Hearing loss meta-analysis

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Methods

Eligibility Criteria

We included peer-review publications in English, involving patients with bilateral congenital and mixed hearing loss and controls with structural Magnetic Resonance Imaging. We included cross-sectional studies with control groups, that investigated the structural relation between MRI changes and the hearing loss. The most common MRI measures were **volume, FA, VBM and thickness.** Each measure was assignated to a specific ROI and to a big brain area. (eg. HG and superior temporal lobe belong to **temporal lobe**). A total of 59 studies were included, 6 of them contained incomplete information. A total of 2778 patients and 4214 controls.
Notes for inclusion:

1. I excluded Xia et al. Chin J Rad, 2008 because I don't understand chinese and it appears to be the same data as Xia et al. Chin J Med Img Tech, 2008.
2. Kim et al. Hear Res 2014 used two groups prelingual deaf and post lingual deaf, I used the average for the main table.
3. Xia et al. Chin J Med Img Tech, 2008 had a total of 40 patients, two groups 9-12 years and 19-22 years, no controls.
4. Zheng et al. Sci Rep, 2017 this variables change; Con rangeLow Con rangeHigh. Why? I didn't find them on the orignal paper.

Effect size direction was directly include in the Cohen's D value by mutipliying by -1 if the effect was decrease and by 1 if it was none of increased. Forests plots were generated form the meta-regression with subgroups left and right. We measure a general regression for white and gray mater by Etiology (congenital and acquired) with subgroups (left and right).

Effects were summarized across studies using the generic inverse-variance weighting method with DerSimonian and Laird random effects. Studies were weighted by $1/SE$š (where SE is the standard error). For the effect size we used Hedges'G, wich takes into account the sample size.

$$Hedges'G = \frac{X_1 - X_2}{\sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}}$$

Assumptions:

1. We assume that the calculation of the cohen's D is correct.
2. We assume that the direction of the effect is correct.

3. Variance was estimated using the cohen's D and sample size of each study. Our estimated variance was used for all meta-regressions, therefore we could have and additional bias in-between studies variance and heterogeneity calculations. We should have calculated the effect size from the mean and standard deviation from each study. Variance was estimated using the following formula:

$$Variance = \frac{n1 + n2}{n1 \times n2} + \frac{Hedges'G^2}{2 \times (n1 + n2 - 2)}$$

Estimatimation of heterogeneity per model

We estimated heterogeneity in results using the τ statistic, which represents the standard deviation in the meta-regression models, we used the heterogeneity test $x2$ and $I2$.
We performed a multi-level meta-analytic model, over our multiple effect size estimates nested withing variables: Etiology, side and Big brain area. We expected that the underlying true effects are more similar for the same level of the grouping variables than thrue effects arising from different levels.
We can account for the correlation in the true effects by adding a random effect to the model at the level corresponding to the grouping variable.
The dataset contains the result from 54 studies, each comparing different measurements between patients and controls. The diference of between groups was quantified in terms of Hedges'G and Cohen's D.

Total included studies

Table 1: Total unique studies 54

	Hearing Loss	Healthy
Total number of patients	2778	4214
Number mean	47.08	71.42
Number sd	128.5	250.6
Age mean	33.07	30.96
Age SD	22.66	20.5
%Female mean	50.02	55.71
%Female sd	12.05	12.78

Table 2: Acquired studies 13

	Hearing Loss	Healthy
Total number of patients	1766	3146
Number mean	110.4	196.6
Number sd	239	468.2
Age mean	64.6	55.27
Age SD	7.863	13.85
%Female mean	45.1	56.52
%Female sd	15.09	12.9

Table 3: Congenital studies 41

	Hearing Loss	Healthy
Total number of patients	1012	1068
Number mean	23.53	24.84
Number sd	17.18	15.04
Age mean	21.06	20.99
Age SD	12.48	13.06
%Female mean	51.83	55.41
%Female sd	10.37	12.88

Table of included studies (Figure 1.A)

Table 4: Studies with incomplete information (NA)

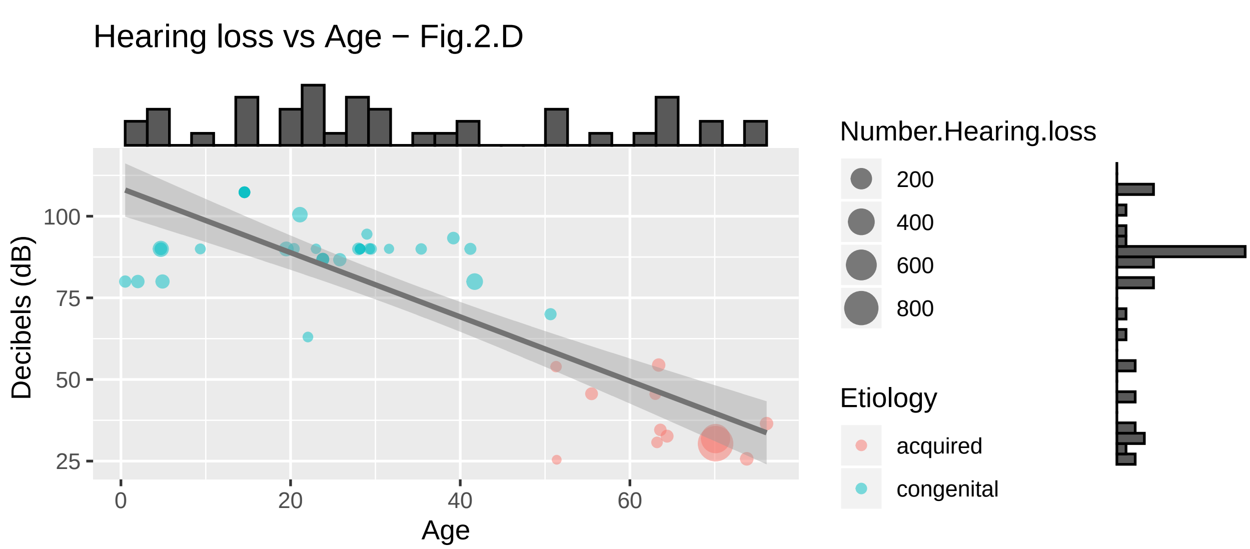
	Source	MRI Tesla	all.techniques	all.measures
5	2006, Kara et al. J Neuroradiol	1.5	VBM	length, Thickness, volume
9	2008, Xia et al. Chin J Med Img Tech	1.5	VBM	volume
12	2010, Husain et al. Brain Res	3	DTI, VBM	FA, volume
26	2014, Lyness et al. Neuroimage	1.5	DTI	FA, MD, RD
41	2017, Karns et al. Hear Res	3	DTI	AD, FA, RD, volume
48	2018, Kumar U, Mishra M. Brain Res	3	VBM	Thickness, VBM

Table 5: Included studies

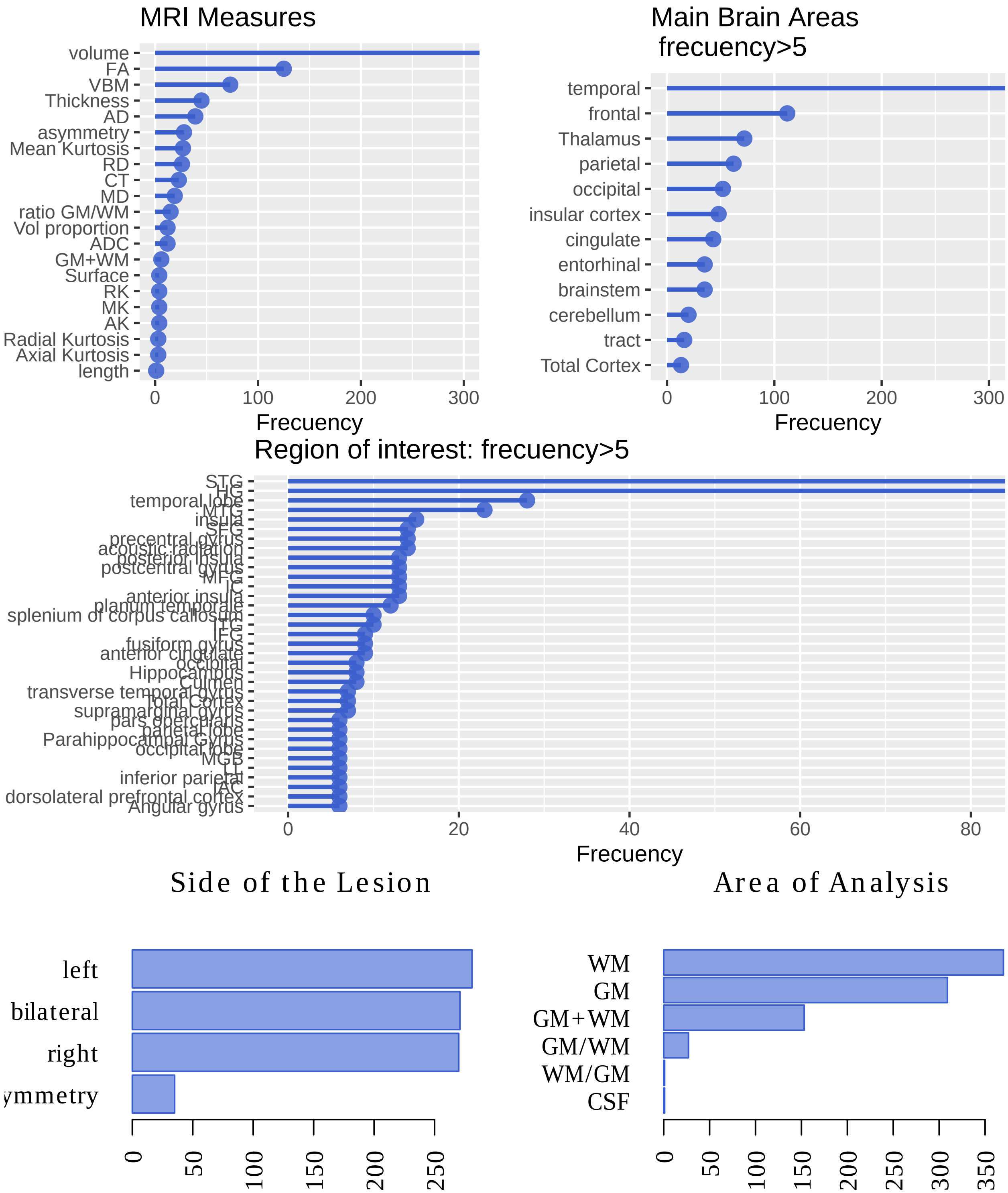
	Source	MRI Tesla	all.techniques	all.measures
1	2000, Bavelier et al. J Neurosci	1.5	VBM	volume
2	2003, Emmorey et al. PNAS	1.5	VBM	asymmetry, GM+WM, ratio GM/WM, volume
3	2003, Penhune et al. Neuroimage	1.5	VBM	asymmetry, ratio GM/WM, volume
4	2004, Chang et al. Neuroreport	3	DTI	asymmetry, FA
6	2007, Meyer et al. Restor Neurol Neurosci	3	VBM	volume
7	2007, Shibata DK. Am J Neuroradiol	1.5	VBM	volume
8	2008, Allen et al. J Neurosci	1.5	VBM	asymmetry, ratio GM/WM, Vol proportion, volume
10	2009, Kim et al. Neuroreport	3	DTI, VBM	FA, volume
11	2009, Wang et al. Chin J Med Img Tech	3	DTI	FA
13	2010, Leporé et al. Hum Brain Mapp	1.5	VBM	VBM
14	2010, Li, et al. J Clin Rad	1.5	VBM	volume
15	2010, Liu et al. Chin J Med Img Tech	3	CT	FA
16	2011, Smith et al. Cereb Cortex	3	VBM	asymmetry, ratio GM/WM, volume
17	2012, Li et al. Brain Res	3	CT	Thickness
18	2012, Li et al. Hum Brain Mapp	3	DTI	AD, FA, RD
19	2013, Allen et al. Front Neuroanat	1.5	VBM	asymmetry, volume
20	2013, Boyen et al. Hear Res	3	VBM	volume
21	2013, Miao et al. Am J Neuroradiol	3	DTI	FA, RD
22	2013, Pénicaud et al. Neuroimage	1.5	VBM	volume
23	2014, Hribar et al. Hear Res	3	DTI, VBM	AD, FA, Thickness
24	2014, Kim et al. Hear Res	3	VBM	volume
25	2014, Lin et al. Neuroimage	1.5	VBM	volume
27	2014, Olulade et al. J Neurosci	3	VBM	volume
28	2014, Profant et al. Neuroscience	3	DTI, VBM	AD, CT, FA, MD, RD, Surface, volume
29	2014, Profant et al. Neuroscience	3	DTI, VBM	AD, CT, FA, MD, RD, Surface, volume
30	2015, Huang et al. PLoS One	1.5	DTI	FA, MD
31	2015, Tae Investig Magn Reson Imaging	1.5	VBM	VBM
32	2016, Amaral et al. Eur J Neurosci	3	VBM	asymmetry, Thickness
33	2016, Chinnadurai et al. Magn Reson Imaging	1.5	DTI	AD, Axial Kurtosis, FA, Mean Kurtosis, Radial Kurtosis, RD
34	2016, Ma et al. AJNR Am J Neuroradiol	3	DTI	AD, FA, MD, RD
35	2016, Shi et al. Neuroreport	3	VBM	volume
36	2016, Shiell et al. Neural Plasticity	3	CT	Thickness
37	2016, Smittenaar et al. Open Neuroimag J	1.5	CT	CT

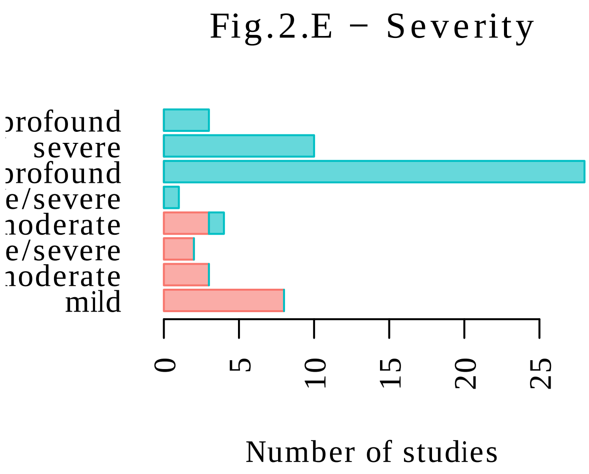
	Source	MRI Tesla	all.techniques	all.measures
38	2016, Wu et al. Brain Res	1.5	VBM	ADC, FA
39	2016, Wu et al. Brain Res	1.5	VBM	ADC, FA
40	2016, Wu et al. Brain Res	1.5	VBM	ADC, FA
42	2017, Kim et al. Neuroreport	3	DTI	FA
43	2017, Shiell & Zatorre. Hear Res	3	DTI	AD, MD, RD, volume
44	2017, Zheng et al. Sci Rep	3	DTI	FA, Mean Kurtosis
45	2018, Benetti et al. Neuroimage	4	DTI	AD, FA, RD
46	2018, Chen et al. Behav Neurosci	3	VBM	volume
47	2018, Feng et al. PNAS	3	VBM	VBM
49	2018, Park et al. Biomed Res Int	3	DTI	FA
50	2018, Pereira-Jorge et al. Neural Plast	1.5	VBM	volume
51	2018, Ren et al. Front Neurosci	3	CT, VBM	Thickness, volume
52	2018, Uchida et al. Front Aging Neurosci	3	VBM	volume
53	2018, Uchida et al. Front Aging Neurosci	3	VBM	volume
54	2018, Zou et al. Otol Neurotol	3	DTI	AK, FA, MK, RK
55	2019, Belkhiria et al. Front. Aging Neurosci	3	VBM	CT, volume
56	2019, Belkhiria et al. Front. Aging Neurosci	3	VBM	CT, volume
57	2019, Luan et al. Front Neurosci	3	DTI, VBM	FA, MD, volume
58	2019, Ponticorvo et al. Hum Brain Mapp	3	VBM	volume
59	2019, Xu et al. J Magn Reson Imaging	3	VBM	volume

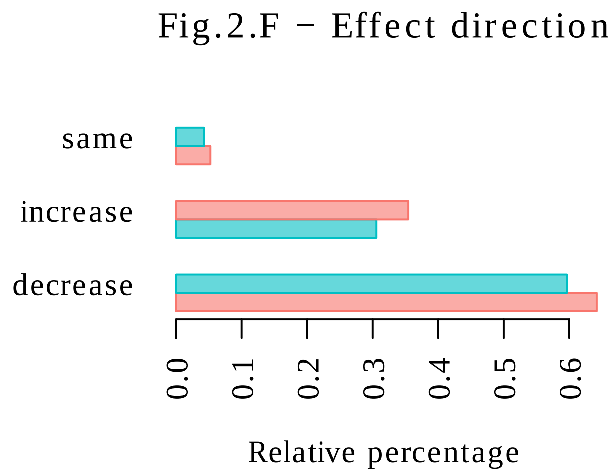
Relation between hearing loss (dB) and age (Figure 2.D)



Studies characteristics (Figure 2.E, 2.F)







Brain structure (GM, WM) and MRI measures

Highlights
a. Most of the studies that measured Gray matter focus on cortical changes (volume, thicknes and VBM).
b. White matter studies are more heterogeneous in their measurements.
c. Diffusion tensor (DT) derived mesurements are the most frequent in white matter, followed by volume.
c.1 It is harder to interpret a meta-analysis of multiple white matter measurements because its effect varies widely in different directions. The measurements derived from DT have the most differences.

We conduct our meta-analysis using the **TWO** most frequent measurements for gray and white matter. We use *volume* for GM and *fractional anysotropy* for WM.

Further meta regressions can be found in the supplementary material.
Gray Matter
- thickness
- VBM

White Matter integrity
- mean diffusivity MD
- radial diffusivity RD
- axial diffusivity AD
- mean kurtosis

White Matter volume
- thickness (I am unsure how they did this)
- VBM
- volume

Biletareal - GM volume
- WM volume
- WM fractional anisotropy

Frequency table: Brain structure (GM, WM) and MRI measures

Table 6: Matter vs measure (continued below)

	AD	ADC	AK	asymmetry	Axial Kurtosis	CT	FA	GM+WM
GM	0	0	2	9	0	23	8	0
WM	39	12	2	8	3	0	117	0

Table 7: Table continues below

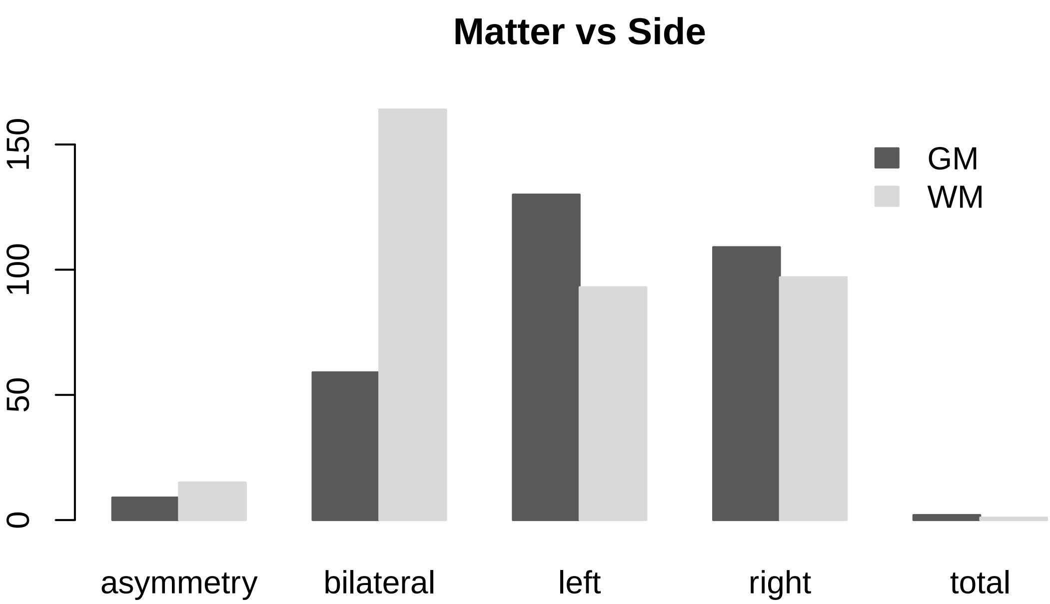
	length	MD	Mean Kurtosis	MK	Radial Kurtosis	ratio GM/WM	RD
GM	0	2	0	2	0	0	0
WM	1	17	27	2	3	0	26

	RK	Surface	Thickness	VBM	Vol proportion	volume
GM	2	4	14	43	6	194
WM	2	0	10	16	6	79

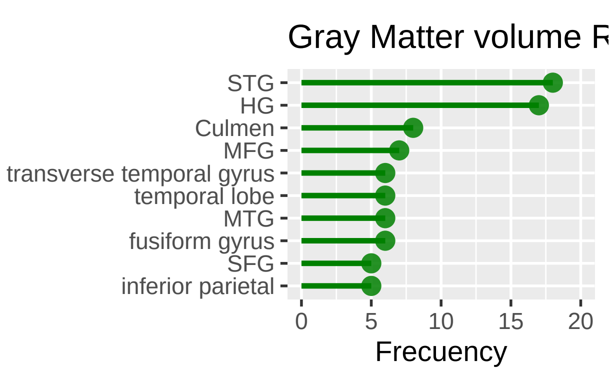
Table 9: Matter vs Side

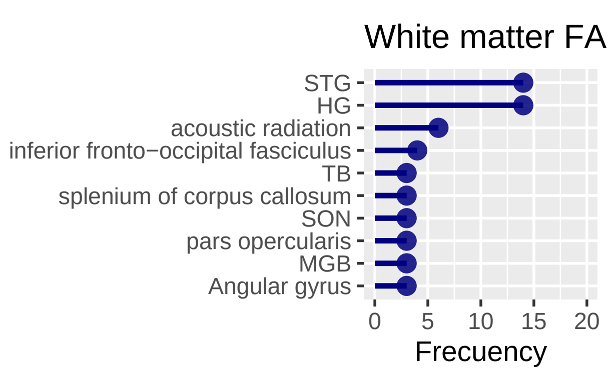
	asymmetry	bilateral	left	right	total
GM	9	59	130	109	2
WM	15	164	93	97	1

