**-8**	**-1**
Insula	L		7.24	-36	-18	18
Insula	L		7.02	-39	-15	2
Insula	**R**	**62**	**8.48**	**36**	**-15**	**4**
Insula	R		7.66	41	0	-6
Insula	R		7.1	38	-15	21
Middle temporal gyrus	**L**	**27**	**8.27**	**-56**	**2**	**-20**
Rolandic operculum	**R**	**22**	**8.01**	**53**	**0**	**10**
Posterior cingulate cortex	**L**	**40**	**7.9**	**-6**	**-30**	**46**
Precentral gyrus	L		6.77	-6	-25	54
Precentral gyrus	**R**	**28**	**7.42**	**1**	**-15**	**62**
Precentral gyrus	L		6.91	-4	-23	70

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Table S12. Young adults: Counting > Semantic fluency ($p < 0.001$ uncorr., FWE-corrected $p < 0.05$ at cluster level).

Anatomical structure	**Hemi**	***k***	***t***	***x***	***y***	***z***
Temporal pole	**R**	**281**	**11.02**	**51**	**10**	**-31**
Temporal pole	R		6.93	43	20	-28
Middle temporal gyrus	R		5.93	61	-8	-12
Superior temporal gyrus	R		4.35	48	-10	-15
Precuneus	**R**	**3620**	**9.7**	**8**	**-65**	**29**
Precuneus	R		9.59	11	-52	35
Precuneus	L		9.05	-9	-52	35
Insula	R		8.48	36	-15	4
Central operculum	R		8.01	53	0	10
Insula	**L**	**438**	**8.62**	**-41**	**-8**	**-1**
Insula	L		7.24	-36	-18	18
Insula	L		7.02	-39	-15	2
Precentral gyrus	L		6.99	-59	2	10
Insula	L		5.22	-41	-3	-12
Middle temporal gyrus	**L**	**151**	**8.27**	**-56**	**2**	**-20**
Temporal pole	L		7.06	-54	10	-31
Temporal pole	L		4.5	-44	20	-31
Temporal pole	L		3.99	-41	7	-23
Anterior cingulate cortex	**L**	**96**	**7.36**	**-6**	**27**	**-6**
Anterior cingulate cortex	L		4.09	-6	42	-4
Angular gyrus	**L**	**281**	**7.11**	**-54**	**-62**	**35**
Angular gyrus	L		5.46	-41	-60	26
Middle temporal gyrus	L		5.05	-46	-62	18
Angular gyrus	L		4.46	-46	-75	35
Angular gyrus	L		4.03	-49	-67	43
Angular gyrus	**R**	**389**	**7.02**	**51**	**-57**	**26**

Angular gyrus	R	4.6	46	-65	48
Angular gyrus	R	4.16	43	-72	35
Lateral occipital cortex	R	4.1	46	-77	26
Lateral occipital cortex	R	3.55	56	-62	7

FWE-corrected ($p < 0.05$) at cluster-level, $p < 0.001$ uncorr. at peak-level.

Table S13. Results for linear mixed-effects model for parameter estimates from fMRI main effects.

		Beta weights	
Coefficient	*Estimates*	*Conf. Int (95%)*	*p*
Intercept	-0.39	-0.54 – -0.24	**< 0.001**
Network	1.07	0.95 – 1.19	**< 0.001**
Age	0.34	0.21 – 0.46	**< 0.001**
Condition	0.49	0.37 – 0.61	**< 0.001**
Network * Age	-0.02	-0.15 – 0.10	0.704
Network * Condition	1.14	1.02 – 1.26	**< 0.001**
Age * Condition	-0.02	-0.14 – 0.10	0.762
Network * Age * Condition	-0.27	-0.39 – -0.15	**< 0.001**
Random Effects			
σ^2	0.91		
$\tau_{00\ Subj}$	0.06		
ICC	0.06		
$N_{\ Subj}$	30		
Observations	232		
Marginal R^2 / Conditional R^2	0.751 / 0.766		

Significant effects are marked in bold. Contrasts are sum coded. P-values were obtained via likelihood ratio tests. Conf. Int. Confidence interval.