Brain structure (GM, WM) and side

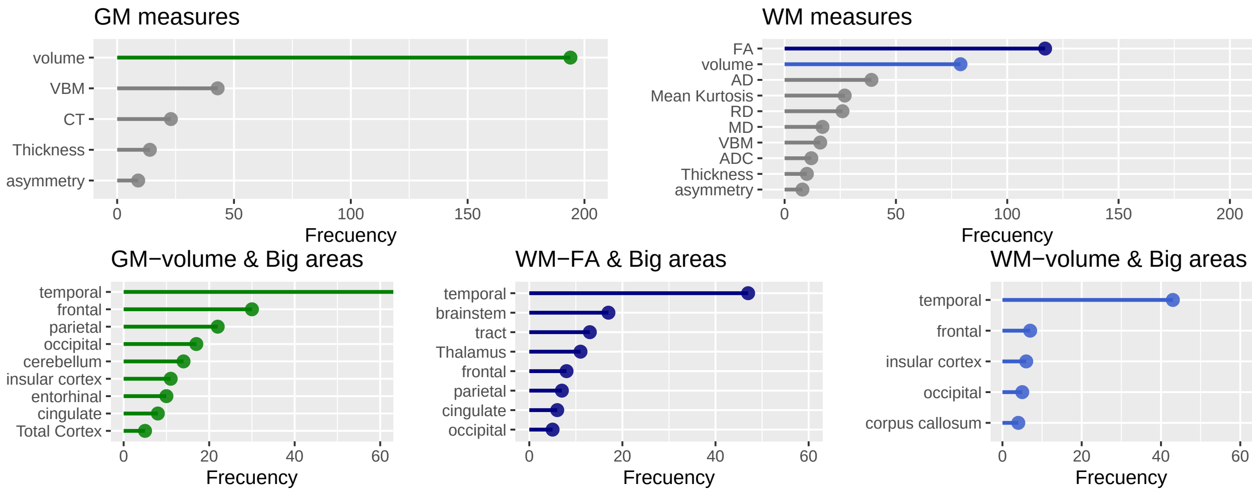


Brain structure (GM, WM) by MRI measure (volume) and ROI

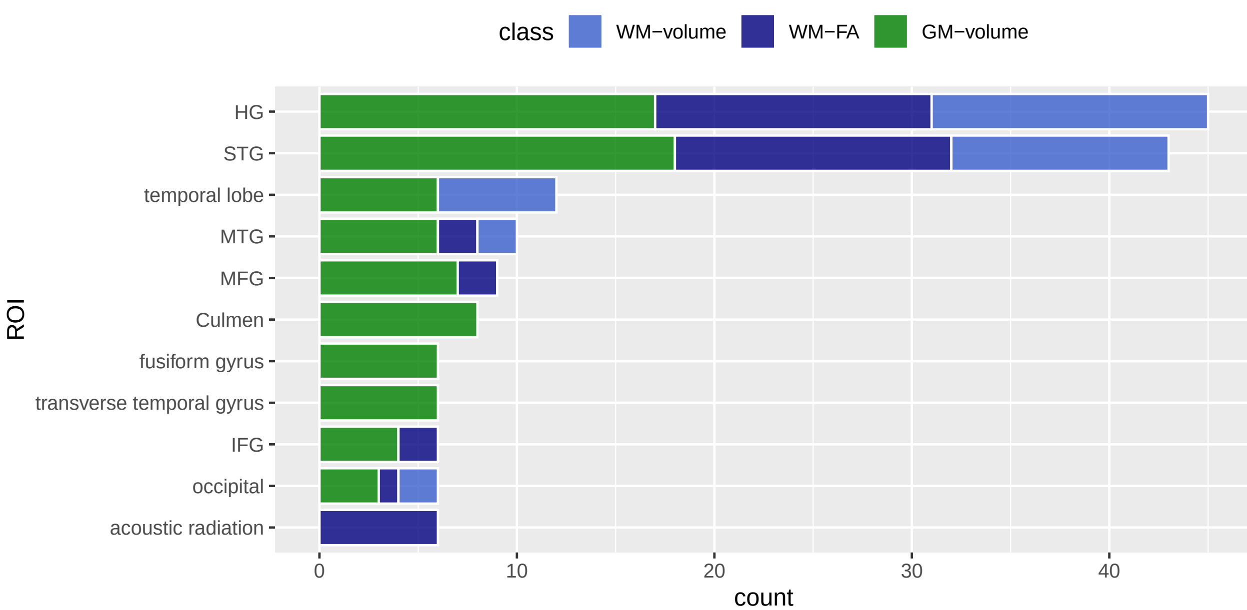




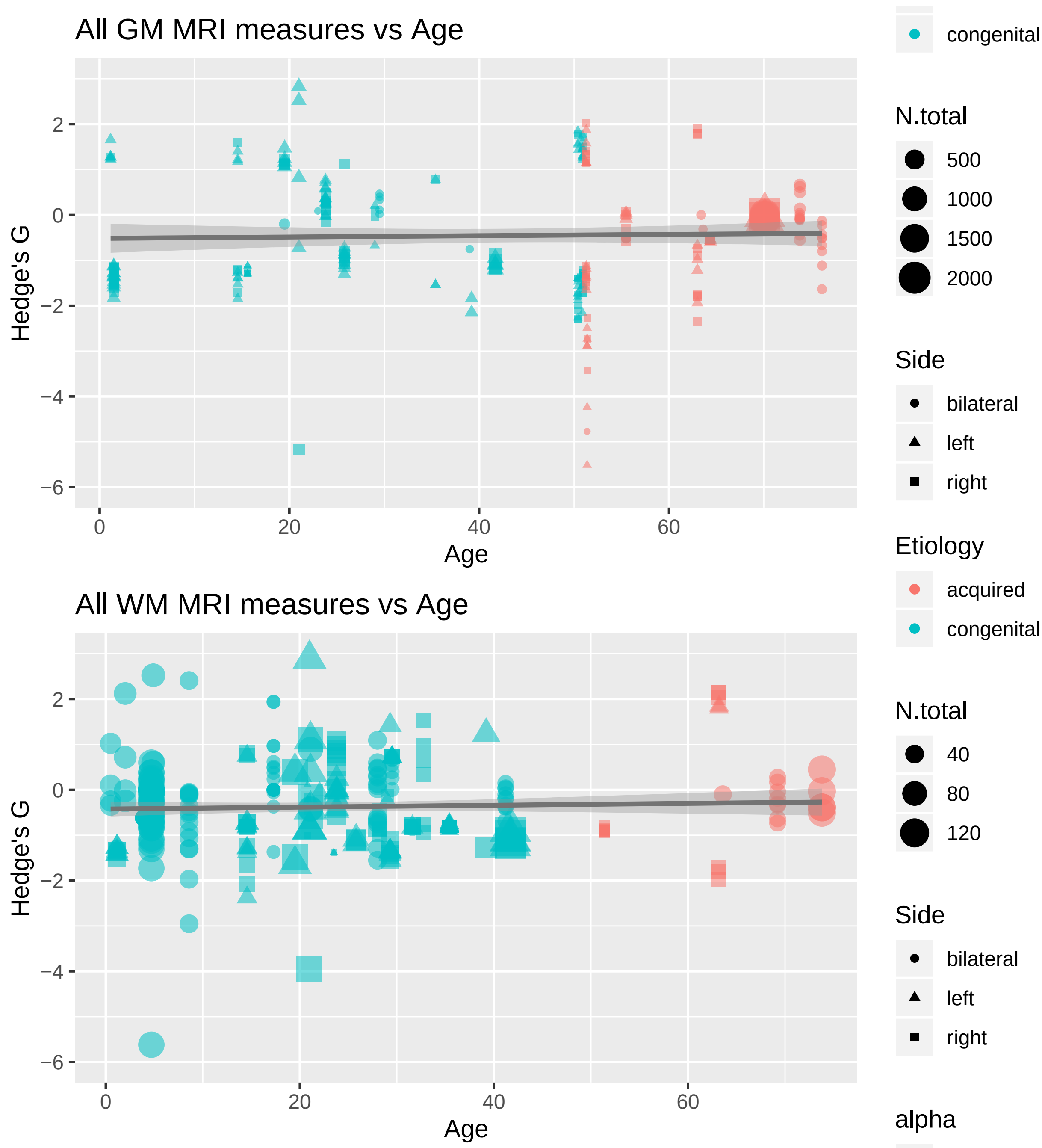
Studies characteristics (Figure 2.A, 2.B): Brain structure (GM, WM) by MRI measure (volume and FA)



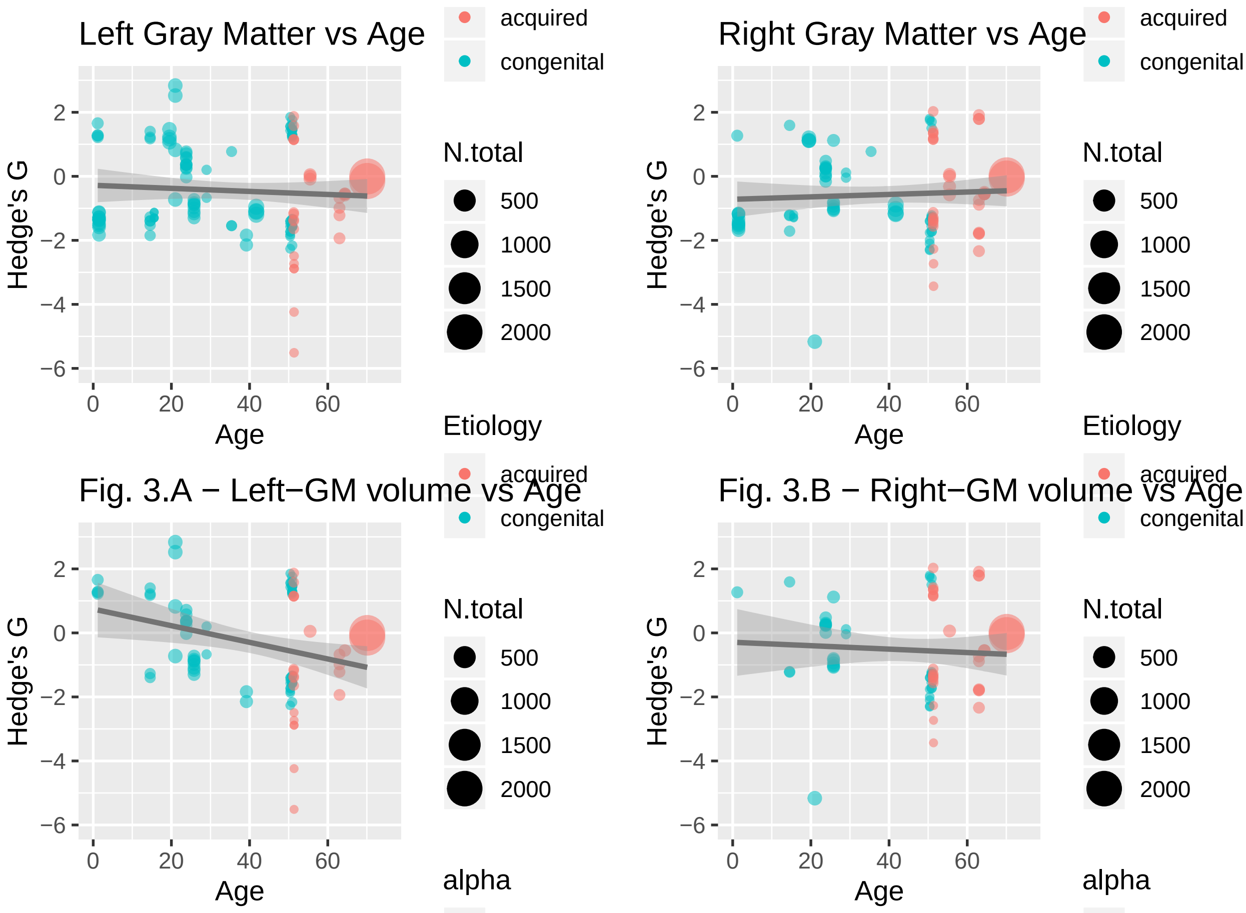
MRI measures by ROI (Figure 2.C)



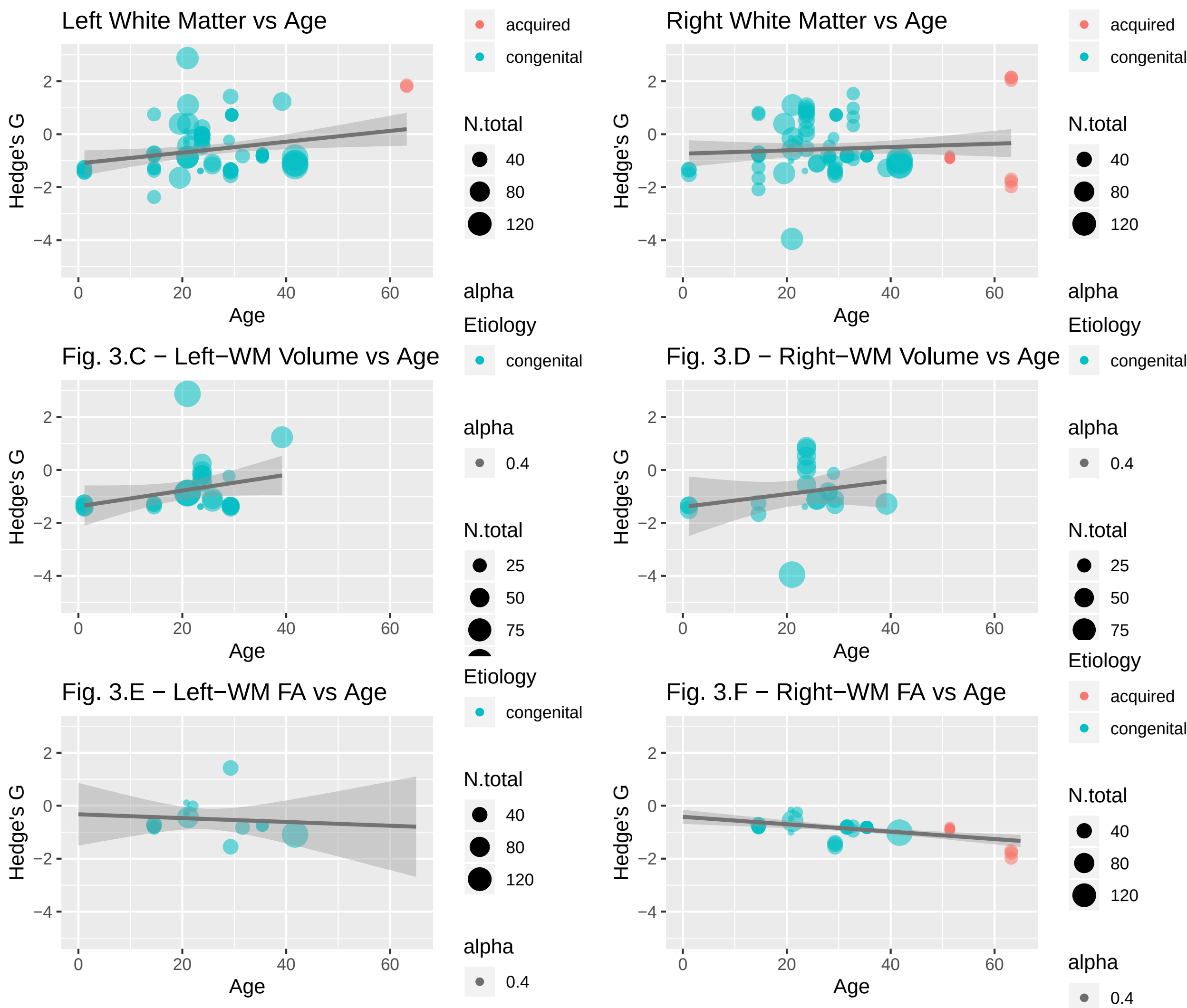
Relations of all MRI measurements of GM and WM with age



Gray matter relation with Age by volume (Figures 3.A and 3.B)



White matter relation with Age by volume and FA (Figures 3.C, 3.D and 3.F)



Gray and White matter relation with Age by asymmetry

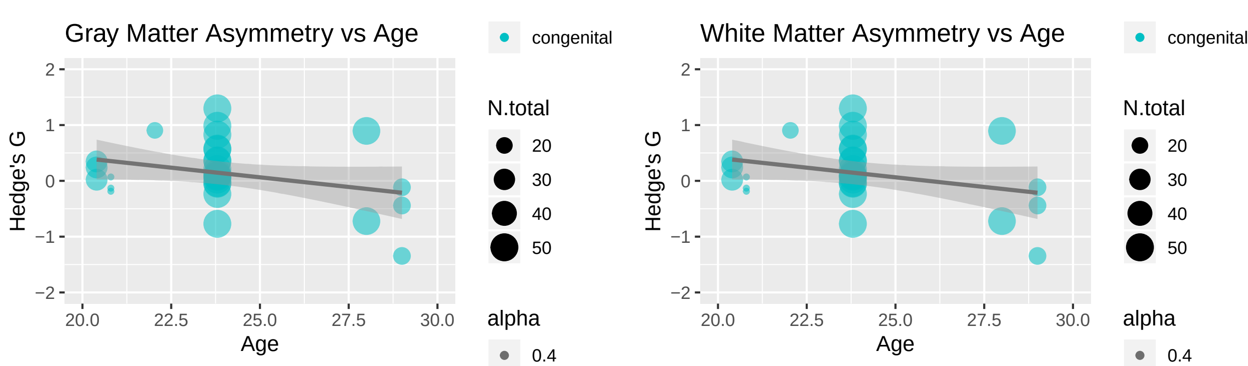
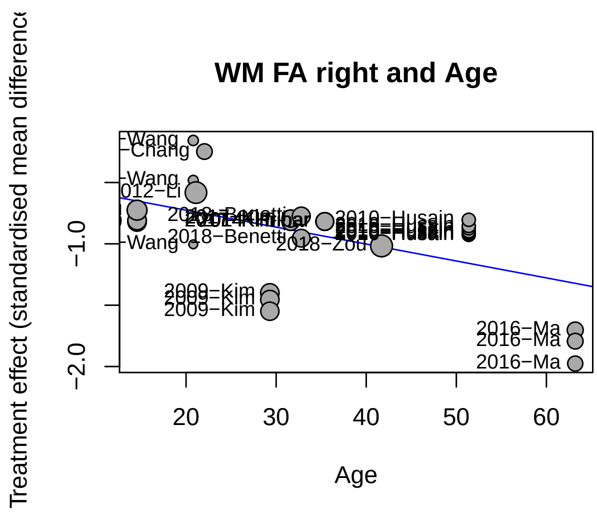
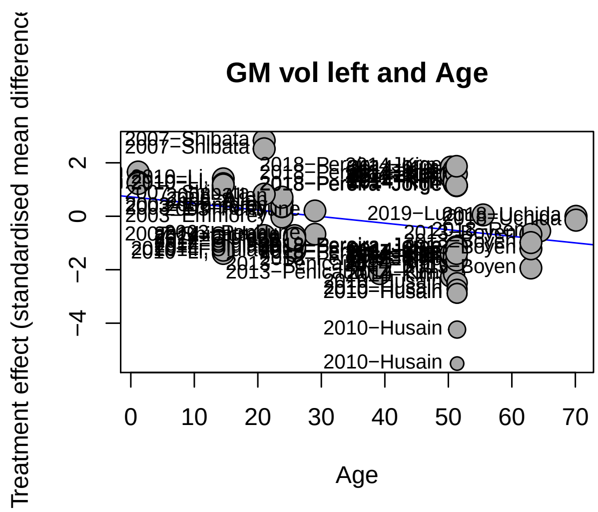


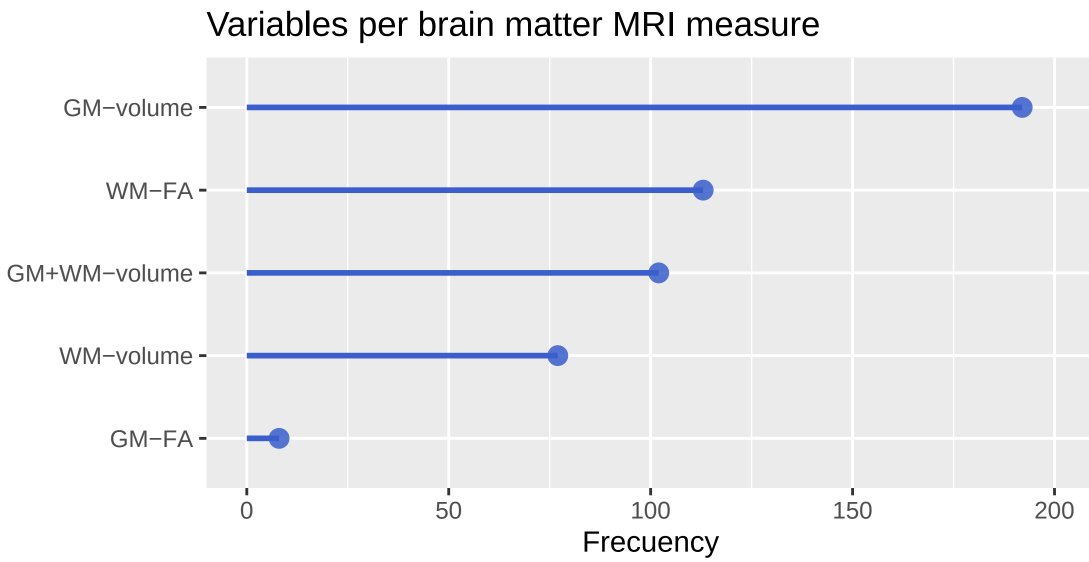
Table of estimates and meta-regression: WM and GM relation with age by MRI measures (volume and FA)

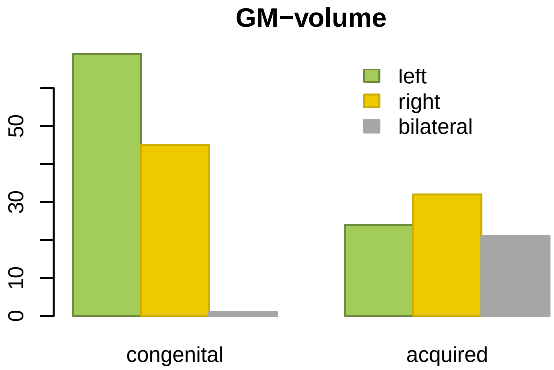
Model	r	p-value	t.stat	df
GM.vol.L	-0.27	0.0103	-2.62	85
WM.vol.L	0.26	0.1687	1.41	28
WM.fa.L	-0.09	0.7393	-0.34	13
GM.vol.R	-0.07	0.5343	-0.62	69
WM.vol.R	0.23	0.316	1.03	19
WM.fa.R	-0.55	2e-04	-4.04	38

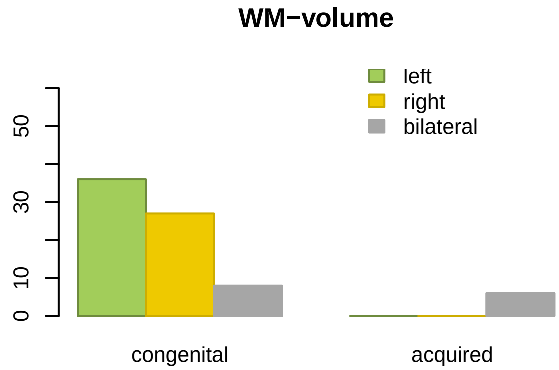


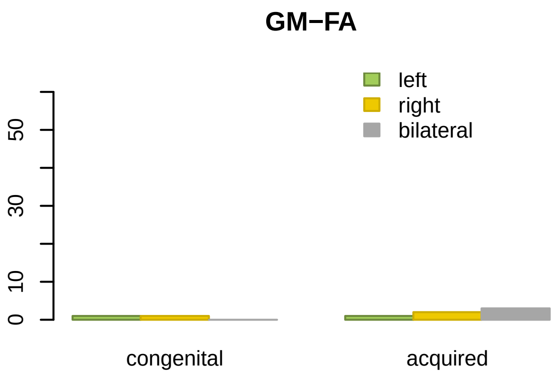


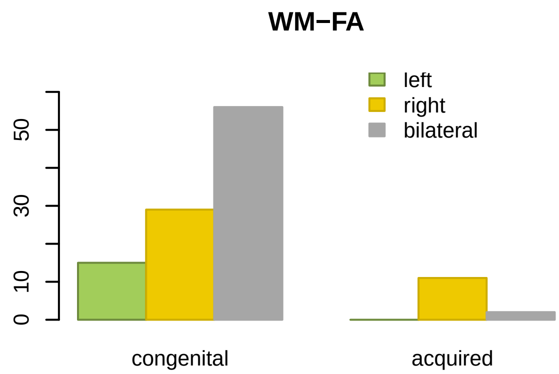
Meta-regression: Variables by Etiology, Brain matter and MRI measure