Table S14. Results for post-hoc tests for three-way interaction Network x Age x Contrast for parameter estimates model. P-values are Bonferroni-corrected.

Contrast	fMRI contrast	*Estimate*	*SE*	*df*	*Conf. Int (95%)*	*t*	*p*
OA MDN - YA MDN	SF > rest	0.04	0.25	196.93	-0.63 – 0.71	0.17	1
OA MDN - OA DMN	SF > rest	3.83	0.25	195.3	3.15 – 4.51	15.05	**< 0.001**
OA MDN - YA DMN	SF > rest	5.05	0.25	196.93	4.38 – 5.72	20.18	**< 0.001**
YA MDN - OA DMN	SF > rest	3.79	0.25	196.93	3.12 – 4.45	15.12	**< 0.001**
YA MDN - YA DMN	SF > rest	5.01	0.25	195.3	4.35 – 5.66	20.38	**< 0.001**
OA DMN - YA DMN	SF > rest	1.22	0.25	196.93	0.56 – 1.89	4.89	**< 0.001**
OA MDN - YA MDN	Count > rest	1.20	0.25	196.93	0.54 – 1.87	4.81	**< 0.001**
OA MDN - OA DMN	Count > rest	0.35	0.25	195.3	-0.33 – 1.03	1.38	1
OA MDN - YA DMN	Count > rest	0.57	0.25	196.93	-0.10 – 1.24	2.27	0.146
YA MDN - OA DMN	Count > rest	-0.85	0.25	196.93	-1.52 – -0.19	-3.41	**0.005**
YA MDN - YA DMN	Count > rest	-0.64	0.25	195.3	-1.29 – 0.02	-2.59	0.062
OA DMN - YA DMN	Count > rest	0.22	0.25	196.93	-0.45 – 0.89	0.87	1

Significant effects are marked in bold. SE standard error; df degrees of freedom; Conf. Int confidence interval.

Table S 15. Young adults: Easy > Difficult semantic categories.

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Middle frontal gyrus	**R**	**20**	**7.24**	**26**	**2**	**51**
Middle frontal gyrus	R		6.49	31	12	51

FWE-corrected ($p < 0.05$) at peak level, $k \geq 20$ voxels.

Activation Tables for Psychophysiological Interactions (PPI)

All individual seeds for PPIs were thresholded at $p < 0.01$. All reported results are for the contrast Semantic fluency > Counting and are FWE-corrected at $p < 0.05$ at peak-level (k ≥ 20 voxels). All X, Y, and Z coordinates are in Montreal Neurological Institute (MNI) atlas space. Cluster size (k) is given in mm^3.

Table S16. PPI seed: Pre-supplementary Motor Area [-6 12 51].

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Older adults						
No significant clusters above threshold.						
Young adults						
Caudate nucleus	**L**	**92**	**9.89**	**-14**	**10**	**4**
Caudate nucleus	L		8.68	-16	20	4
Caudate nucleus	L		6.18	-11	7	13
Caudate nucleus	**R**	**76**	**9.19**	**8**	**12**	**2**
Caudate nucleus	R		7.72	18	22	-4
Putamen	R		7.30	18	12	-1
Caudate nucleus	R		6.93	18	25	4
Precuneus	**L**	**125**	**8.31**	**-6**	**-52**	**16**
Posterior cingulate cortex	L		7.60	-4	-55	26
Precuneus	L		7.44	-11	-55	7
Thalamus	**L**	**35**	**7.30**	**-1**	**-13**	**7**
Thalamus	R		7.29	4	-20	10
Thalamus	L		6.50	-9	-25	13

Table S17. PPI seed: Left Insula [-31 25 2].