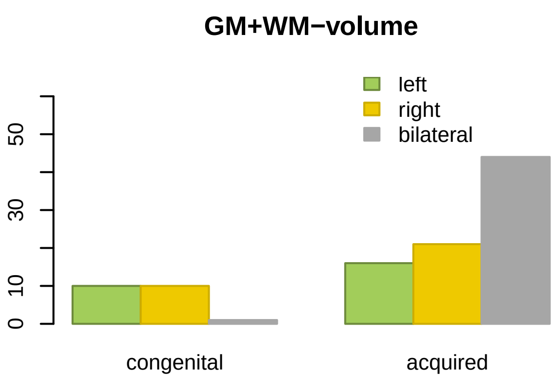












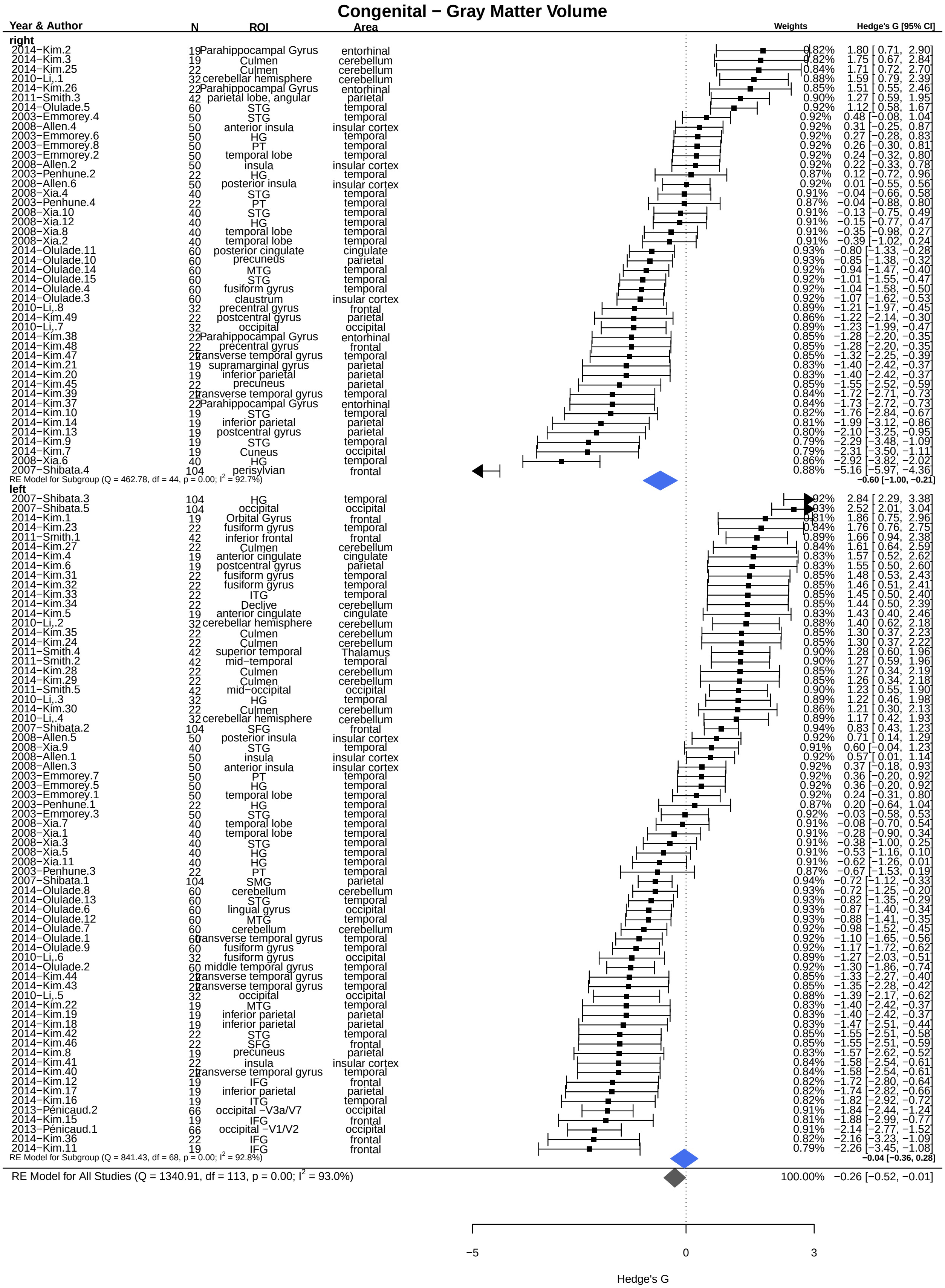
Gray Matter Volume: Random effects model no intercept covariated by Big area

Table 11: Table continues below

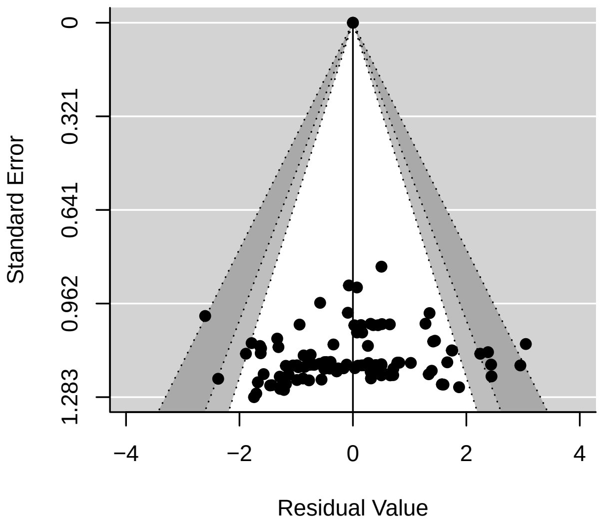
	HedgeG	se	zval	ci.lo	ci.up
left cerebellum	0.9013	0.3735	2.413	0.1693	1.633
left cingulate	1.5	0.9037	1.66	-0.2712	3.271
left frontal	-0.588	0.4468	-1.316	-1.464	0.2877
left insular cortex	0.0628	0.6065	0.1035	-1.126	1.252
left occipital	-0.5252	0.4567	-1.15	-1.42	0.3699
left parietal	-0.8875	0.5149	-1.724	-1.897	0.1217
left temporal	-0.116	0.2235	-0.5189	-0.554	0.3221
left Thalamus	1.282	1.213	1.056	-1.097	3.66
right cerebellum	1.682	0.7284	2.309	0.254	3.109

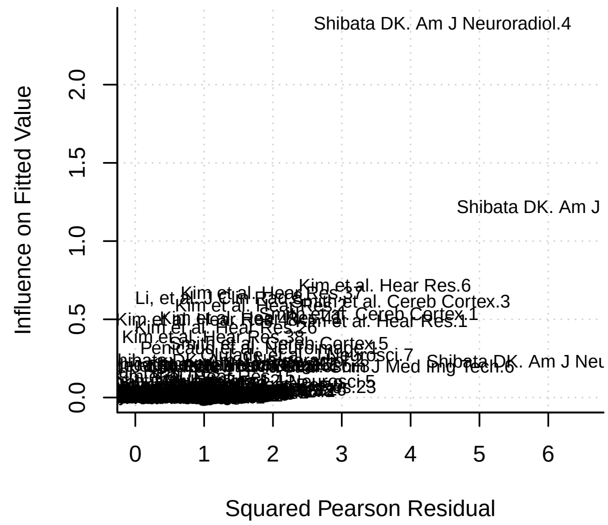
	HedgeG	se	zval	ci.lo	ci.up
right cingulate	-0.8018	1.193	-0.6721	-3.14	1.536
right entorhinal	0.05865	0.6339	0.09251	-1.184	1.301
right frontal	-2.559	0.7143	-3.583	-3.959	-1.159
right insular cortex	-0.1339	0.598	-0.2239	-1.306	1.038
right occipital	-1.73	0.8957	-1.932	-3.486	0.02545
right parietal	-1.113	0.4445	-2.503	-1.984	-0.2413
right temporal	-0.5427	0.2729	-1.989	-1.078	-0.007815

	pval	N
left cerebellum	0.01581	11
left cingulate	0.09694	2
left frontal	0.1882	8
left insular cortex	0.9175	4
left occipital	0.2502	7
left parietal	0.08478	6
left temporal	0.6039	30
left Thalamus	0.2909	1
right cerebellum	0.02096	3
right cingulate	0.5015	1
right entorhinal	0.9263	4
right frontal	0.0003399	3
right insular cortex	0.8228	4
right occipital	0.05341	2
right parietal	0.01233	8
right temporal	0.04675	20

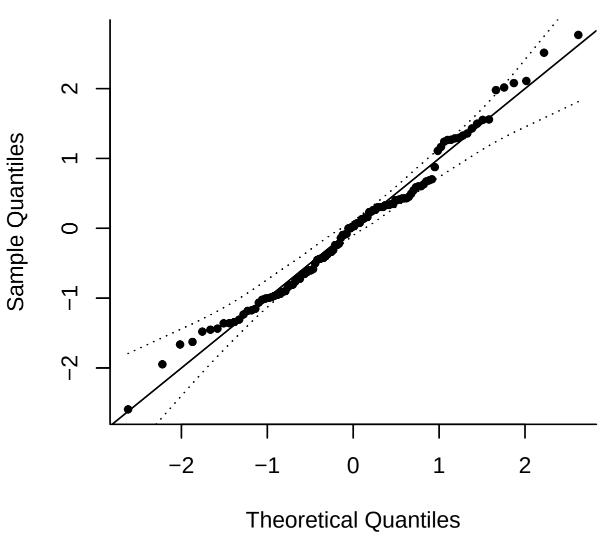


Congenital − Gray Matter Volume
Year & Author N ROI Area Weights Hedge's G [95% CI]
right
2014−Kim.2 19 Parahippocampal Gyrus entorhinal 0.82% 1.80 [0.71, 2.90]
2014−Kim.3 19 Culmen cerebellum 0.82% 1.75 [0.67, 2.84]
2014−Kim.25 22 Culmen cerebellum 0.84% 1.71 [0.72, 2.70]
2010−Li,.1 32 cerebellar hemisphere cerebellum 0.88% 1.59 [0.79, 2.39]
2014−Kim.26 22 Parahippocampal Gyrus entorhinal 0.85% 1.51 [0.55, 2.46]
2011−Smith.3 42 parietal lobe, angular parietal 0.90% 1.27 [0.59, 1.95]
2014−Olulade.5 60 STG temporal 0.92% 1.12 [0.58, 1.67]
2003−Emmorey.4 50 STG temporal 0.92% 0.48 [−0.08, 1.04]
2008−Allen.4 50 anterior insula insular cortex 0.92% 0.31 [−0.25, 0.87]
2003−Emmorey.6 50 HG temporal 0.92% 0.27 [−0.28, 0.83]
2003−Emmorey.8 50 PT temporal 0.92% 0.26 [−0.30, 0.81]
2003−Emmorey.2 50 temporal lobe temporal 0.92% 0.24 [−0.32, 0.80]
2008−Allen.2 50 insula insular cortex 0.92% 0.22 [−0.33, 0.78]
2003−Penhune.2 22 HG temporal 0.87% 0.12 [−0.72, 0.96]
2008−Allen.6 50 posterior insula insular cortex 0.92% 0.01 [−0.55, 0.56]
2008−Xia.4 40 STG temporal 0.91% −0.04 [−0.66, 0.58]
2003−Penhune.4 22 PT temporal 0.87% −0.04 [−0.88, 0.80]
2008−Xia.10 40 STG temporal 0.91% −0.13 [−0.75, 0.49]
2008−Xia.12 40 HG temporal 0.91% −0.15 [−0.77, 0.47]
2008−Xia.8 40 temporal lobe temporal 0.91% −0.35 [−0.98, 0.27]
2008−Xia.2 40 temporal lobe temporal 0.91% −0.39 [−1.02, 0.24]
2014−Olulade.11 60 posterior cingulate cingulate 0.93% −0.80 [−1.33, −0.28]
2014−Olulade.10 60 precuneus parietal 0.93% −0.85 [−1.38, −0.32]
2014−Olulade.14 60 MTG temporal 0.92% −0.94 [−1.47, −0.40]
2014−Olulade.15 60 STG temporal 0.92% −1.01 [−1.55, −0.47]
2014−Olulade.4 60 fusiform gyrus temporal 0.92% −1.04 [−1.58, −0.50]
2014−Olulade.3 60 claustrum insular cortex 0.92% −1.07 [−1.62, −0.53]
2010−Li,.8 32 precentral gyrus frontal 0.89% −1.21 [−1.97, −0.45]
2014−Kim.49 22 postcentral gyrus parietal 0.86% −1.22 [−2.14, −0.30]
2010−Li,.7 32 occipital occipital 0.89% −1.23 [−1.99, −0.47]
2014−Kim.38 22 Parahippocampal Gyrus entorhinal 0.85% −1.28 [−2.20, −0.35]
2014−Kim.48 22 precentral gyrus frontal 0.85% −1.28 [−2.20, −0.35]
2014−Kim.47 22 transverse temporal gyrus temporal 0.85% −1.32 [−2.25, −0.39]
2014−Kim.21 19 supramarginal gyrus parietal 0.83% −1.40 [−2.42, −0.37]
2014−Kim.20 19 inferior parietal parietal 0.83% −1.40 [−2.42, −0.37]
2014−Kim.45 22 precuneus parietal 0.85% −1.55 [−2.52, −0.59]
2014−Kim.39 22 transverse temporal gyrus temporal 0.84% −1.72 [−2.71, −0.73]
2014−Kim.37 22 Parahippocampal Gyrus entorhinal 0.84% −1.73 [−2.72, −0.73]
2014−Kim.10 19 STG temporal 0.82% −1.76 [−2.84, −0.67]
2014−Kim.14 19 inferior parietal parietal 0.81% −1.99 [−3.12, −0.86]
2014−Kim.13 19 postcentral gyrus parietal 0.80% −2.10 [−3.25, −0.95]
2014−Kim.9 19 STG temporal 0.79% −2.29 [−3.48, −1.09]
2014−Kim.7 19 Cuneus occipital 0.79% −2.31 [−3.50, −1.11]
2008−Xia.6 40 HG temporal 0.86% −2.92 [−3.82, −2.02]
2007−Shibata.4 104 perisylvian frontal 0.88% −5.16 [−5.97, −4.36]
RE Model for Subgroup (Q = 462.78, df = 44, p = 0.00; I² = 92.7%) −0.60 [−1.00, −0.21]
left
2007−Shibata.3 104 HG temporal 0.92% 2.84 [2.29, 3.38]
2007−Shibata.5 104 occipital occipital 0.93% 2.52 [2.01, 3.04]
2014−Kim.1 19 Orbital Gyrus frontal 0.81% 1.86 [0.75, 2.96]
2014−Kim.23 22 fusiform gyrus temporal 0.84% 1.76 [0.76, 2.75]
2011−Smith.1 42 inferior frontal frontal 0.89% 1.66 [0.94, 2.38]
2014−Kim.27 22 Culmen cerebellum 0.84% 1.61 [0.64, 2.59]
2014−Kim.4 19 anterior cingulate cingulate 0.83% 1.57 [0.52, 2.62]
2014−Kim.6 19 postcentral gyrus parietal 0.83% 1.55 [0.50, 2.60]
2014−Kim.31 22 fusiform gyrus temporal 0.85% 1.48 [0.53, 2.43]
2014−Kim.32 22 fusiform gyrus temporal 0.85% 1.46 [0.51, 2.41]
2014−Kim.33 22 ITG temporal 0.85% 1.45 [0.50, 2.40]
2014−Kim.34 22 Declive cerebellum 0.85% 1.44 [0.50, 2.39]
2014−Kim.5 19 anterior cingulate cingulate 0.83% 1.43 [0.40, 2.46]
2010−Li,.2 32 cerebellar hemisphere cerebellum 0.88% 1.40 [0.62, 2.18]
2014−Kim.35 22 Culmen cerebellum 0.85% 1.30 [0.37, 2.23]
2014−Kim.24 22 Culmen cerebellum 0.85% 1.30 [0.37, 2.22]
2011−Smith.4 42 superior temporal Thalamus 0.90% 1.28 [0.60, 1.96]
2011−Smith.2 42 mid−temporal temporal 0.90% 1.27 [0.59, 1.96]
2014−Kim.28 22 Culmen cerebellum 0.85% 1.27 [0.34, 2.19]
2014−Kim.29 22 Culmen cerebellum 0.85% 1.26 [0.34, 2.18]
2011−Smith.5 42 mid−occipital occipital 0.90% 1.23 [0.55, 1.90]
2010−Li,.3 32 HG temporal 0.89% 1.22 [0.46, 1.98]
2014−Kim.30 22 Culmen cerebellum 0.86% 1.21 [0.30, 2.13]
2010−Li,.4 32 cerebellar hemisphere cerebellum 0.89% 1.17 [0.42, 1.93]
2007−Shibata.2 104 SFG frontal 0.94% 0.83 [0.43, 1.23]
2008−Allen.5 50 posterior insula insular cortex 0.92% 0.71 [0.14, 1.29]
2008−Xia.9 40 STG temporal 0.91% 0.60 [−0.04, 1.23]
2008−Allen.1 50 insula insular cortex 0.92% 0.57 [0.01, 1.14]
2008−Allen.3 50 anterior insula insular cortex 0.92% 0.37 [−0.18, 0.93]
2003−Emmorey.7 50 PT temporal 0.92% 0.36 [−0.20, 0.92]
2003−Emmorey.5 50 HG temporal 0.92% 0.36 [−0.20, 0.92]
2003−Emmorey.1 50 temporal lobe temporal 0.92% 0.24 [−0.31, 0.80]
2003−Penhune.1 22 HG temporal 0.87% 0.20 [−0.64, 1.04]
2003−Emmorey.3 50 STG temporal 0.92% −0.03 [−0.58, 0.53]
2008−Xia.7 40 temporal lobe temporal 0.91% −0.08 [−0.70, 0.54]
2008−Xia.1 40 temporal lobe temporal 0.91% −0.28 [−0.90, 0.34]
2008−Xia.3 40 STG temporal 0.91% −0.38 [−1.00, 0.25]
2008−Xia.5 40 HG temporal 0.91% −0.53 [−1.16, 0.10]
2008−Xia.11 40 HG temporal 0.91% −0.62 [−1.26, 0.01]
2003−Penhune.3 22 PT temporal 0.87% −0.67 [−1.53, 0.19]
2007−Shibata.1 104 SMG parietal 0.94% −0.72 [−1.12, −0.33]
2014−Olulade.8 60 cerebellum cerebellum 0.93% −0.72 [−1.25, −0.20]
2014−Olulade.13 60 STG temporal 0.93% −0.82 [−1.35, −0.29]
2014−Olulade.6 60 lingual gyrus occipital 0.93% −0.87 [−1.40, −0.34]
2014−Olulade.12 60 MTG temporal 0.93% −0.88 [−1.41, −0.35]
2014−Olulade.7 60 cerebellum cerebellum 0.92% −0.98 [−1.52, −0.45]
2014−Olulade.1 60 transverse temporal gyrus temporal 0.92% −1.10 [−1.65, −0.56]
2014−Olulade.9 60 fusiform gyrus temporal 0.92% −1.17 [−1.72, −0.62]
2010−Li,.6 32 fusiform gyrus occipital 0.89% −1.27 [−2.03, −0.51]
2014−Olulade.2 60 middle temporal gyrus temporal 0.92% −1.30 [−1.86, −0.74]
2014−Kim.44 22 transverse temporal gyrus temporal 0.85% −1.33 [−2.27, −0.40]
2014−Kim.43 22 transverse temporal gyrus temporal 0.85% −1.35 [−2.28, −0.42]
2010−Li,.5 32 occipital occipital 0.88% −1.39 [−2.17, −0.62]
2014−Kim.22 19 MTG temporal 0.83% −1.40 [−2.42, −0.37]
2014−Kim.19 19 inferior parietal parietal 0.83% −1.40 [−2.42, −0.37]
2014−Kim.18 19 inferior parietal parietal 0.83% −1.47 [−2.51, −0.44]
2014−Kim.42 22 STG temporal 0.85% −1.55 [−2.51, −0.58]
2014−Kim.46 22 SFG frontal 0.85% −1.55 [−2.51, −0.59]
2014−Kim.8 19 precuneus parietal 0.83% −1.57 [−2.62, −0.52]
2014−Kim.41 22 insula insular cortex 0.84% −1.58 [−2.54, −0.61]
2014−Kim.40 22 transverse temporal gyrus temporal 0.84% −1.58 [−2.54, −0.61]
2014−Kim.12 19 IFG frontal 0.82% −1.72 [−2.80, −0.64]
2014−Kim.17 19 inferior parietal parietal 0.82% −1.74 [−2.82, −0.66]
2014−Kim.16 19 ITG temporal 0.82% −1.82 [−2.92, −0.72]
2013−Pénicaud.2 66 occipital −V3a/V7 occipital 0.91% −1.84 [−2.44, −1.24]
2014−Kim.15 19 IFG frontal 0.81% −1.88 [−2.99, −0.77]
2013−Pénicaud.1 66 occipital −V1/V2 occipital 0.91% −2.14 [−2.77, −1.52]
2014−Kim.36 22 IFG frontal 0.82% −2.16 [−3.23, −1.09]
2014−Kim.11 19 IFG frontal 0.79% −2.26 [−3.45, −1.08]
RE Model for Subgroup (Q = 841.43, df = 68, p = 0.00; I² = 92.8%) −0.04 [−0.36, 0.28]
RE Model for All Studies (Q = 1340.91, df = 113, p = 0.00; I² = 93.0%) 100.00% −0.26 [−0.52, −0.01]
−5
0
3
Hedge's G





Congenital − GM Volume



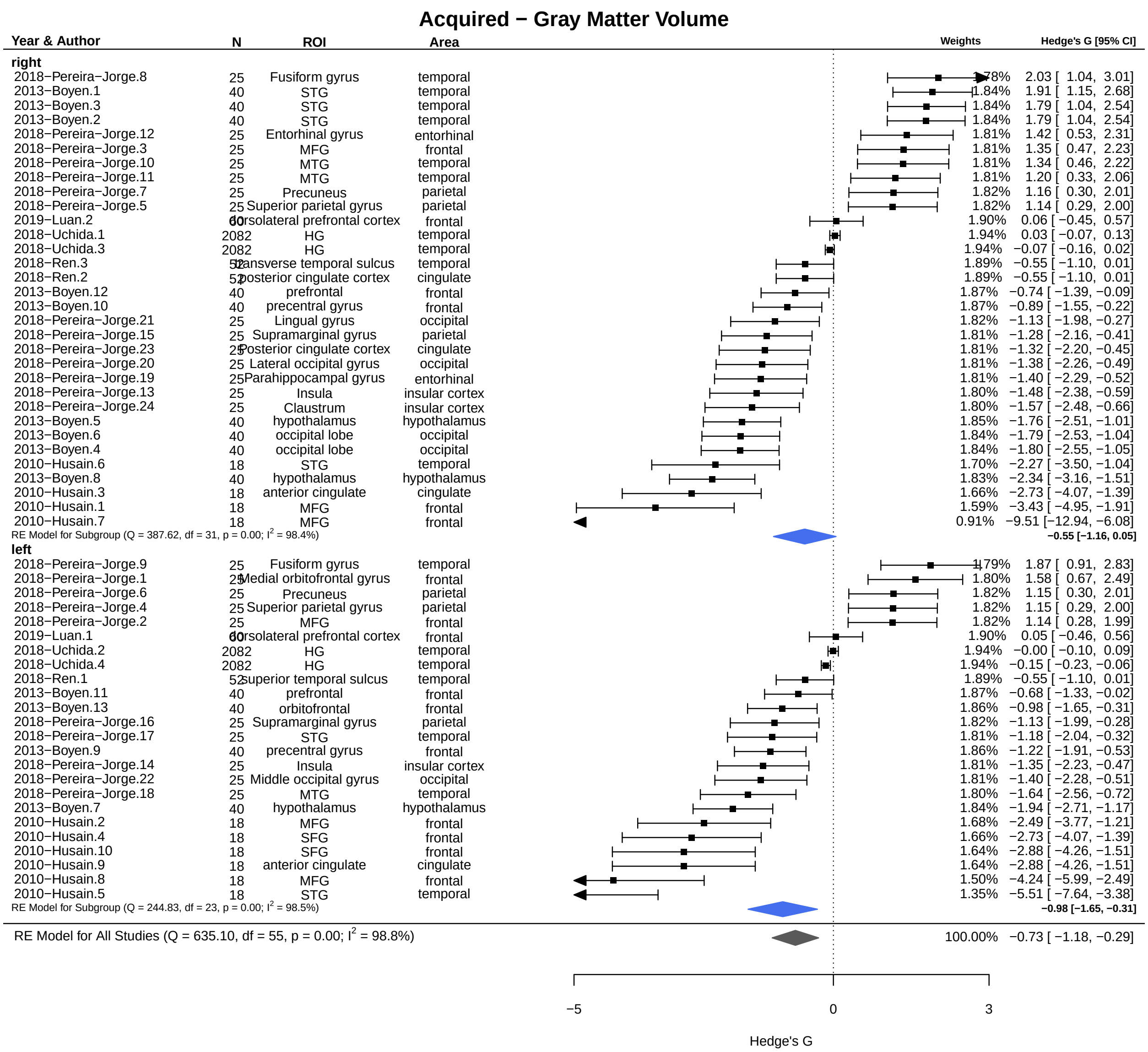
ACQUIRED - Meta-regressions of Gray Matter by Volume

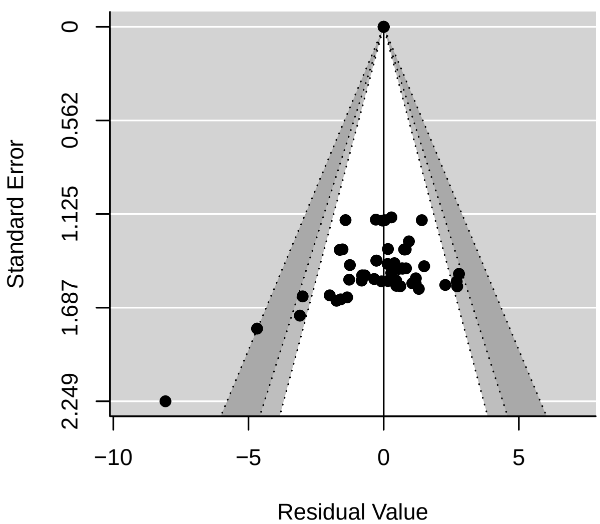
Random effects model no intercept covariated by Big area

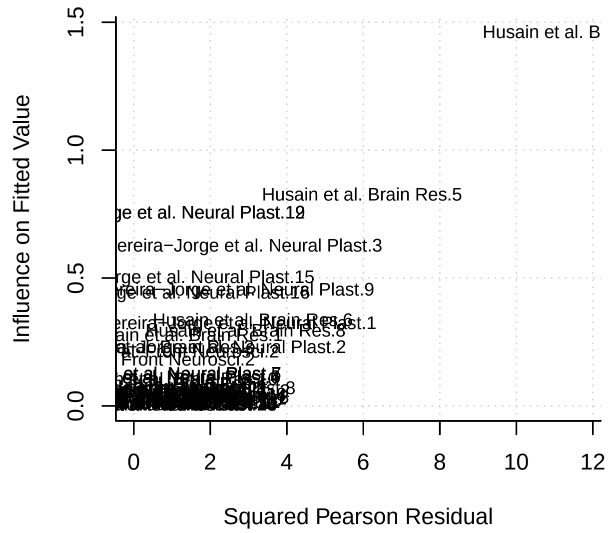
Table 13: Table continues below

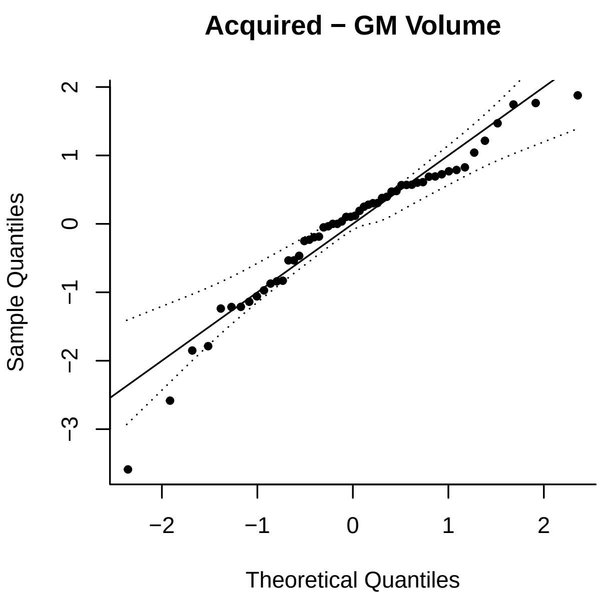
	HedgeG	se	zval	ci.lo	ci.up
left cingulate	-2.883	1.728	-1.669	-6.269	0.5024
left frontal	-1.14	0.5268	-2.164	-2.173	-0.1076
left hypothalamus	-1.937	1.626	-1.191	-5.124	1.25
left insular cortex	-1.353	1.641	-0.8248	-4.57	1.863
left occipital	-1.398	1.642	-0.8514	-4.616	1.82
left parietal	0.3896	0.9454	0.4121	-1.463	2.243
left temporal	-0.8302	0.6236	-1.331	-2.052	0.3921
right cingulate	-1.483	0.954	-1.554	-3.352	0.3872
right entorhinal	0.007072	1.161	0.006091	-2.269	2.283
right frontal	-1.438	0.7012	-2.05	-2.812	-0.06331
right hypothalamus	-2.047	1.151	-1.778	-4.304	0.2095
right insular cortex	-1.525	1.163	-1.311	-3.803	0.7542
right occipital	-1.524	0.8158	-1.868	-3.123	0.07522
right parietal	0.3405	0.9459	0.36	-1.513	2.194
right temporal	0.727	0.5141	1.414	-0.2806	1.735

	pval	N
left cingulate	0.09509	1
left frontal	0.03045	10
left hypothalamus	0.2335	1
left insular cortex	0.4095	1
left occipital	0.3945	1
left parietal	0.6803	3
left temporal	0.1831	7
right cingulate	0.1202	3
right entorhinal	0.9951	2
right frontal	0.04034	6
right hypothalamus	0.0754	2
right insular cortex	0.1898	2
right occipital	0.0618	4
right parietal	0.7189	3
right temporal	0.1573	10









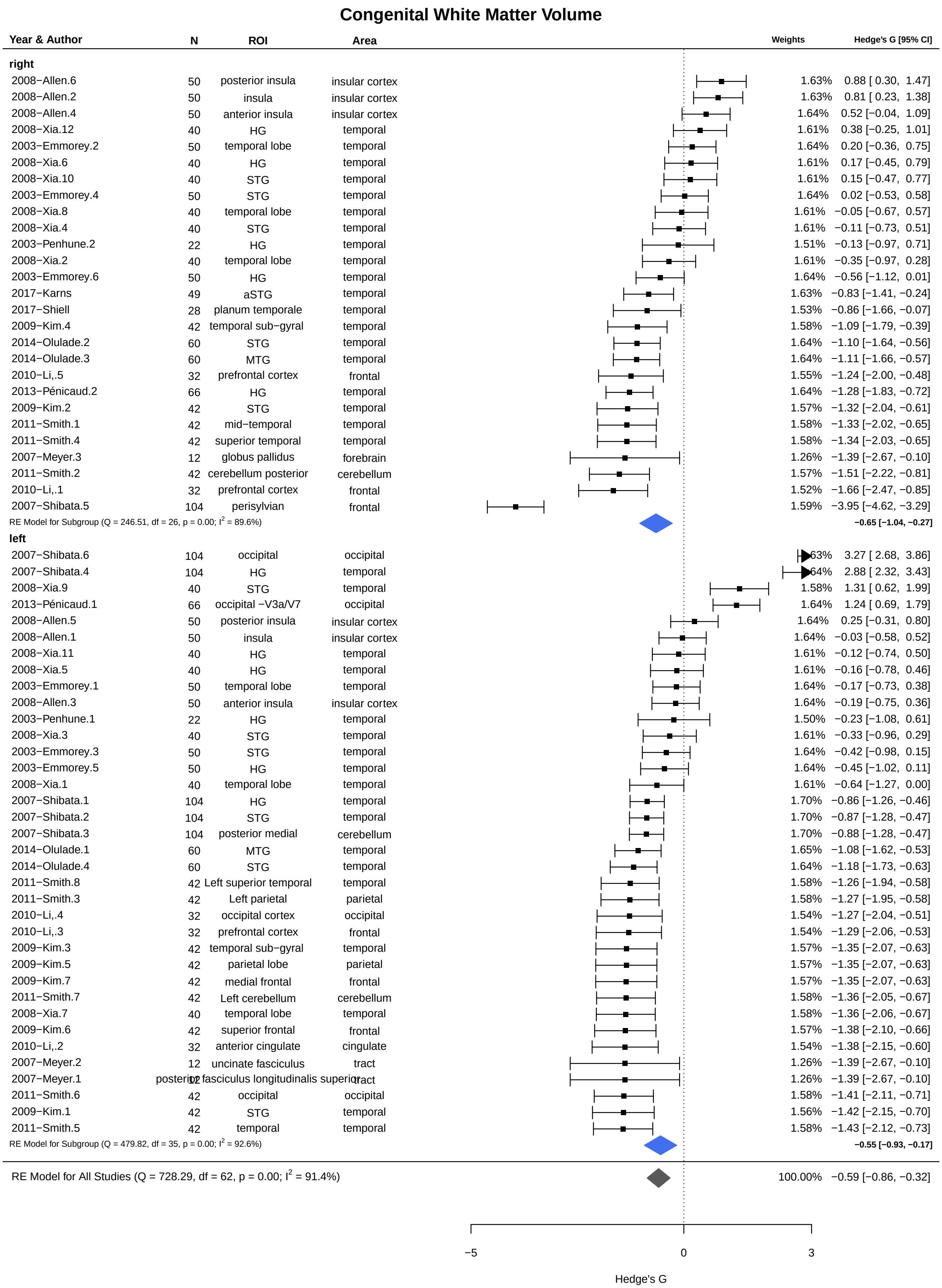
CONGENITAL - White Matter by VOLUME

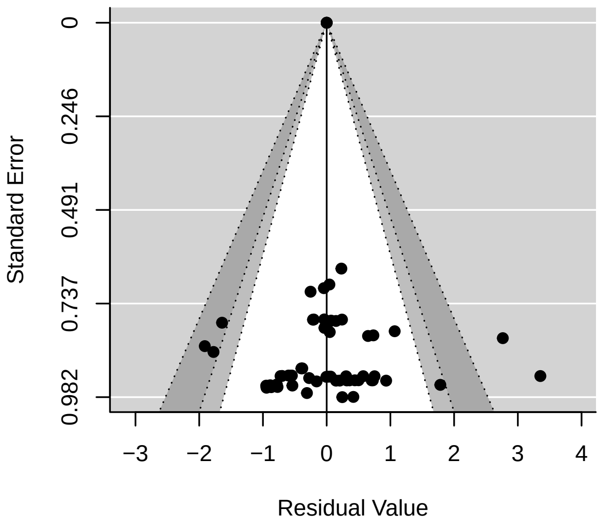
Random effects model no intercept covariated by Big area

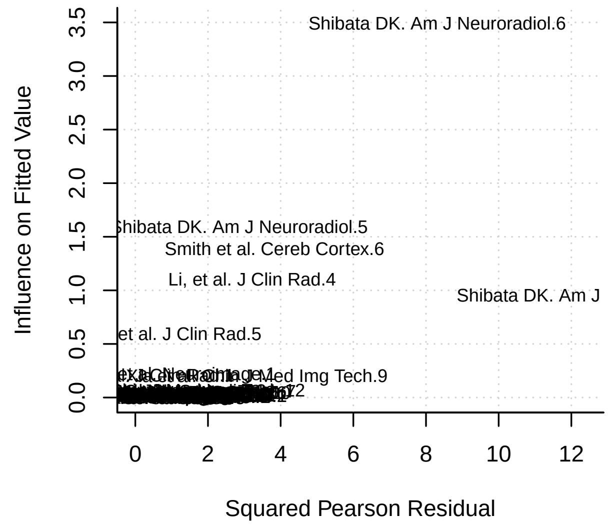
Table 15: Table continues below

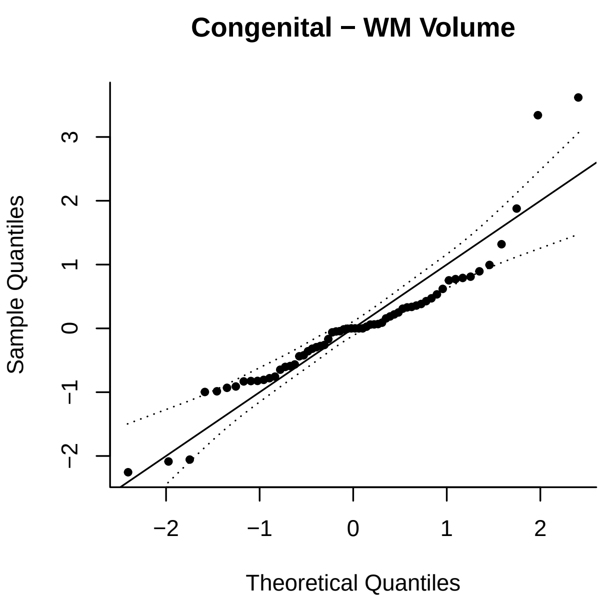
	HedgeG	se	zval	ci.lo	ci.up
left cerebellum	-1.107	0.6745	-1.641	-2.429	0.2149
left cingulate	-1.379	0.9926	-1.389	-3.324	0.5668
left frontal	-1.34	0.5684	-2.358	-2.454	-0.2262
left insular cortex	0.007913	0.5504	0.01438	-1.071	1.087
left occipital	0.5024	0.4846	1.037	-0.4475	1.452
left parietal	-1.308	0.6914	-1.892	-2.663	0.04705
left temporal	-0.478	0.2211	-2.163	-0.9113	-0.04478
left tract	-1.386	0.7931	-1.747	-2.94	0.1688
right cerebellum	-1.513	0.9789	-1.546	-3.432	0.4051
right forebrain	-1.386	1.122	-1.235	-3.584	0.8126
right frontal	-2.31	0.5697	-4.055	-3.426	-1.193
right insular cortex	0.737	0.5521	1.335	-0.3451	1.819
right temporal	-0.5529	0.2218	-2.493	-0.9875	-0.1183

	pval	N
left cerebellum	0.1007	2
left cingulate	0.1649	1
left frontal	0.01838	3
left insular cortex	0.9885	3
left occipital	0.2999	4
left parietal	0.0585	2
left temporal	0.03058	19
left tract	0.08061	2
right cerebellum	0.1221	1
right forebrain	0.2167	1
right frontal	5.021e-05	3
right insular cortex	0.1819	3
right temporal	0.01266	19


Congenital White Matter Volume
Year & Author N ROI Area Weights Hedge's G [95% CI]
right
2008−Allen.6 50 posterior insula insular cortex 1.63% 0.88 [0.30, 1.47]
2008−Allen.2 50 insula insular cortex 1.63% 0.81 [0.23, 1.38]
2008−Allen.4 50 anterior insula insular cortex 1.64% 0.52 [−0.04, 1.09]
2008−Xia.12 40 HG temporal 1.61% 0.38 [−0.25, 1.01]
2003−Emmorey.2 50 temporal lobe temporal 1.64% 0.20 [−0.36, 0.75]
2008−Xia.6 40 HG temporal 1.61% 0.17 [−0.45, 0.79]
2008−Xia.10 40 STG temporal 1.61% 0.15 [−0.47, 0.77]
2003−Emmorey.4 50 STG temporal 1.64% 0.02 [−0.53, 0.58]
2008−Xia.8 40 temporal lobe temporal 1.61% −0.05 [−0.67, 0.57]
2008−Xia.4 40 STG temporal 1.61% −0.11 [−0.73, 0.51]
2003−Penhune.2 22 HG temporal 1.51% −0.13 [−0.97, 0.71]
2008−Xia.2 40 temporal lobe temporal 1.61% −0.35 [−0.97, 0.28]
2003−Emmorey.6 50 HG temporal 1.64% −0.56 [−1.12, 0.01]
2017−Karns 49 aSTG temporal 1.63% −0.83 [−1.41, −0.24]
2017−Shiell 28 planum temporale temporal 1.53% −0.86 [−1.66, −0.07]
2009−Kim.4 42 temporal sub−gyral temporal 1.58% −1.09 [−1.79, −0.39]
2014−Olulade.2 60 STG temporal 1.64% −1.10 [−1.64, −0.56]
2014−Olulade.3 60 MTG temporal 1.64% −1.11 [−1.66, −0.57]
2010−Li,.5 32 prefrontal cortex frontal 1.55% −1.24 [−2.00, −0.48]
2013−Pénicaud.2 66 HG temporal 1.64% −1.28 [−1.83, −0.72]
2009−Kim.2 42 STG temporal 1.57% −1.32 [−2.04, −0.61]
2011−Smith.1 42 mid−temporal temporal 1.58% −1.33 [−2.02, −0.65]
2011−Smith.4 42 superior temporal temporal 1.58% −1.34 [−2.03, −0.65]
2007−Meyer.3 12 globus pallidus forebrain 1.26% −1.39 [−2.67, −0.10]
2011−Smith.2 42 cerebellum posterior cerebellum 1.57% −1.51 [−2.22, −0.81]
2010−Li,.1 32 prefrontal cortex frontal 1.52% −1.66 [−2.47, −0.85]
2007−Shibata.5 104 perisylvian frontal 1.59% −3.95 [−4.62, −3.29]
RE Model for Subgroup (Q = 246.51, df = 26, p = 0.00; I2 = 89.6%) −0.65 [−1.04, −0.27]
left
2007−Shibata.6 104 occipital occipital 63% 3.27 [2.68, 3.86]
2007−Shibata.4 104 HG temporal 64% 2.88 [2.32, 3.43]
2008−Xia.9 40 STG temporal 1.58% 1.31 [0.62, 1.99]
2013−Pénicaud.1 66 occipital −V3a/V7 occipital 1.64% 1.24 [0.69, 1.79]
2008−Allen.5 50 posterior insula insular cortex 1.64% 0.25 [−0.31, 0.80]
2008−Allen.1 50 insula insular cortex 1.64% −0.03 [−0.58, 0.52]
2008−Xia.11 40 HG temporal 1.61% −0.12 [−0.74, 0.50]
2008−Xia.5 40 HG temporal 1.61% −0.16 [−0.78, 0.46]
2003−Emmorey.1 50 temporal lobe temporal 1.64% −0.17 [−0.73, 0.38]
2008−Allen.3 50 anterior insula insular cortex 1.64% −0.19 [−0.75, 0.36]
2003−Penhune.1 22 HG temporal 1.50% −0.23 [−1.08, 0.61]
2008−Xia.3 40 STG temporal 1.61% −0.33 [−0.96, 0.29]
2003−Emmorey.3 50 STG temporal 1.64% −0.42 [−0.98, 0.15]
2003−Emmorey.5 50 HG temporal 1.64% −0.45 [−1.02, 0.11]
2008−Xia.1 40 temporal lobe temporal 1.61% −0.64 [−1.27, 0.00]
2007−Shibata.1 104 HG temporal 1.70% −0.86 [−1.26, −0.46]
2007−Shibata.2 104 STG temporal 1.70% −0.87 [−1.28, −0.47]
2007−Shibata.3 104 posterior medial cerebellum 1.70% −0.88 [−1.28, −0.47]
2014−Olulade.1 60 MTG temporal 1.65% −1.08 [−1.62, −0.53]
2014−Olulade.4 60 STG temporal 1.64% −1.18 [−1.73, −0.63]
2011−Smith.8 42 Left superior temporal temporal 1.58% −1.26 [−1.94, −0.58]
2011−Smith.3 42 Left parietal parietal 1.58% −1.27 [−1.95, −0.58]
2010−Li,.4 32 occipital cortex occipital 1.54% −1.27 [−2.04, −0.51]
2010−Li,.3 32 prefrontal cortex frontal 1.54% −1.29 [−2.06, −0.53]
2009−Kim.3 42 temporal sub−gyral temporal 1.57% −1.35 [−2.07, −0.63]
2009−Kim.5 42 parietal lobe parietal 1.57% −1.35 [−2.07, −0.63]
2009−Kim.7 42 medial frontal frontal 1.57% −1.35 [−2.07, −0.63]
2011−Smith.7 42 Left cerebellum cerebellum 1.58% −1.36 [−2.05, −0.67]
2008−Xia.7 40 temporal lobe temporal 1.58% −1.36 [−2.06, −0.67]
2009−Kim.6 42 superior frontal frontal 1.57% −1.38 [−2.10, −0.66]
2010−Li,.2 32 anterior cingulate cingulate 1.54% −1.38 [−2.15, −0.60]
2007−Meyer.2 12 uncinate fasciculus tract 1.26% −1.39 [−2.67, −0.10]
2007−Meyer.1 12 posterior fasciculus longitudinalis superior tract 1.26% −1.39 [−2.67, −0.10]
2011−Smith.6 42 occipital occipital 1.58% −1.41 [−2.11, −0.71]
2009−Kim.1 42 STG temporal 1.56% −1.42 [−2.15, −0.70]
2011−Smith.5 42 temporal temporal 1.58% −1.43 [−2.12, −0.73]
RE Model for Subgroup (Q = 479.82, df = 35, p = 0.00; I2 = 92.6%) −0.55 [−0.93, −0.17]
RE Model for All Studies (Q = 728.29, df = 62, p = 0.00; I2 = 91.4%) 100.00% −0.59 [−0.86, −0.32]
−5
0
3
Hedge's G