Anatomical structure	Hemi	*k*	*t*	x	y	z
Older adults						
No significant clusters above threshold.						
Young adults						
Caudate nucleus	**R**	**36**	**10.09**	**8**	**12**	**2**
Caudate nucleus	**L**	**34**	**7.04**	**-14**	**12**	**4**
Caudate nucleus	L		6.33	-16	22	2
Precuneus	**L**	**31**	**6.88**	**-9**	**-60**	**7**
Precuneus	L		6.75	-6	-52	16

Table S18. PPI seed: Right Insula [31 27 2].

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Older adults						

Precuneus	**R**	**29**	**8.92**	**1**	**-60**	**26**
Posterior cingulate gyrus	L		8.56	-1	-45	26
Inferior frontal gyrus, pars orbitalis	**L**	**20**	**7.39**	**-31**	**35**	**-15**
Inferior frontal gyrus, pars orbitalis	L		6.46	-44	30	-12
Young adults						
No significant clusters above threshold.						

Table S19. PPI seed: Right Temporal Pole [48 15 -31].

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Older adults						
Inferior frontal gyrus, pars opercularis	**R**	**24**	**7.33**	**51**	**17**	**-1**
Insula	R		7.02	41	27	-1
Insula	R		6.31	41	12	-1
Young adults						
Inferior frontal gyrus, pars opercularis	**R**	**47**	**8.48**	**43**	**12**	**21**
Inferior frontal gyrus, pars opercularis	R		7.08	53	12	18
Superior frontal gyrus	**R**	**46**	**8.28**	**18**	**2**	**65**
Middle frontal gyrus	R		6.94	31	-3	62
Superior frontal gyrus	R		6.44	21	12	65
Insula	**R**	**75**	**7.22**	**43**	**15**	**2**
Frontal operculum	R		6.76	33	25	7
Frontal operculum	R		6.53	36	15	10
Supramarginal gyrus	**R**	**23**	**7.21**	**58**	**-32**	**48**

Table S20. PPI seed: Right Precuneus [8 -65 29].

Anatomical structure	Hemi	*k*	*t*	*x*	*y*	*z*
Older adults						
Insula	**R**	**295**	**9.27**	**33**	**22**	**10**
Inferior frontal gyrus, pars triangularis	R		9.27	53	25	10
Insula	R		8.97	41	25	-6
Inferior frontal gyrus, pars triangularis	R		8.79	46	25	4
Supramarginal gyrus	**R**	**410**	**9.20**	**53**	**-40**	**46**
Angular gyrus	R		9.18	56	-45	32
Supramarginal gyrus	R		8.91	63	-42	35
Angular gyrus	R		8.72	56	-47	48
Middle frontal gyrus	**R**	**125**	**8.78**	**33**	**47**	**32**
Middle frontal gyrus	R		8.04	41	42	29
Middle frontal gyrus	R		7.39	46	45	21
Supramarginal gyrus	**L**	**42**	**8.77**	**-61**	**-47**	**32**