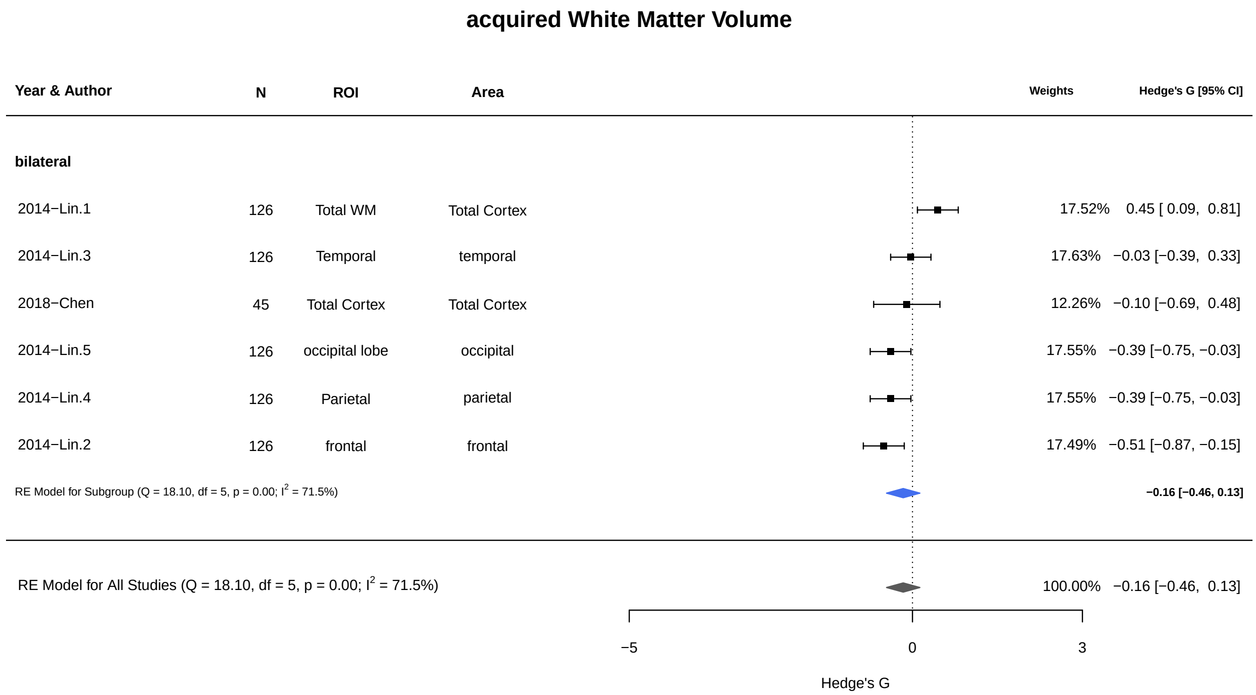






ACQUIRED - White Matter by VOLUME (ONLY BILATERAL)

Not enough values for the Random effects model no intercept covariated by Big area and Side (left or right)



	HedgeG	se	zval	ci.lo	ci.up
bilateral frontal	-0.5069	0.35	-1.448	-1.193	0.1792

bilateral occipital -0.3876 0.3494 -1.109 -1.073 0.2972

bilateral parietal -0.3876 0.3494 -1.109 -1.073 0.2972

bilateral temporal -0.02982 0.3486 -0.08555 -0.713 0.6534

bilateral Total Cortex 0.2239 0.2691 0.8321 -0.3035 0.7514

Table 18: Table continues below

	pval	N
bilateral frontal	0.1476	1
bilateral occipital	0.2673	1
bilateral parietal	0.2673	1
bilateral temporal	0.9318	1
bilateral Total Cortex	0.4053	2

Nothing is significant

CONGENITAL - White Matter by FA fractional anisotropy

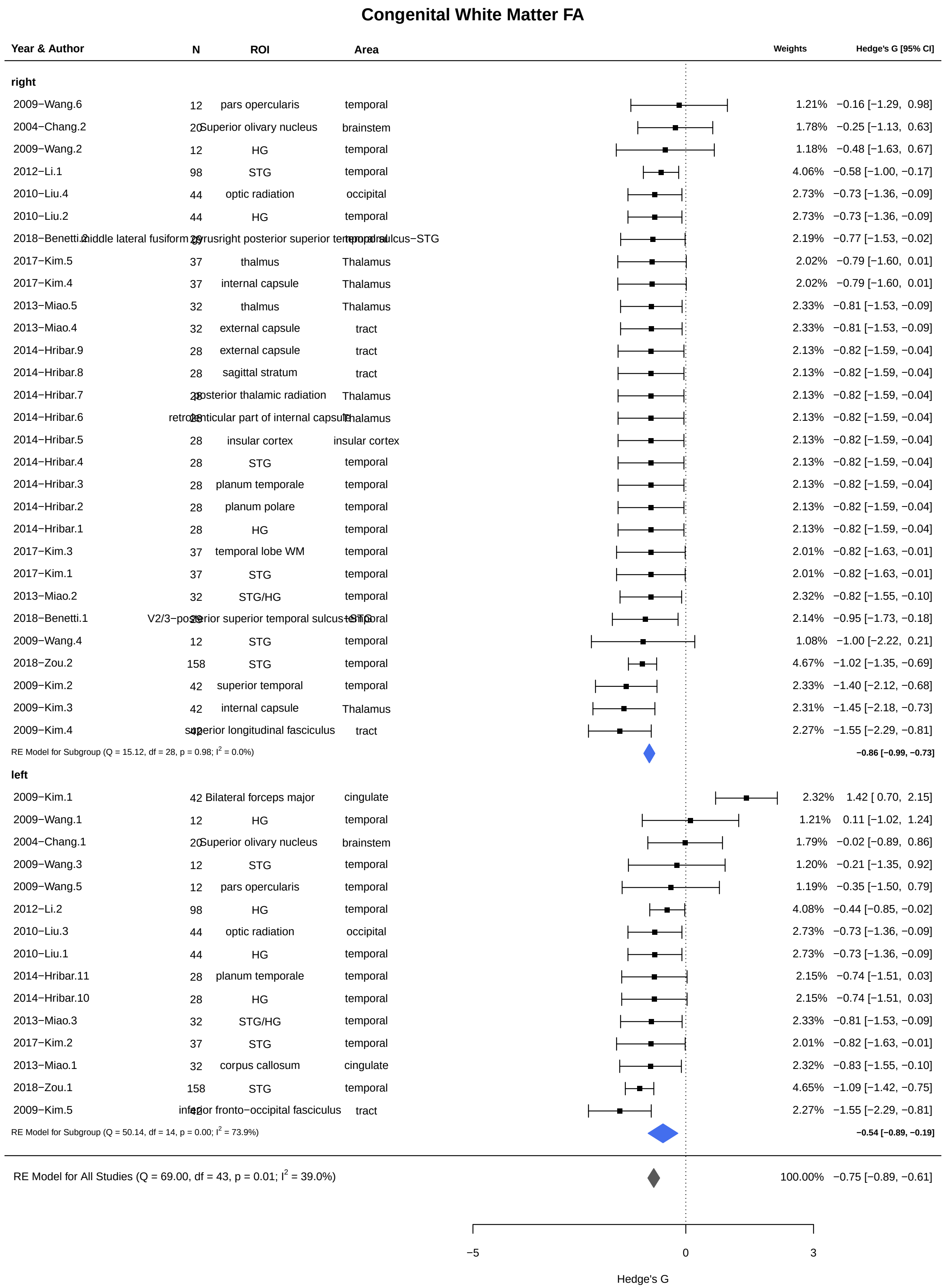
Random effects model no intercept covariated by Big area

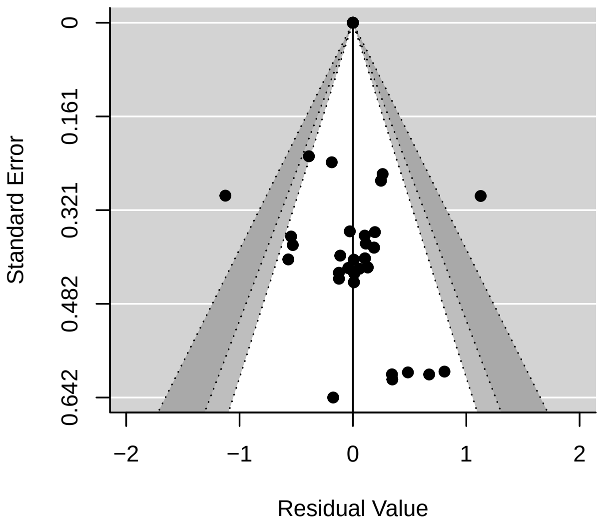
Table 19: Table continues below

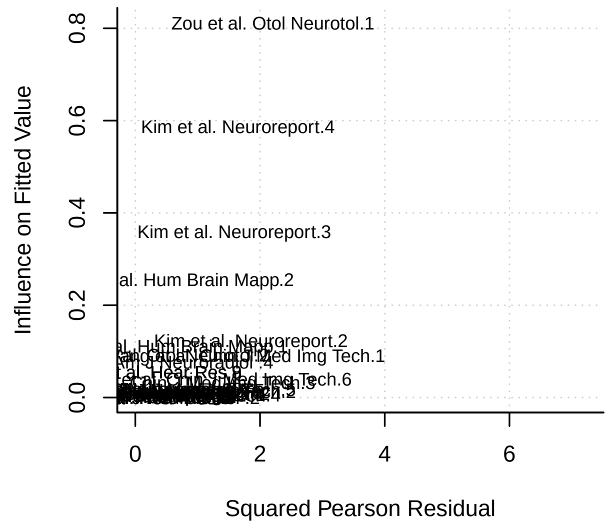
	HedgeG	se	zval	ci.lo	ci.up
left brainstem	-0.01557	0.4891	-0.03183	-0.9742	0.9431
left cingulate	0.297	0.2965	1.002	-0.2841	0.8781
left occipital	-0.7254	0.3791	-1.914	-1.468	0.01755
left temporal	-0.698	0.1265	-5.518	-0.946	-0.4501
left tract	-1.549	0.425	-3.645	-2.382	-0.7163
right brainstem	-0.2476	0.4908	-0.5044	-1.21	0.7145
right insular cortex	-0.8178	0.4415	-1.852	-1.683	0.04759
right occipital	-0.7254	0.3791	-1.914	-1.468	0.01755

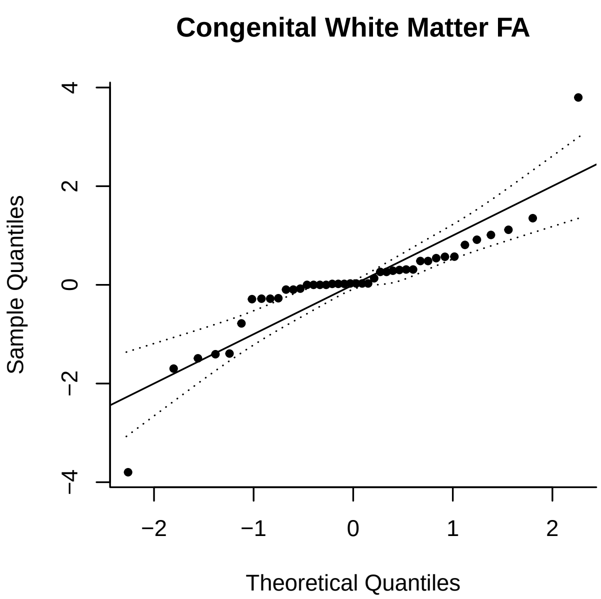
	HedgeG	se	zval	ci.lo	ci.up
right temporal	-0.8298	0.1036	-8.013	-1.033	-0.6269
right Thalamus	-0.9238	0.1789	-5.164	-1.274	-0.5732
right tract	-1.004	0.2156	-4.656	-1.427	-0.5813

	pval	N
left brainstem	0.9746	1
left cingulate	0.3165	2
left occipital	0.05566	1
left temporal	3.421e-08	10
left tract	0.000267	1
right brainstem	0.614	1
right insular cortex	0.064	1
right occipital	0.05566	1
right temporal	1.121e-15	16
right Thalamus	2.416e-07	6
right tract	3.226e-06	4


Congenital White Matter FA
Year & Author N ROI Area Weights Hedge's G [95% CI]
right
2009−Wang.6 12 pars opercularis temporal 1.21% −0.16 [−1.29, 0.98]
2004−Chang.2 20 Superior olivary nucleus brainstem 1.78% −0.25 [−1.13, 0.63]
2009−Wang.2 12 HG temporal 1.18% −0.48 [−1.63, 0.67]
2012−Li.1 98 STG temporal 4.06% −0.58 [−1.00, −0.17]
2010−Liu.4 44 optic radiation occipital 2.73% −0.73 [−1.36, −0.09]
2010−Liu.2 44 HG temporal 2.73% −0.73 [−1.36, −0.09]
2018−Benetti.2 20 middle lateral fusiform gyrusright posterior superior temporal sulcus−STG temporal 2.19% −0.77 [−1.53, −0.02]
2017−Kim.5 37 thalmus Thalamus 2.02% −0.79 [−1.60, 0.01]
2017−Kim.4 37 internal capsule Thalamus 2.02% −0.79 [−1.60, 0.01]
2013−Miao.5 32 thalmus Thalamus 2.33% −0.81 [−1.53, −0.09]
2013−Miao.4 32 external capsule tract 2.33% −0.81 [−1.53, −0.09]
2014−Hribar.9 28 external capsule tract 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.8 28 sagittal stratum tract 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.7 28 posterior thalamic radiation Thalamus 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.6 28 retrolenticular part of internal capsule Thalamus 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.5 28 insular cortex insular cortex 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.4 28 STG temporal 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.3 28 planum temporale temporal 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.2 28 planum polare temporal 2.13% −0.82 [−1.59, −0.04]
2014−Hribar.1 28 HG temporal 2.13% −0.82 [−1.59, −0.04]
2017−Kim.3 37 temporal lobe WM temporal 2.01% −0.82 [−1.63, −0.01]
2017−Kim.1 37 STG temporal 2.01% −0.82 [−1.63, −0.01]
2013−Miao.2 32 STG/HG temporal 2.32% −0.82 [−1.55, −0.10]
2018−Benetti.1 20 V2/3−posterior superior temporal sulcus−STG temporal 2.14% −0.95 [−1.73, −0.18]
2009−Wang.4 12 STG temporal 1.08% −1.00 [−2.22, 0.21]
2018−Zou.2 158 STG temporal 4.67% −1.02 [−1.35, −0.69]
2009−Kim.2 42 superior temporal temporal 2.33% −1.40 [−2.12, −0.68]
2009−Kim.3 42 internal capsule Thalamus 2.31% −1.45 [−2.18, −0.73]
2009−Kim.4 42 superior longitudinal fasciculus tract 2.27% −1.55 [−2.29, −0.81]
RE Model for Subgroup (Q = 15.12, df = 28, p = 0.98; I2 = 0.0%) −0.86 [−0.99, −0.73]
left
2009−Kim.1 42 Bilateral forceps major cingulate 2.32% 1.42 [0.70, 2.15]
2009−Wang.1 12 HG temporal 1.21% 0.11 [−1.02, 1.24]
2004−Chang.1 20 Superior olivary nucleus brainstem 1.79% −0.02 [−0.89, 0.86]
2009−Wang.3 12 STG temporal 1.20% −0.21 [−1.35, 0.92]
2009−Wang.5 12 pars opercularis temporal 1.19% −0.35 [−1.50, 0.79]
2012−Li.2 98 HG temporal 4.08% −0.44 [−0.85, −0.02]
2010−Liu.3 44 optic radiation occipital 2.73% −0.73 [−1.36, −0.09]
2010−Liu.1 44 HG temporal 2.73% −0.73 [−1.36, −0.09]
2014−Hribar.11 28 planum temporale temporal 2.15% −0.74 [−1.51, 0.03]
2014−Hribar.10 28 HG temporal 2.15% −0.74 [−1.51, 0.03]
2013−Miao.3 32 STG/HG temporal 2.33% −0.81 [−1.53, −0.09]
2017−Kim.2 37 STG temporal 2.01% −0.82 [−1.63, −0.01]
2013−Miao.1 32 corpus callosum cingulate 2.32% −0.83 [−1.55, −0.10]
2018−Zou.1 158 STG temporal 4.65% −1.09 [−1.42, −0.75]
2009−Kim.5 42 inferior fronto−occipital fasciculus tract 2.27% −1.55 [−2.29, −0.81]
RE Model for Subgroup (Q = 50.14, df = 14, p = 0.00; I2 = 73.9%) −0.54 [−0.89, −0.19]
RE Model for All Studies (Q = 69.00, df = 43, p = 0.01; I2 = 39.0%) 100.00% −0.75 [−0.89, −0.61]
−5
0
3
Hedge's G



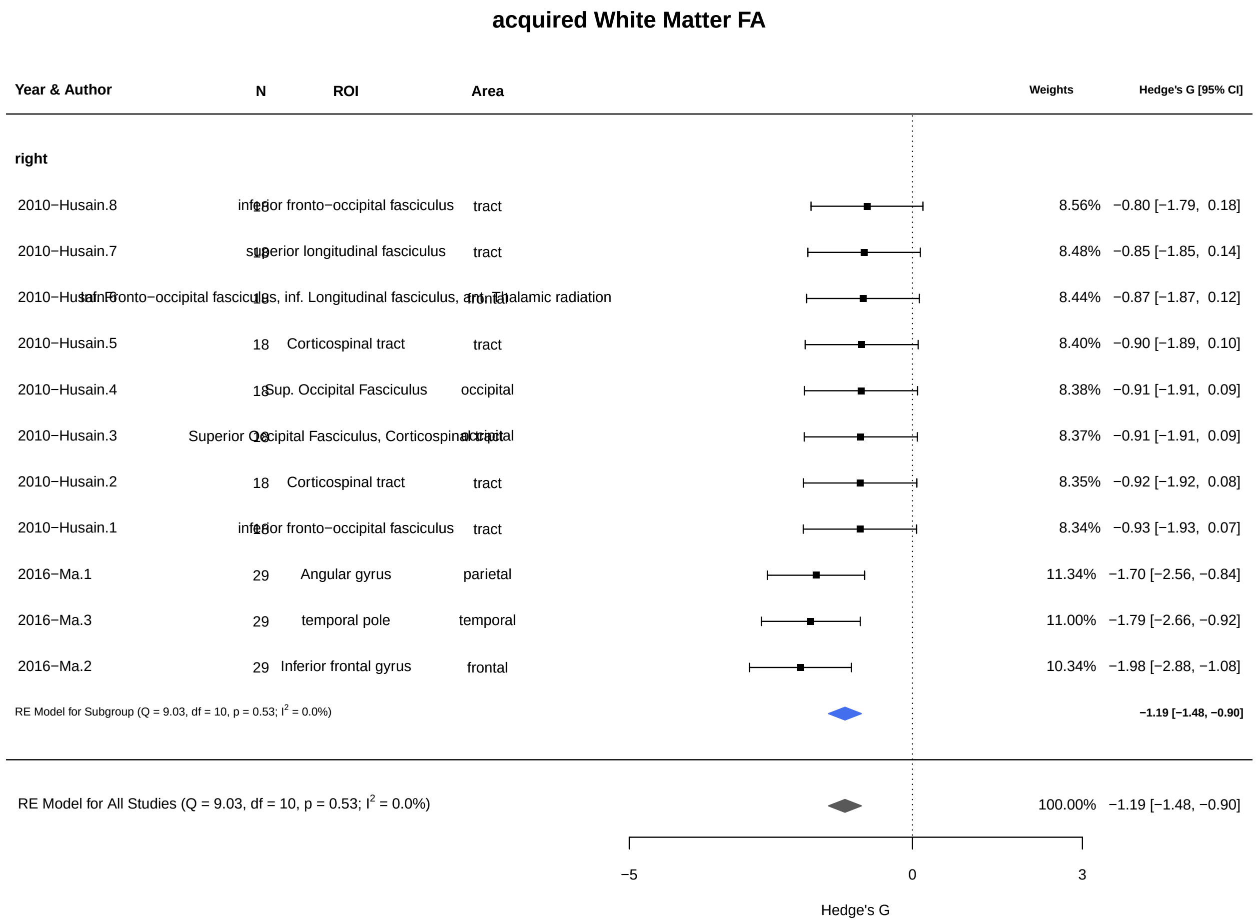


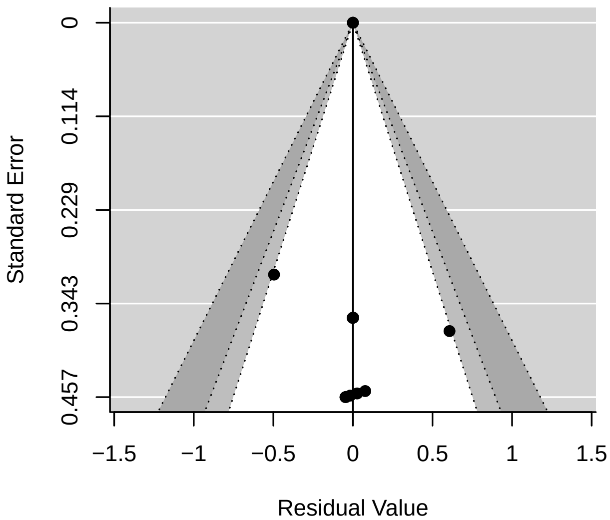


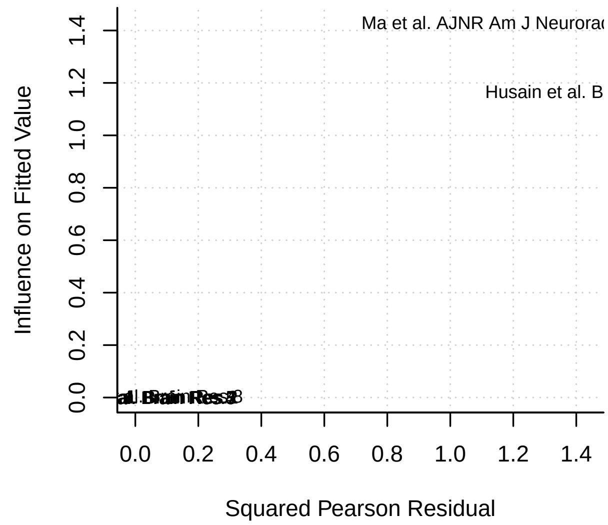
ACQUIRED - White Matter by FA fractional anisotropy (ONLY RIGHT)