Supramarginal gyrus	L		6.89	-54	-50	35
Inferior frontal gyrus, pars orbitalis	**R**	**61**	**8.4**	**48**	**45**	**-6**
Inferior frontal gyrus, pars triangularis	R		8.03	51	37	-1
Inferior frontal gyrus, pars triangularis	R		7.78	48	40	7
Inferior frontal gyrus, pars triangularis	R		7.38	41	42	-1
Presupplementary motor area	**R**	**35**	**8.06**	**4**	**7**	**60**
Presupplementary motor area	R		7.44	6	10	68
Inferior frontal gyrus, pars triangularis	**L**	**70**	**8.02**	**-41**	**17**	**7**
Inferior frontal gyrus, pars triangularis	L		7.85	-36	30	4
Inferior frontal gyrus, pars opercularis	L		6.84	-46	10	7
Superior temporal gyrus	**R**	**32**	**7.86**	**53**	**-15**	**-4**
Middle temporal gyrus	R		7.03	56	-30	-1
Superior temporal gyrus	R		6.77	63	-20	-1
Precentral gyrus	**R**	**93**	**7.85**	**46**	**7**	**35**
Middle frontal gyrus	R		6.89	41	10	46
Middle frontal gyrus	R		6.88	41	15	29
Precentral gyrus	R		6.82	43	5	26
Inferior frontal gyrus, pars opercularis	**R**	**21**	**7.77**	**56**	**15**	**24**
Angular gyrus	**L**	**39**	**7.61**	**-51**	**-52**	**48**
Supramarginal gyrus	L		7.19	-59	-47	43
Lateral occipital cortex	**R**	**29**	**7.15**	**33**	**-67**	**29**
Lateral occipital cortex	R		6.78	26	-77	26
Young adults						
Supramarginal gyrus	**R**	**1300**	**9.69**	**61**	**-45**	**26**
Angular gyrus	R		8.29	63	-47	18
Supramarginal gyrus	R		8.28	51	-42	13
Supramarginal gyrus	R		8.17	58	-32	43
Superior frontal gyrus	**R**	**21**	**9.35**	**8**	**30**	**54**
Superior frontal gyrus	**R**	**185**	**9.03**	**11**	**5**	**62**
Superior frontal gyrus	R		8.40	16	12	65
Superior frontal gyrus	R		7.35	11	-10	68
Superior frontal gyrus	R		6.78	18	-3	73
Insula	**L**	**194**	**8.80**	**-44**	**10**	**-4**
Insula	L		7.86	-46	2	4
Insula	L		7.81	-34	2	0
Insula	L		6.91	-44	22	-6
Precentral gyrus	**R**	**79**	**8.36**	**46**	**-3**	**48**
Middle frontal gyrus	R		6.85	43	-3	57
Precentral gyrus	R		6.53	51	2	40
Precentral gyrus	R		6.49	33	-8	48
Anterior cingulate cortex, dorsal part	**R**	**147**	**7.97**	**11**	**17**	**35**

Anterior cingulate cortex, dorsal part	L		7.14	-1	5	43
Anterior cingulate cortex	L		6.79	-4	25	24
Anterior cingulate cortex, dorsal part	R		6.00	4	-5	40
Middle temporal gyrus	**R**	**161**	**7.92**	**48**	**-60**	**13**
Middle temporal gyrus	R		7.44	56	-52	2
Middle temporal gyrus	R		6.88	56	-57	10
Middle temporal gyrus	R		6.34	43	-67	-1
Angular gyrus	**L**	**201**	**7.84**	**-61**	**-50**	**35**
Supramarginal gyrus	L		7.80	-64	-47	26
Supramarginal gyrus	L		7.40	-64	-40	32
Central operculum	L		6.85	-59	-23	16
Posterior cingulate cortex	**R**	**187**	**7.60**	**8**	**-30**	**46**
Precuneus	R		7.35	6	-42	51
Precentral gyrus	R		7.35	6	-18	48
Precuneus	R		7.15	8	-57	62
Posterior cingulate cortex	**L**	**24**	**7.59**	**-1**	**-25**	**26**
Posterior cingulate cortex	R		6.86	6	-28	29
Superior occipital gyrus	**L**	**24**	**7.39**	**-16**	**-77**	**43**
Lateral occipital cortex	**L**	**38**	**7.34**	**-31**	**-82**	**16**
Lateral occipital cortex	L		6.37	-29	-92	18
Cuneus	**R**	**31**	**7.32**	**18**	**-82**	**26**
Cuneus	**R**	**58**	**7.30**	**13**	**-75**	**26**
Lateral occipital cortex	R		6.51	13	-75	46
Cuneus	R		6.23	13	-75	35
Cuneus	R		6.0	8	-80	40
Lateral occipital cortex	**R**	**61**	**7.30**	**31**	**-75**	**24**
Calcarine gyrus	**R**	**50**	**7.11**	**1**	**-70**	**13**
Lingual gyrus	R		6.44	4	-80	2
Intracalcarine cortex	L		6.38	-6	-75	18
Postcentral gyrus	**L**	**20**	**6.74**	**-9**	**-47**	**57**
Precentral gyrus	L		6.33	-14	-37	43
Fusiform gyrus	**R**	**24**	**6.67**	**36**	**-67**	**-15**
Fusiform gyrus	R		6.66	28	-72	-12
Middle frontal gyrus	**R**	**23**	**6.51**	**31**	**40**	**26**
Middle frontal gyrus	R		6.22	41	42	29

Result Tables for functional connectivity

Table S21. Results for linear model for within and between network connectivity.

PPI variable	FC	IV	*b*	*SE*	*t*	*p*
Semantic fluency > Counting	Within MDN	Intercept	0.05	0.02	2.70	**0.009**
		Age	0.005	0.03	0.18	0.85
	Within DMN	Intercept	-0.002	0.02	-0.07	0.95
		Age	0.02	0.03	0.50	0.63
	Between MDN and DMN	Intercept	0.10	0.02	4.47	**< 0.001**
		Age	0.04	0.03	1.25	0.22

Significant effects are marked in bold: $p < Meff$-corrected α of 0.018; FC Functional connectivity; IV Independent variable; MDN Multiple-demand network; DMN Default-mode network.

Table S22. Results for generalized linear mixed models for within- and between-network functional connectivity effects, age, and condition on accuracy and response time.

	Accuracy			**Response time**		
Coefficient	*Log-Odds*	*Conf. Int (95%)*	*p*	*Estimates*	*Conf. Int (95%)*	*p*
Intercept	3.09	2.48 – 3.70	**< 0.001**	6.53	6.48 – 6.58	**< 0.001**
Within-MDN FC	-0.06	-1.68 – 1.55	0.849	-0.15	-0.30 – 0.00	0.234
Within-DMN FC	-0.37	-1.93 – 1.18	0.621	-0.33	-0.50 – -0.16	**< 0.001**
Between-network FC	0.25	-1.51 – 2.01	0.829	0.53	0.36 – 0.70	**< 0.001**
Age	-0.01	-0.17 – 0.16	0.866	0.07	0.05 – 0.08	**< 0.001**
Within-MDN FC * Age	1.55	-1.53 – 4.63	0.329	0.98	0.65 – 1.31	**< 0.001**
Within-DMN FC * Age	2.10	-0.74 – 4.93	0.151	0.90	0.62 – 1.19	**< 0.001**
Between-network FC * Age	-2.58	-5.59 – 0.43	0.096	-0.80	-1.11 – -0.49	**< 0.001**
Random Effects						
σ^2	3.29			0.13		

τ_{00}	0.22 $_{Subj}$	0.01 $_{Subj}$
	1.71 $_{Category}$	0.00 $_{Category}$
ICC	0.37	0.12
N	58 $_{Subj}$	52 $_{Subj}$
	20 $_{Category}$	20 $_{Category}$
Observations	9837	9675
Marginal R^2 / Conditional R^2	0.002 / 0.371	0.027 / 0.143

Significant effects are marked in bold. Contrasts are sum coded. P-values were obtained via likelihood ratio tests. Conf. Int. Confidence interval.

Table S23. Results of post-hoc tests for two-way interactions Age x Connectivity measure for response time model. P-values are Bonferroni-corrected.

Contrast	**FC**	***Estimate***	***SE***	***df***	***Conf. Int (95%)***	***z***	***p***
OA – YA	Within MDN	661	116	Inf	434 – 887	5.72	**< 0.001**
	Within DMN	602	100	Inf	405 – 799	6	**< 0.001**
	Between MDN and DMN	-524	110	Inf	-739 – -308	-4.76	**< 0.001**

Significant effects are marked in bold. FC functional connectivity; SE standard error; df degrees of freedom; Conf. Int confidence intervals.