Random effects model no intercept covariated by Big area

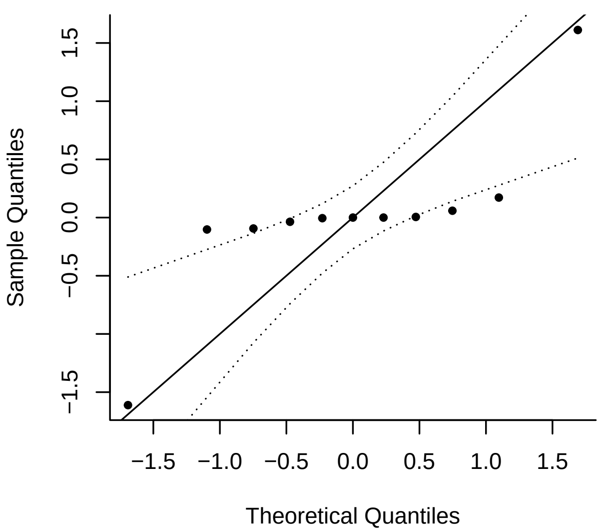
	HedgeG	se	zval	ci.lo	ci.up	p.val	N
right frontal	-1.48	0.3403	-4.35	-2.147	-0.8134	1.36e-05	2
right occipital	-0.9105	0.3603	-2.527	-1.617	-0.2042	0.01151	2
right parietal	-1.703	0.4379	-3.888	-2.561	-0.8443	0.0001011	1
right temporal	-1.793	0.4446	-4.034	-2.665	-0.922	5.488e-05	1
right tract	-0.8812	0.2272	-3.878	-1.326	-0.4359	0.0001052	5


acquired White Matter FA
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2010−Husain.8 18 inferior fronto−occipital fasciculus tract 8.56% −0.80 [−1.79, 0.18]
2010−Husain.7 18 superior longitudinal fasciculus tract 8.48% −0.85 [−1.85, 0.14]
2010−Husain.6 18 Inf. Fronto−occipital fasciculus, inf. Longitudinal fasciculus, ant. Thalamic radiation frontal 8.44% −0.87 [−1.87, 0.12]
2010−Husain.5 18 Corticospinal tract tract 8.40% −0.90 [−1.89, 0.10]
2010−Husain.4 18 Sup. Occipital Fasciculus occipital 8.38% −0.91 [−1.91, 0.09]
2010−Husain.3 18 Superior Occipital Fasciculus, Corticospinal tract occipital 8.37% −0.91 [−1.91, 0.09]
2010−Husain.2 18 Corticospinal tract tract 8.35% −0.92 [−1.92, 0.08]
2010−Husain.1 18 inferior fronto−occipital fasciculus tract 8.34% −0.93 [−1.93, 0.07]
2016−Ma.1 29 Angular gyrus parietal 11.34% −1.70 [−2.56, −0.84]
2016−Ma.3 29 temporal pole temporal 11.00% −1.79 [−2.66, −0.92]
2016−Ma.2 29 Inferior frontal gyrus frontal 10.34% −1.98 [−2.88, −1.08]
RE Model for Subgroup (Q = 9.03, df = 10, p = 0.53; I2 = 0.0%) −1.19 [−1.48, −0.90]
RE Model for All Studies (Q = 9.03, df = 10, p = 0.53; I2 = 0.0%) 100.00% −1.19 [−1.48, −0.90]
−5
0
3
Hedge's G



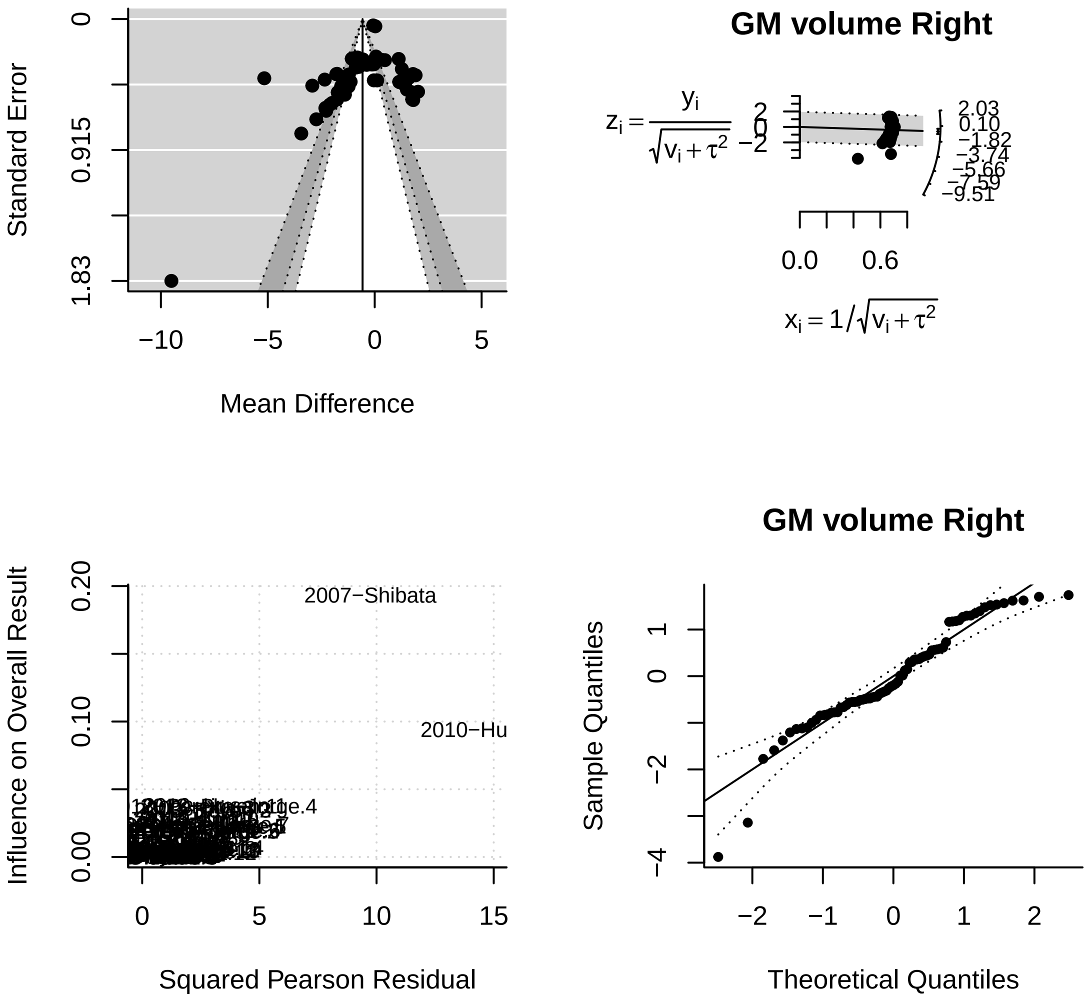


acquired White Matter FA

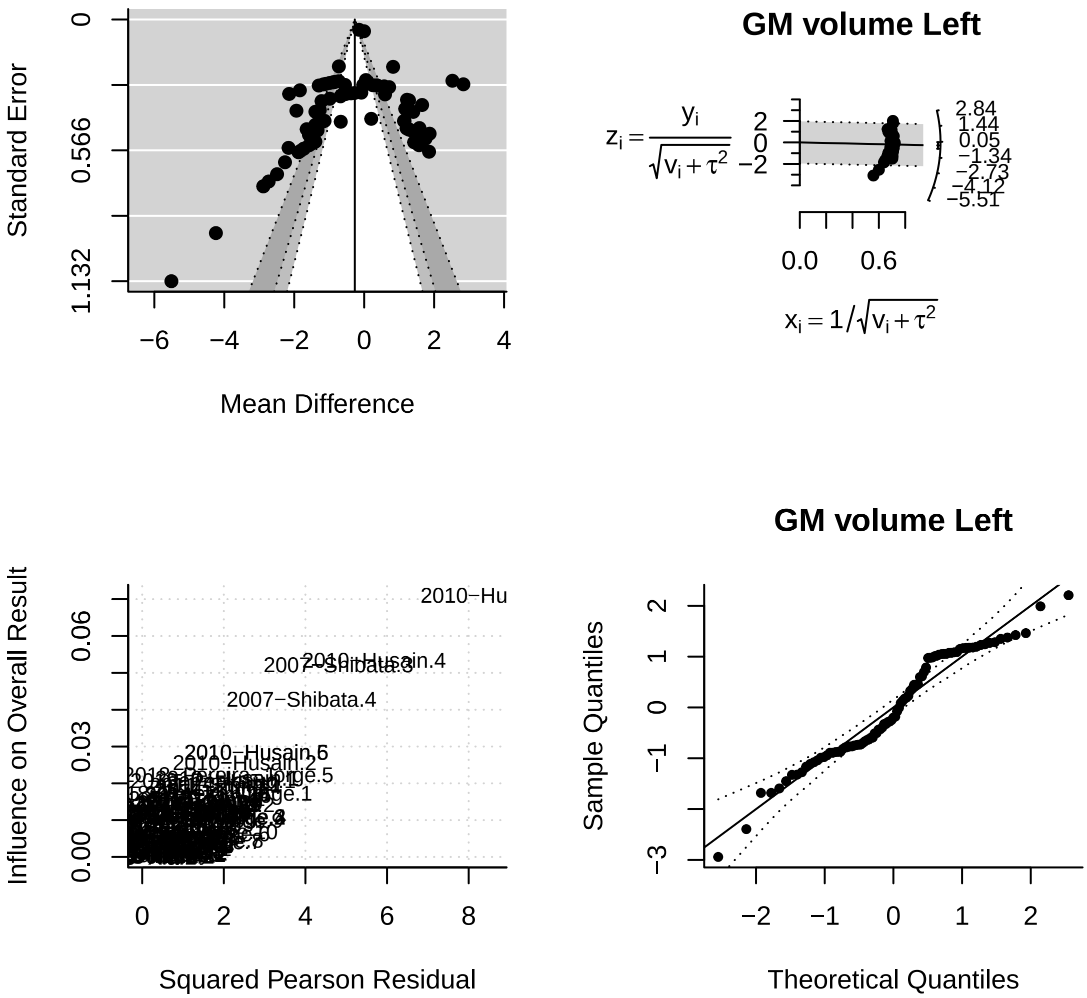


Supplementary material: heterogeneity per model

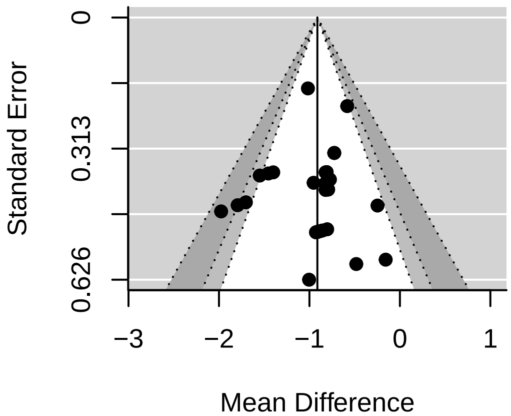
Heterogeney: GM volume Right

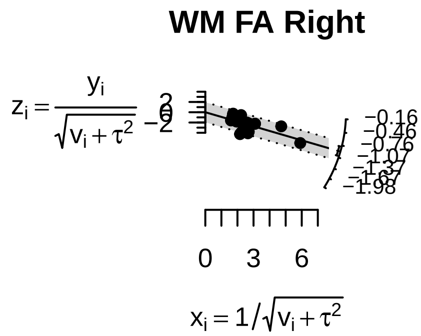


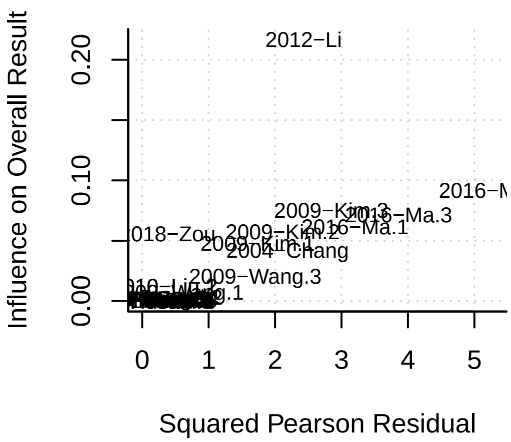
Heterogeney: GM volume Left

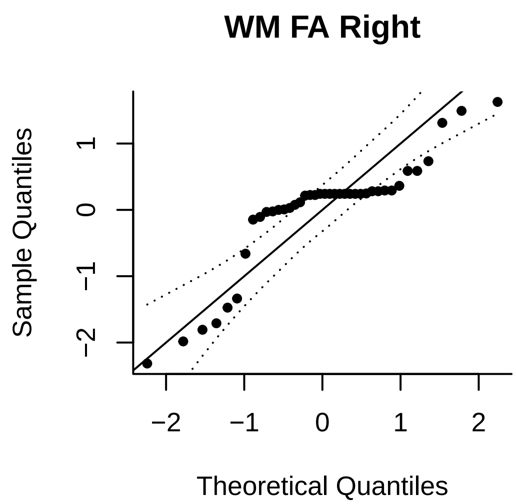


Heterogeney: WM FA Right

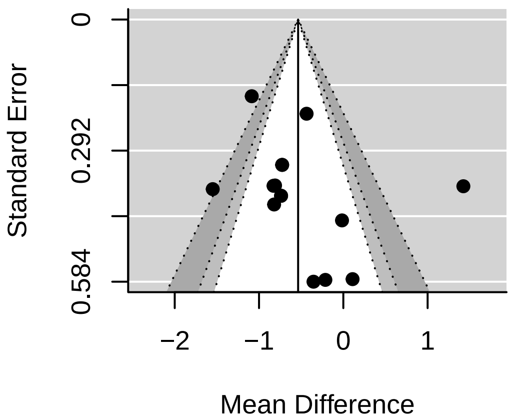


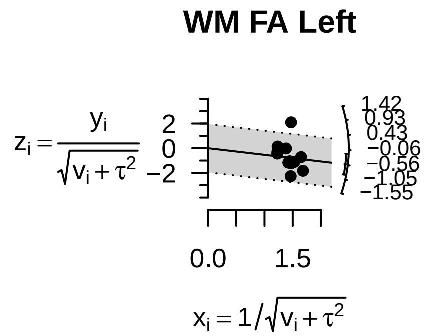


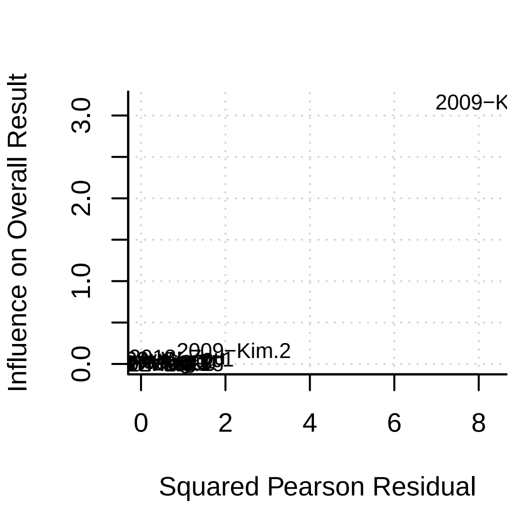


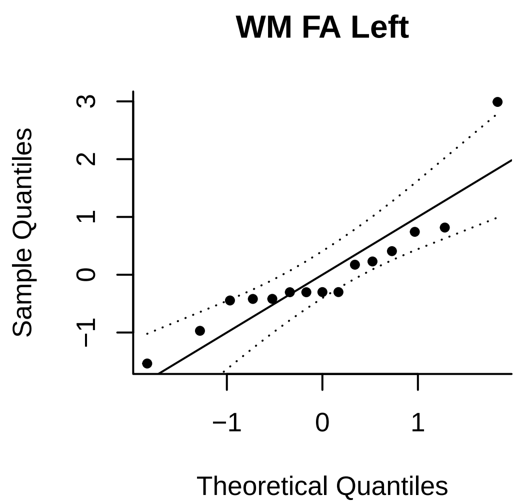


Heterogeney: WM FA Left

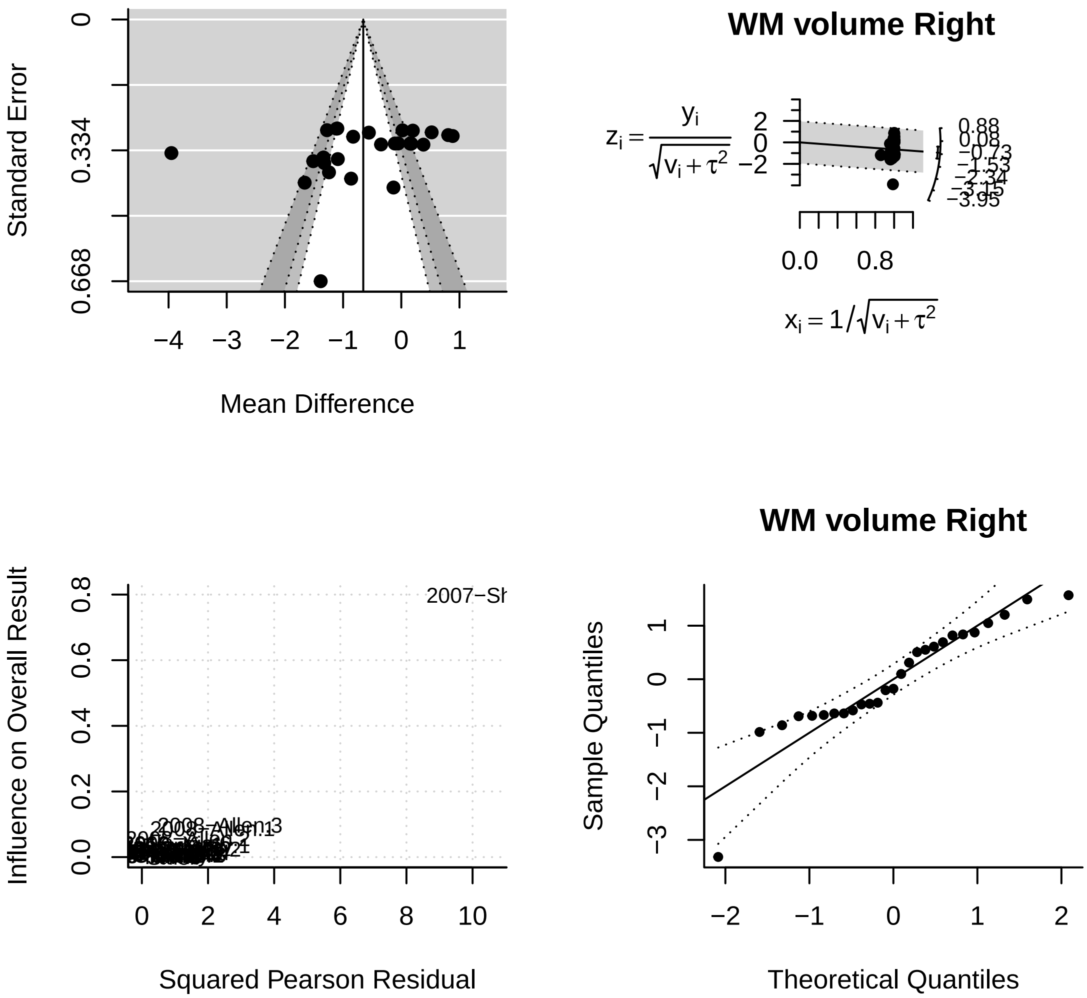




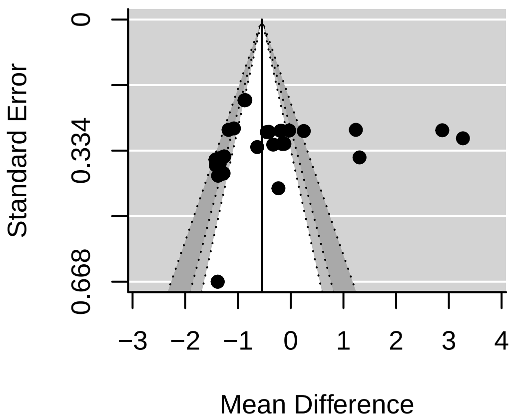


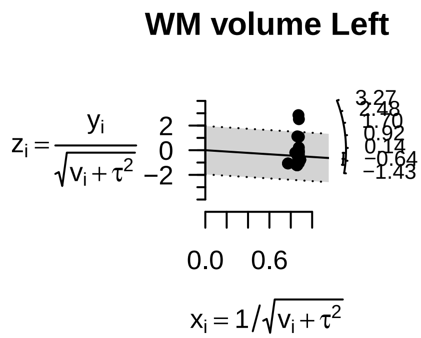


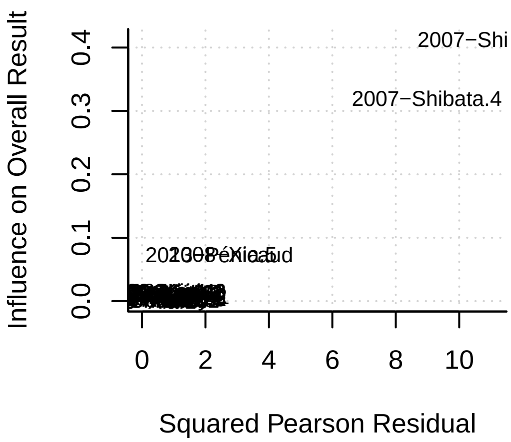
Heterogeney: WM volume Right

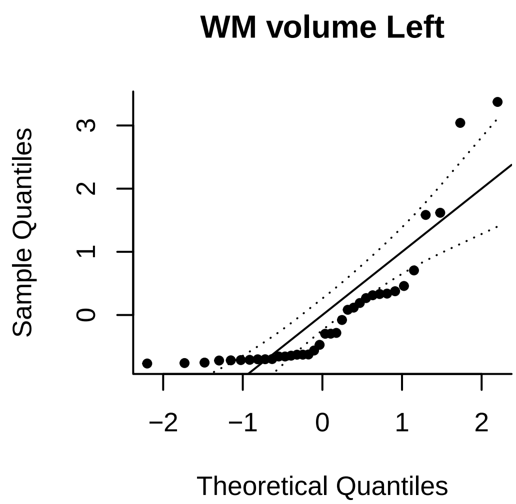


Heterogeney: WM volume Left

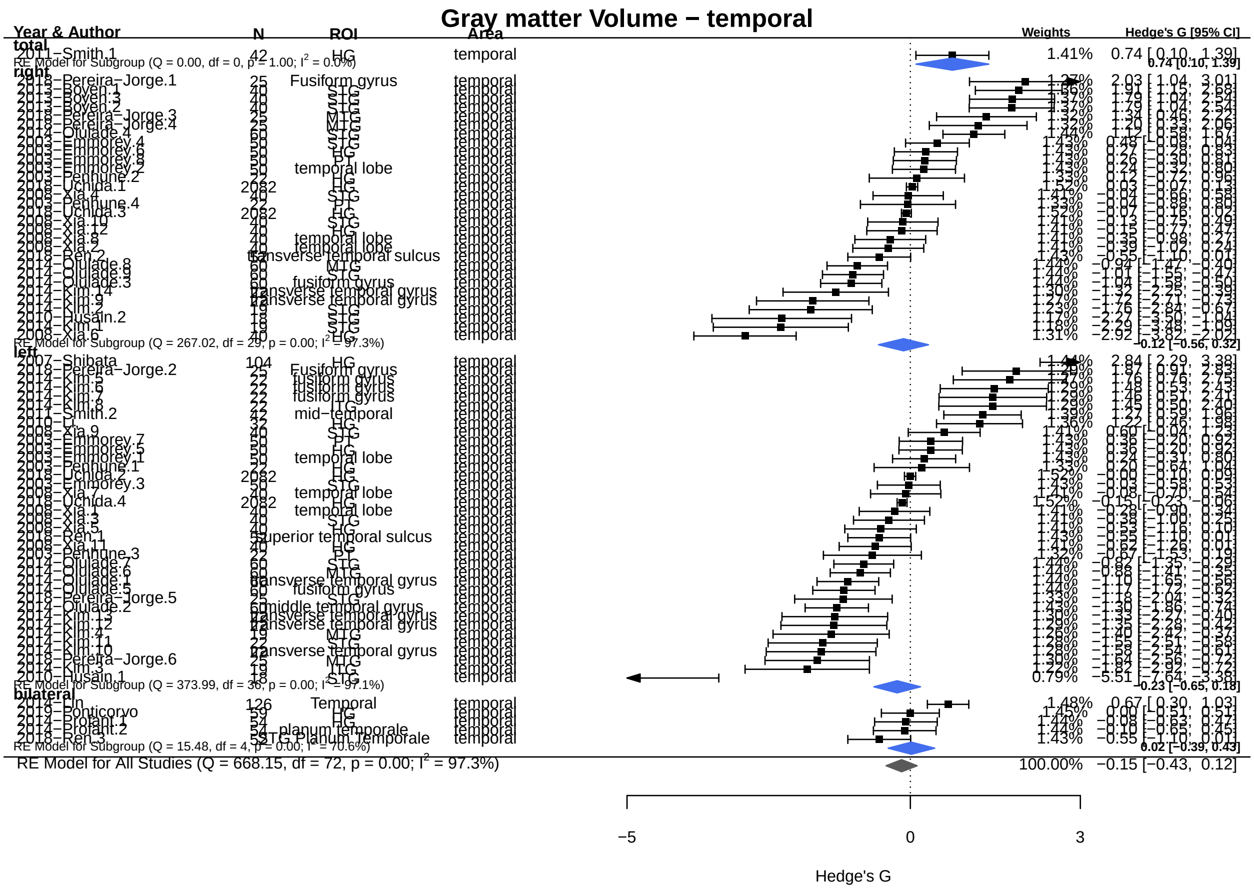


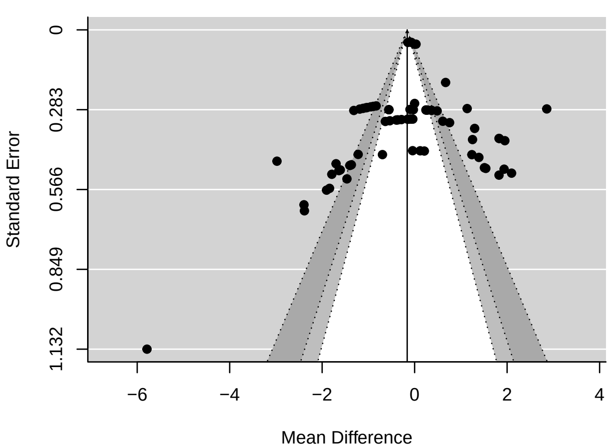


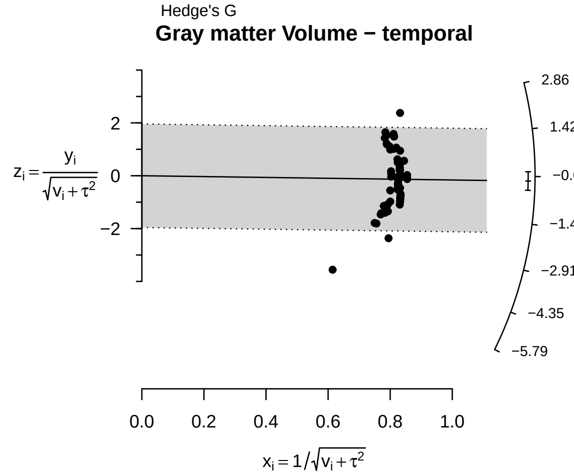


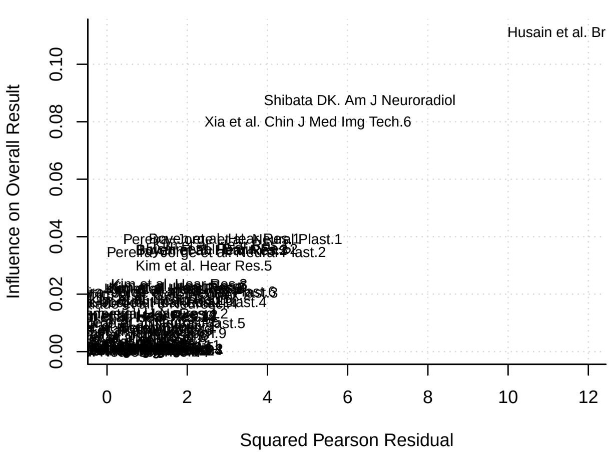


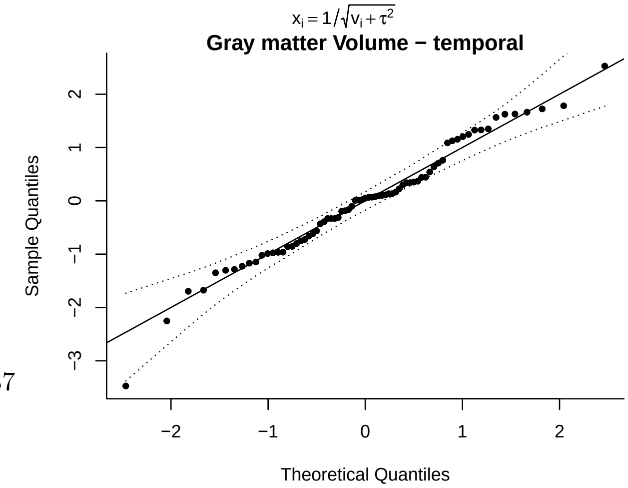
Meta-regressions of Gray Matter Volume & Brain Areas: Random effects model no intercept covariated by Side

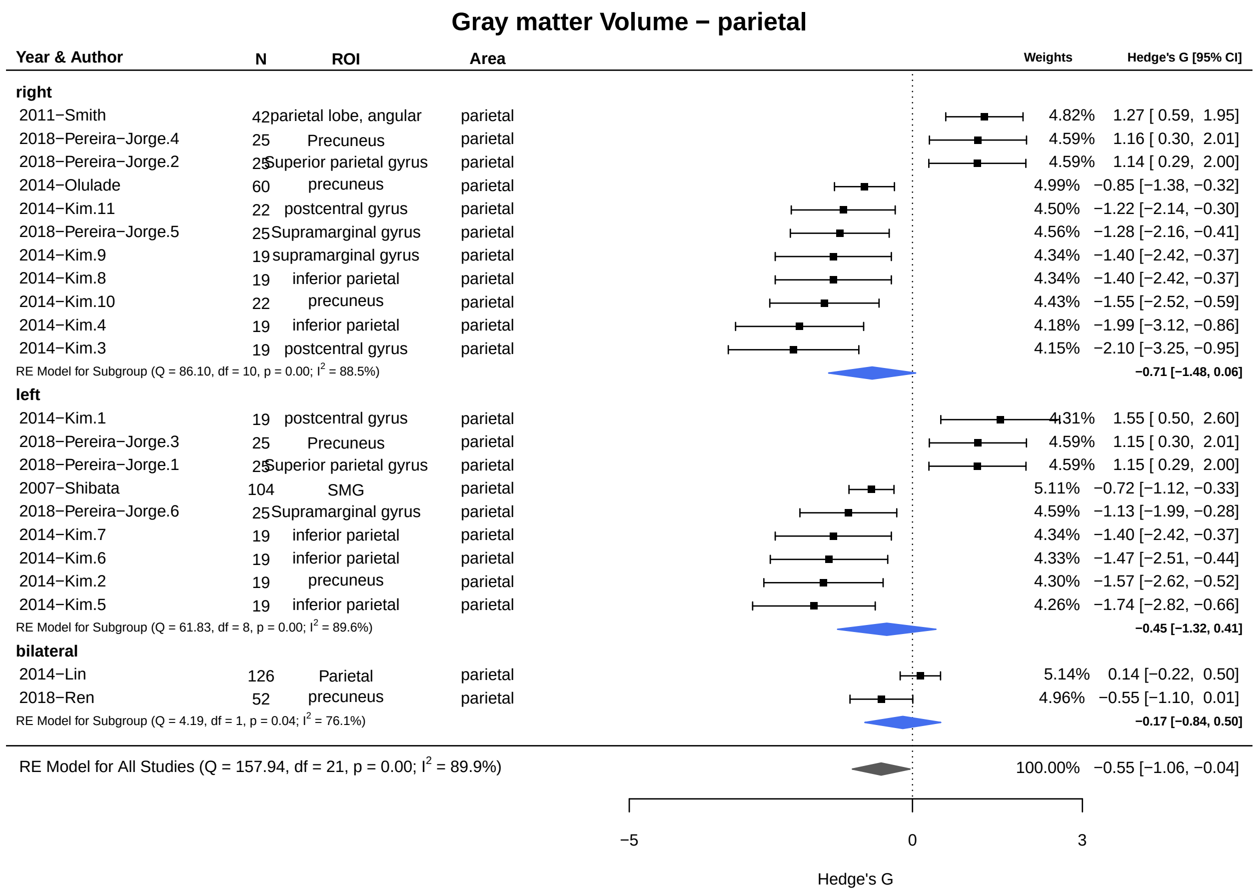


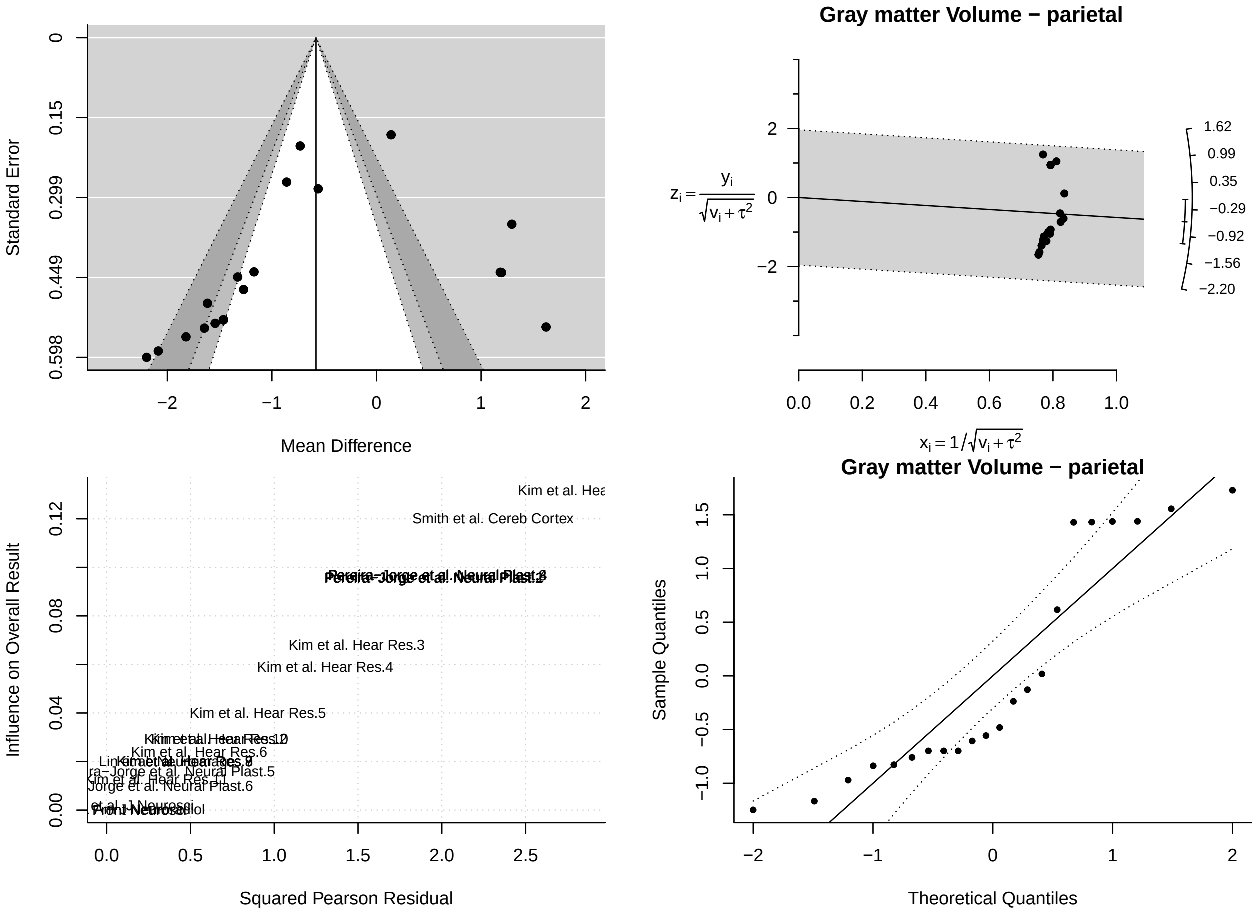


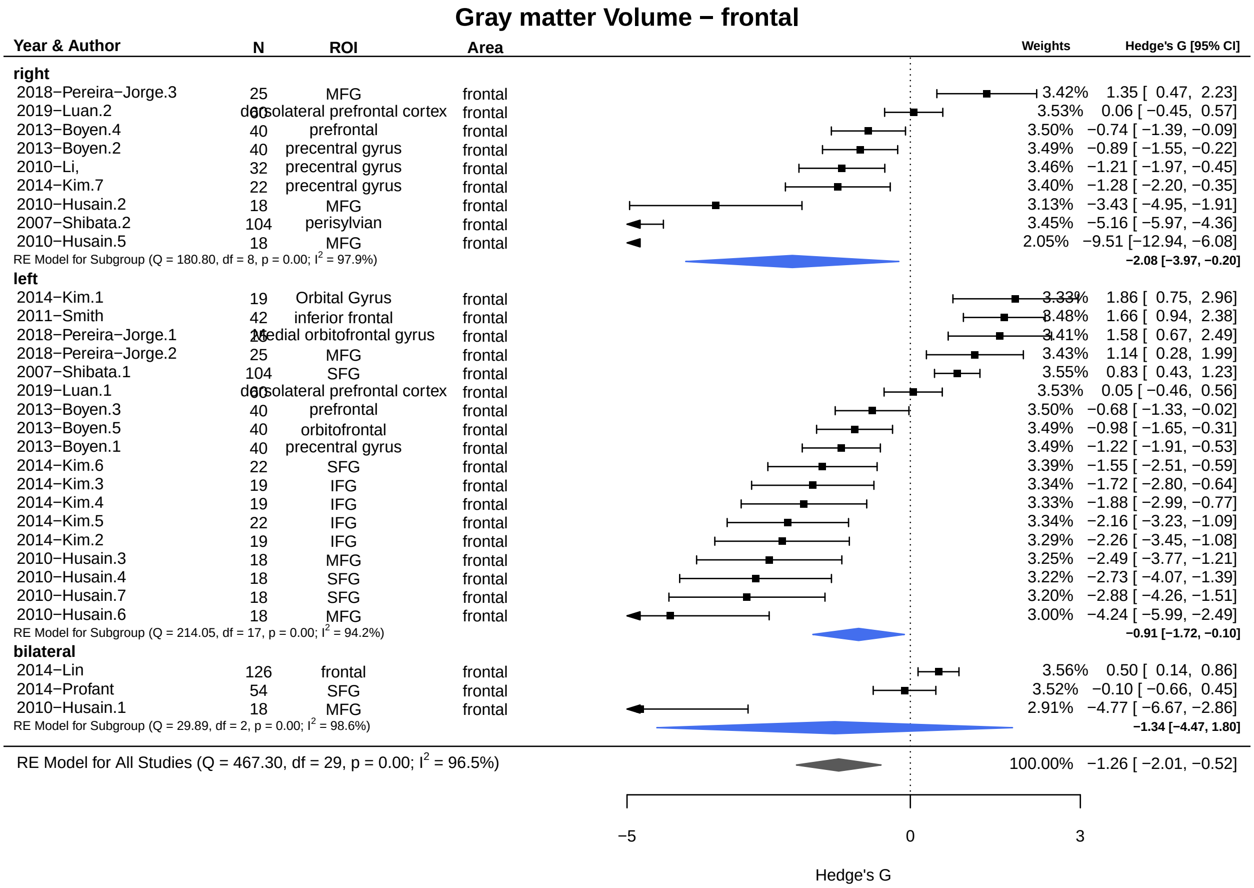




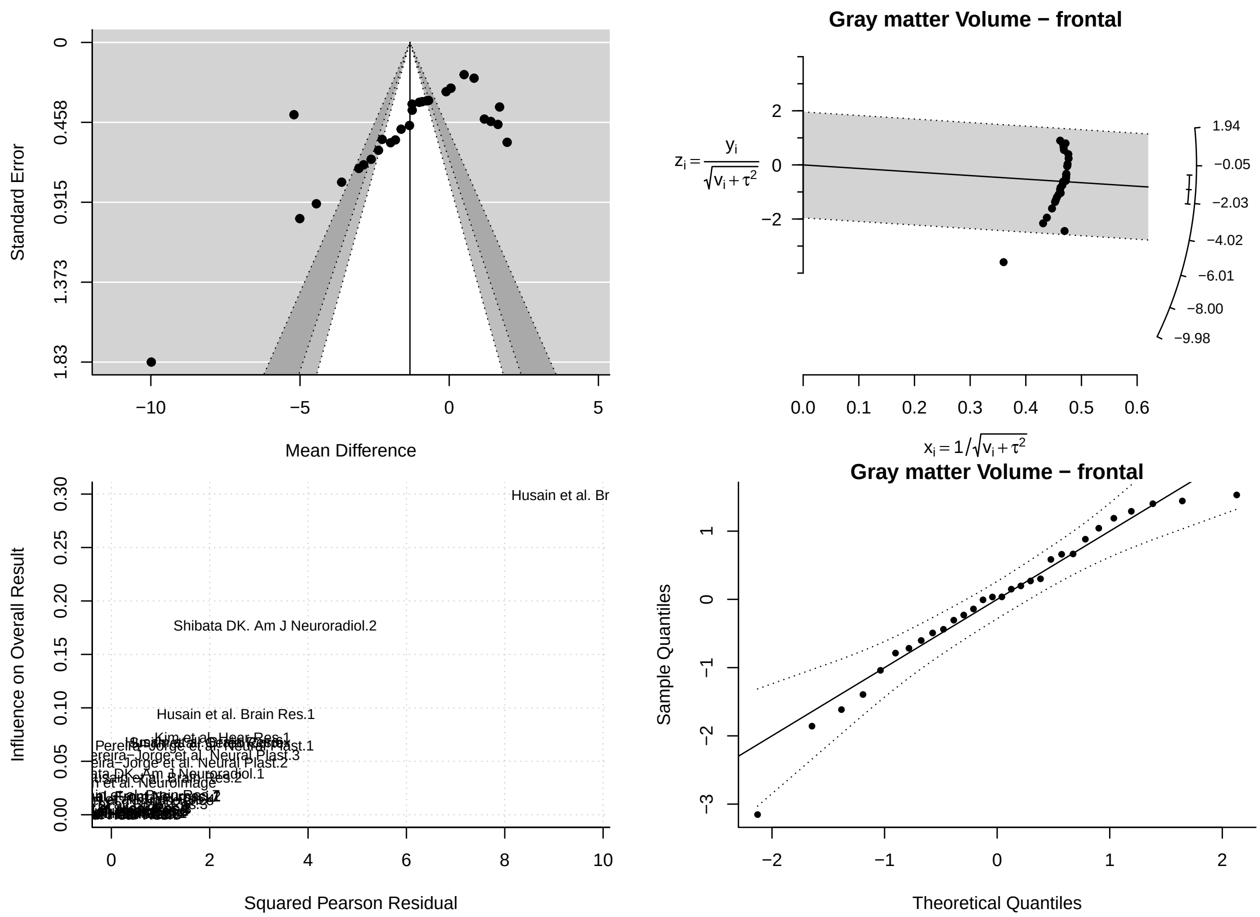


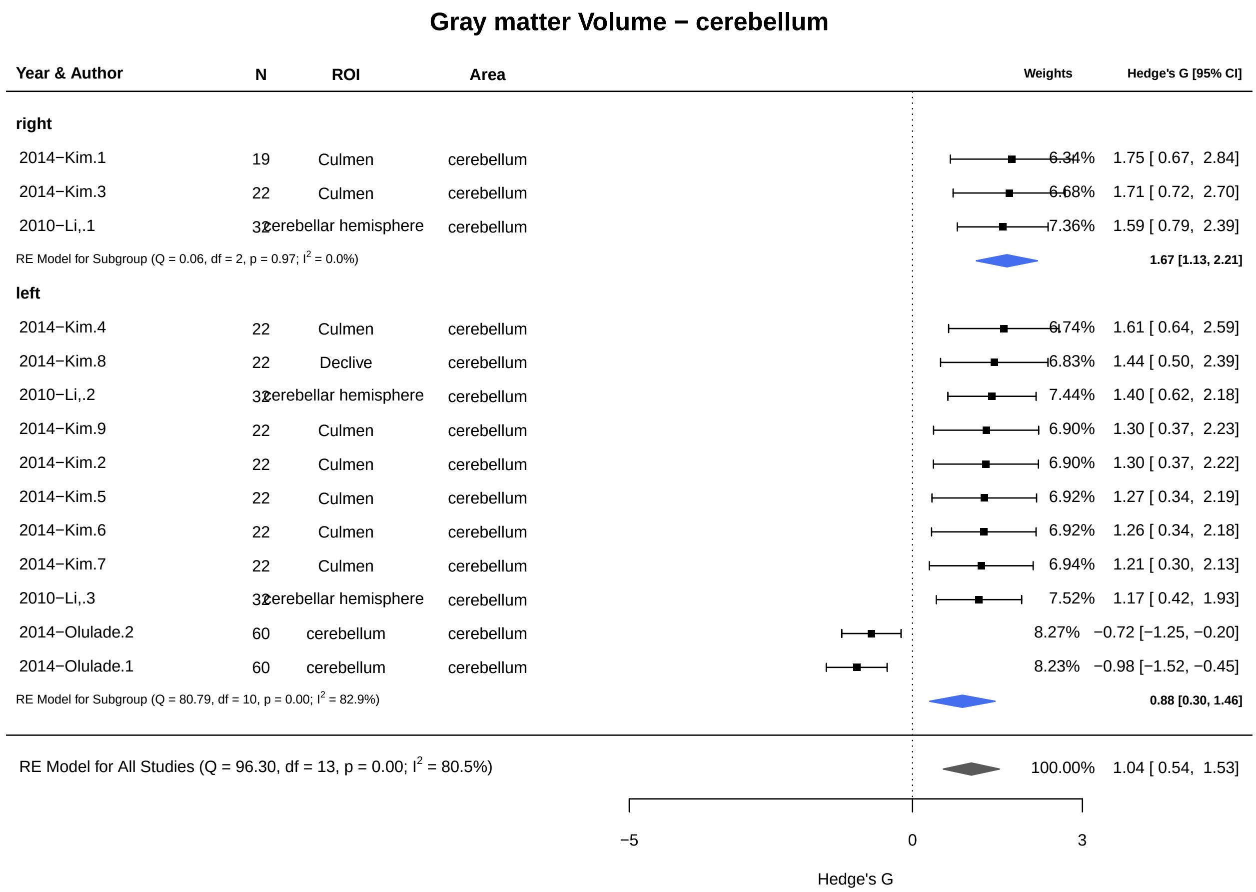

Gray matter Volume − parietal
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2011−Smith 42 parietal lobe, angular parietal 4.82% 1.27 [0.59, 1.95]
2018−Pereira−Jorge.4 25 Precuneus parietal 4.59% 1.16 [0.30, 2.01]
2018−Pereira−Jorge.2 25 Superior parietal gyrus parietal 4.59% 1.14 [0.29, 2.00]
2014−Olulade 60 precuneus parietal 4.99% −0.85 [−1.38, −0.32]
2014−Kim.11 22 postcentral gyrus parietal 4.50% −1.22 [−2.14, −0.30]
2018−Pereira−Jorge.5 25 Supramarginal gyrus parietal 4.56% −1.28 [−2.16, −0.41]
2014−Kim.9 19 supramarginal gyrus parietal 4.34% −1.40 [−2.42, −0.37]
2014−Kim.8 19 inferior parietal parietal 4.34% −1.40 [−2.42, −0.37]
2014−Kim.10 22 precuneus parietal 4.43% −1.55 [−2.52, −0.59]
2014−Kim.4 19 inferior parietal parietal 4.18% −1.99 [−3.12, −0.86]
2014−Kim.3 19 postcentral gyrus parietal 4.15% −2.10 [−3.25, −0.95]
RE Model for Subgroup (Q = 86.10, df = 10, p = 0.00; I2 = 88.5%) −0.71 [−1.48, 0.06]
left
2014−Kim.1 19 postcentral gyrus parietal 4.31% 1.55 [0.50, 2.60]
2018−Pereira−Jorge.3 25 Precuneus parietal 4.59% 1.15 [0.30, 2.01]
2018−Pereira−Jorge.1 25 Superior parietal gyrus parietal 4.59% 1.15 [0.29, 2.00]
2007−Shibata 104 SMG parietal 5.11% −0.72 [−1.12, −0.33]
2018−Pereira−Jorge.6 25 Supramarginal gyrus parietal 4.59% −1.13 [−1.99, −0.28]
2014−Kim.7 19 inferior parietal parietal 4.34% −1.40 [−2.42, −0.37]
2014−Kim.6 19 inferior parietal parietal 4.33% −1.47 [−2.51, −0.44]
2014−Kim.2 19 precuneus parietal 4.30% −1.57 [−2.62, −0.52]
2014−Kim.5 19 inferior parietal parietal 4.26% −1.74 [−2.82, −0.66]
RE Model for Subgroup (Q = 61.83, df = 8, p = 0.00; I2 = 89.6%) −0.45 [−1.32, 0.41]
bilateral
2014−Lin 126 Parietal parietal 5.14% 0.14 [−0.22, 0.50]
2018−Ren 52 precuneus parietal 4.96% −0.55 [−1.10, 0.01]
RE Model for Subgroup (Q = 4.19, df = 1, p = 0.04; I2 = 76.1%) −0.17 [−0.84, 0.50]
RE Model for All Studies (Q = 157.94, df = 21, p = 0.00; I2 = 89.9%) 100.00% −0.55 [−1.06, −0.04]
−5
0
3
Hedge's G

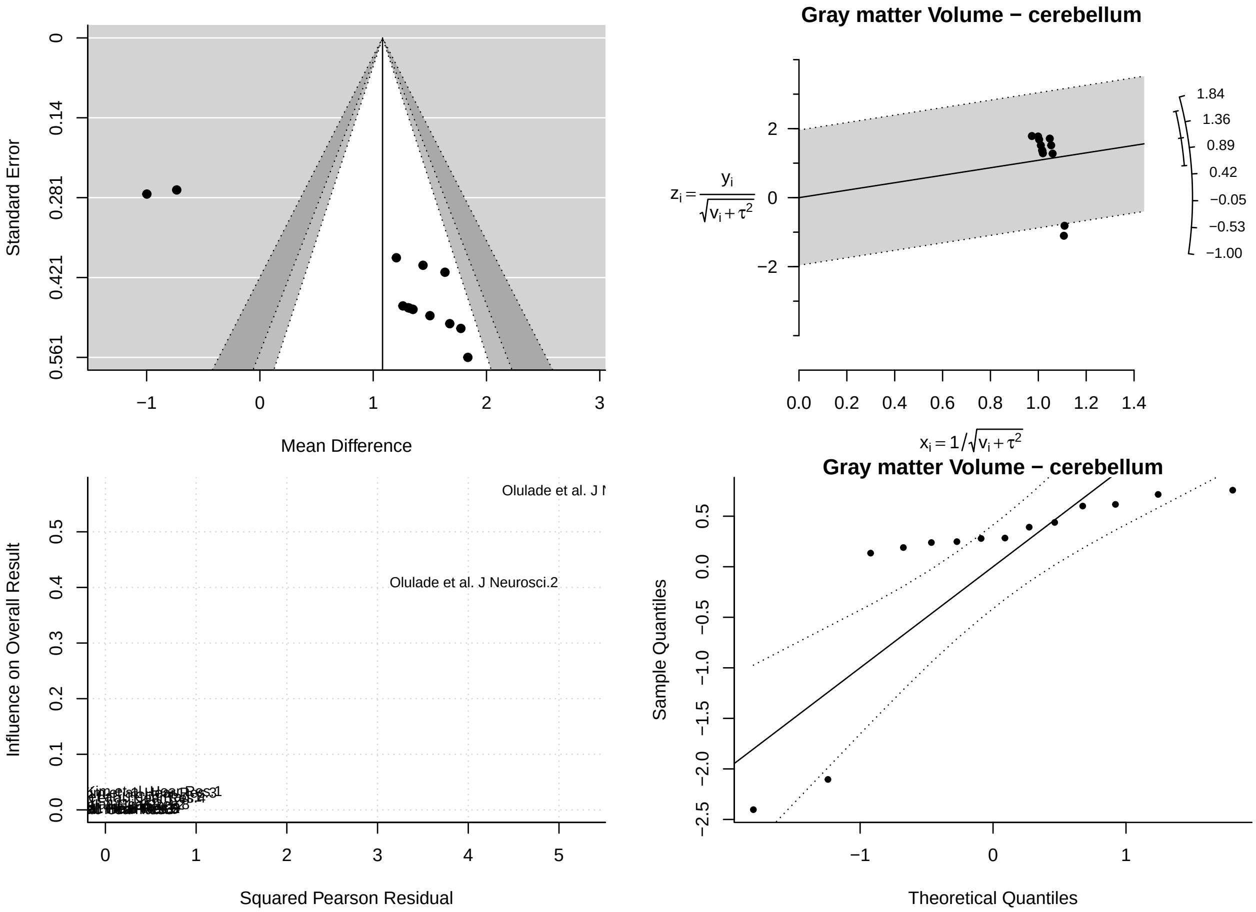

Gray matter Volume − parietal
Gray matter Volume − parietal
Standard Error
Mean Difference
Influence on Overall Result
Squared Pearson Residual
Sample Quantiles
Theoretical Quantiles
Smith et al. Cereb Cortex
Kim et al. Hear Res.3
Kim et al. Hear Res.4
Kim et al. Hear Res.5
Kim et al. Hear Res.6

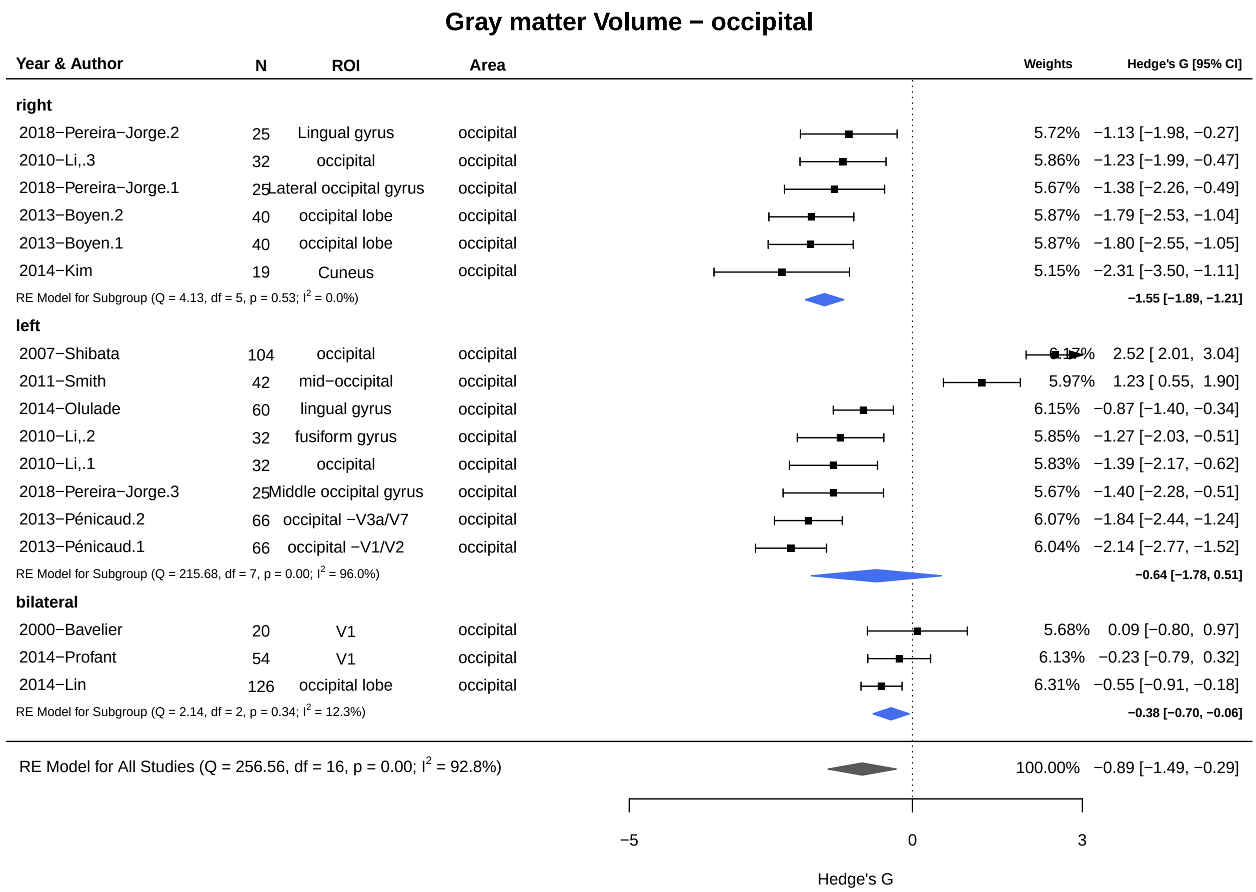


Gray matter Volume − frontal
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2018−Pereira−Jorge.3 25 MFG frontal 3.42% 1.35 [0.47, 2.23]
2019−Luan.2 60 dorsolateral prefrontal cortex frontal 3.53% 0.06 [−0.45, 0.57]
2013−Boyen.4 40 prefrontal frontal 3.50% −0.74 [−1.39, −0.09]
2013−Boyen.2 40 precentral gyrus frontal 3.49% −0.89 [−1.55, −0.22]
2010−Li, 32 precentral gyrus frontal 3.46% −1.21 [−1.97, −0.45]
2014−Kim.7 22 precentral gyrus frontal 3.40% −1.28 [−2.20, −0.35]
2010−Husain.2 18 MFG frontal 3.13% −3.43 [−4.95, −1.91]
2007−Shibata.2 104 perisylvian frontal 3.45% −5.16 [−5.97, −4.36]
2010−Husain.5 18 MFG frontal 2.05% −9.51 [−12.94, −6.08]
RE Model for Subgroup (Q = 180.80, df = 8, p = 0.00; I2 = 97.9%) −2.08 [−3.97, −0.20]
left
2014−Kim.1 19 Orbital Gyrus frontal 3.33% 1.86 [0.75, 2.96]
2011−Smith 42 inferior frontal frontal 3.48% 1.66 [0.94, 2.38]
2018−Pereira−Jorge.1 25 Medial orbitofrontal gyrus frontal 3.41% 1.58 [0.67, 2.49]
2018−Pereira−Jorge.2 25 MFG frontal 3.43% 1.14 [0.28, 1.99]
2007−Shibata.1 104 SFG frontal 3.55% 0.83 [0.43, 1.23]
2019−Luan.1 60 dorsolateral prefrontal cortex frontal 3.53% 0.05 [−0.46, 0.56]
2013−Boyen.3 40 prefrontal frontal 3.50% −0.68 [−1.33, −0.02]
2013−Boyen.5 40 orbitofrontal frontal 3.49% −0.98 [−1.65, −0.31]
2013−Boyen.1 40 precentral gyrus frontal 3.49% −1.22 [−1.91, −0.53]
2014−Kim.6 22 SFG frontal 3.39% −1.55 [−2.51, −0.59]
2014−Kim.3 19 IFG frontal 3.34% −1.72 [−2.80, −0.64]
2014−Kim.4 19 IFG frontal 3.33% −1.88 [−2.99, −0.77]
2014−Kim.5 22 IFG frontal 3.34% −2.16 [−3.23, −1.09]
2014−Kim.2 19 IFG frontal 3.29% −2.26 [−3.45, −1.08]
2010−Husain.3 18 MFG frontal 3.25% −2.49 [−3.77, −1.21]
2010−Husain.4 18 SFG frontal 3.22% −2.73 [−4.07, −1.39]
2010−Husain.7 18 SFG frontal 3.20% −2.88 [−4.26, −1.51]
2010−Husain.6 18 MFG frontal 3.00% −4.24 [−5.99, −2.49]
RE Model for Subgroup (Q = 214.05, df = 17, p = 0.00; I2 = 94.2%) −0.91 [−1.72, −0.10]
bilateral
2014−Lin 126 frontal frontal 3.56% 0.50 [0.14, 0.86]
2014−Profant 54 SFG frontal 3.52% −0.10 [−0.66, 0.45]
2010−Husain.1 18 MFG frontal 2.91% −4.77 [−6.67, −2.86]
RE Model for Subgroup (Q = 29.89, df = 2, p = 0.00; I2 = 98.6%) −1.34 [−4.47, 1.80]
RE Model for All Studies (Q = 467.30, df = 29, p = 0.00; I2 = 96.5%) 100.00% −1.26 [−2.01, −0.52]
−5
0
3
Hedge's G

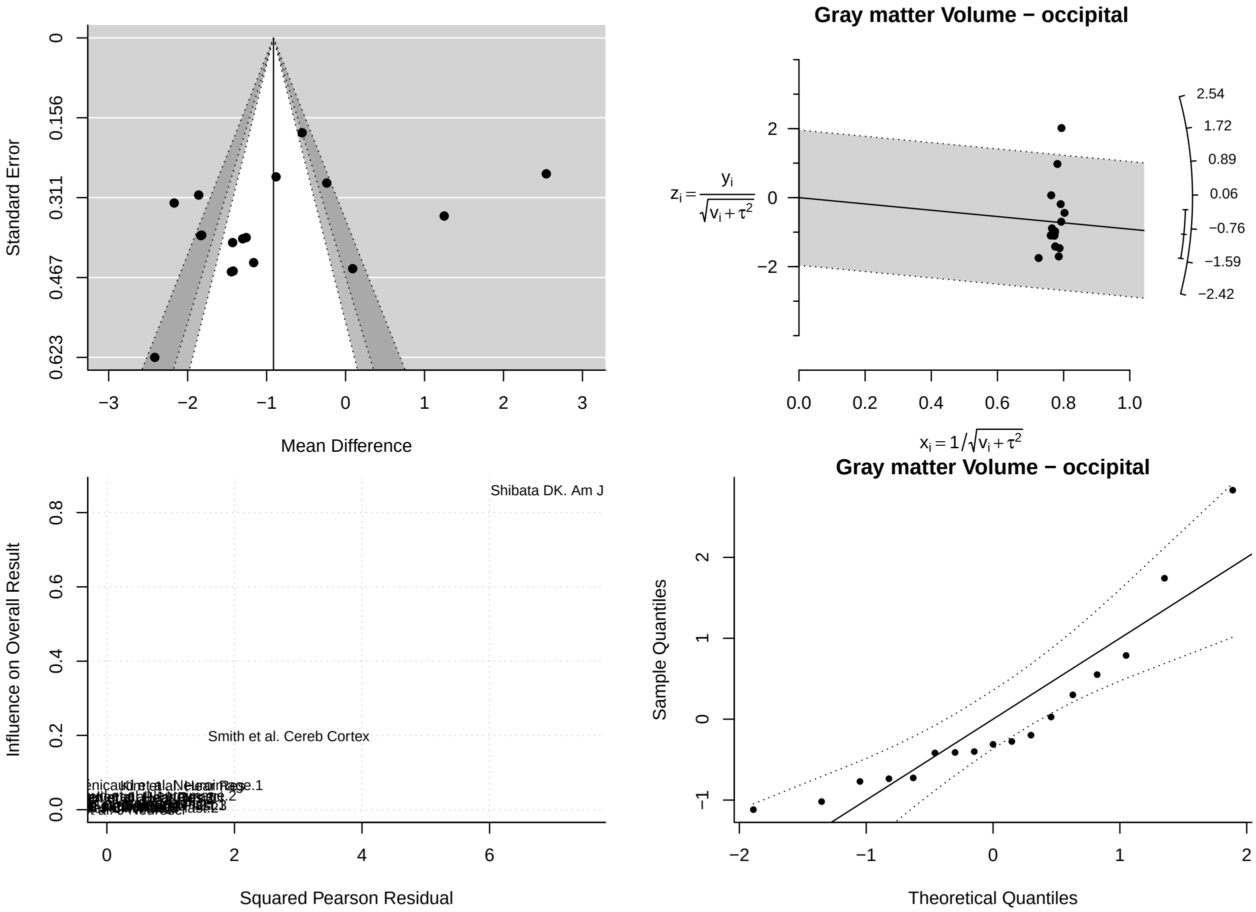

Standard Error
0
0.458
0.915
1.373
1.83
−10
−5
0
5
Mean Difference
Gray matter Volume − frontal
$z_i = \frac{y_i}{\sqrt{v_i + \tau^2}}$
2
0
−2
1.94
−0.05
−2.03
−4.02
−6.01
−8.00
−9.98
0.0
0.1
0.2
0.3
0.4
0.5
0.6
$x_i = 1/\sqrt{v_i + \tau^2}$
Influence on Overall Result
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Husain et al. Br
Shibata DK. Am J Neuroradiol.2
Husain et al. Brain Res.1
0
2
4
6
8
10
Squared Pearson Residual
Gray matter Volume − frontal
Sample Quantiles
1
0
−1
−2
−3
−2
−1
0
1
2
Theoretical Quantiles

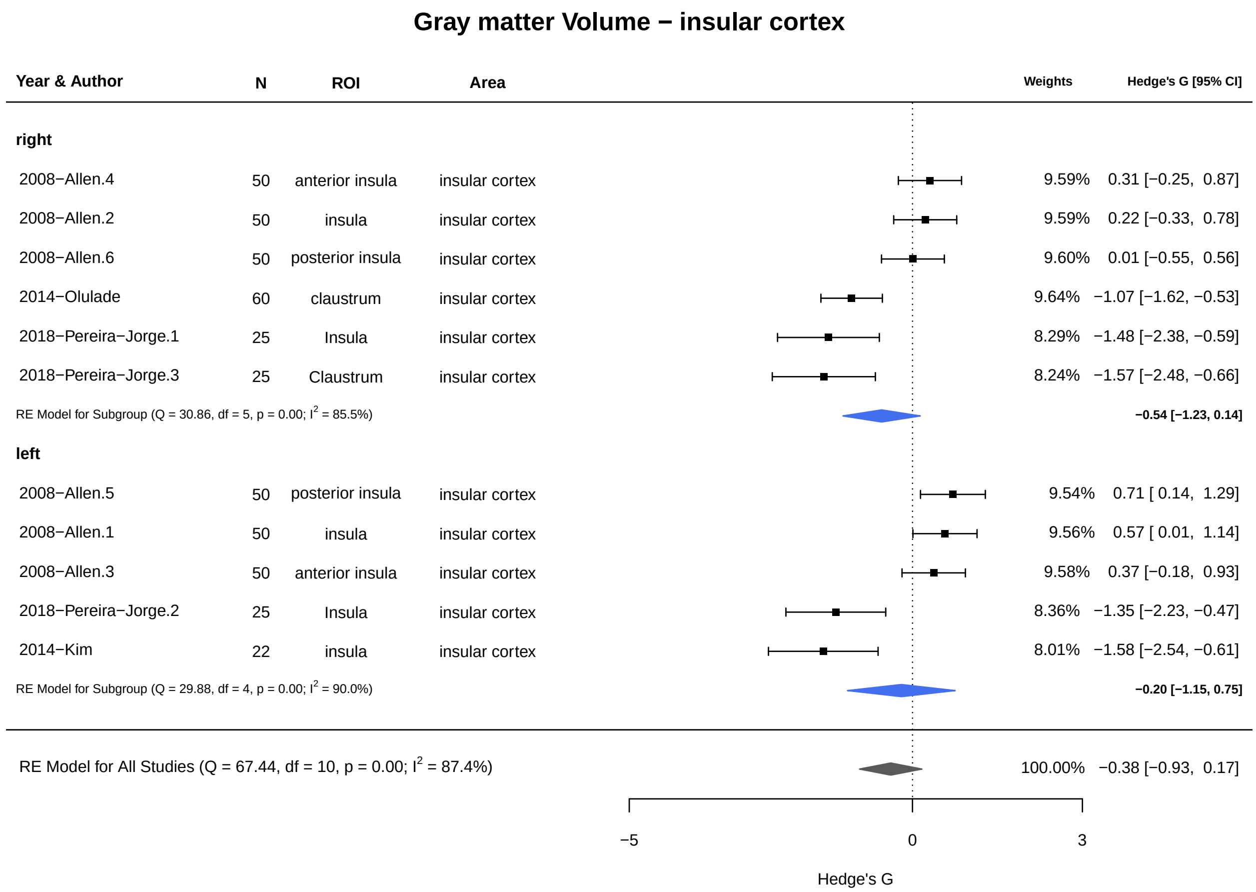

Gray matter Volume − cerebellum
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2014−Kim.1 19 Culmen cerebellum 6.34% 1.75 [0.67, 2.84]
2014−Kim.3 22 Culmen cerebellum 6.68% 1.71 [0.72, 2.70]
2010−Li,.1 32 cerebellar hemisphere cerebellum 7.36% 1.59 [0.79, 2.39]
RE Model for Subgroup (Q = 0.06, df = 2, p = 0.97; I2 = 0.0%) 1.67 [1.13, 2.21]
left
2014−Kim.4 22 Culmen cerebellum 6.74% 1.61 [0.64, 2.59]
2014−Kim.8 22 Declive cerebellum 6.83% 1.44 [0.50, 2.39]
2010−Li,.2 32 cerebellar hemisphere cerebellum 7.44% 1.40 [0.62, 2.18]
2014−Kim.9 22 Culmen cerebellum 6.90% 1.30 [0.37, 2.23]
2014−Kim.2 22 Culmen cerebellum 6.90% 1.30 [0.37, 2.22]
2014−Kim.5 22 Culmen cerebellum 6.92% 1.27 [0.34, 2.19]
2014−Kim.6 22 Culmen cerebellum 6.92% 1.26 [0.34, 2.18]
2014−Kim.7 22 Culmen cerebellum 6.94% 1.21 [0.30, 2.13]
2010−Li,.3 32 cerebellar hemisphere cerebellum 7.52% 1.17 [0.42, 1.93]
2014−Olulade.2 60 cerebellum cerebellum 8.27% −0.72 [−1.25, −0.20]
2014−Olulade.1 60 cerebellum cerebellum 8.23% −0.98 [−1.52, −0.45]
RE Model for Subgroup (Q = 80.79, df = 10, p = 0.00; I2 = 82.9%) 0.88 [0.30, 1.46]
RE Model for All Studies (Q = 96.30, df = 13, p = 0.00; I2 = 80.5%) 100.00% 1.04 [0.54, 1.53]
−5
0
3
Hedge's G

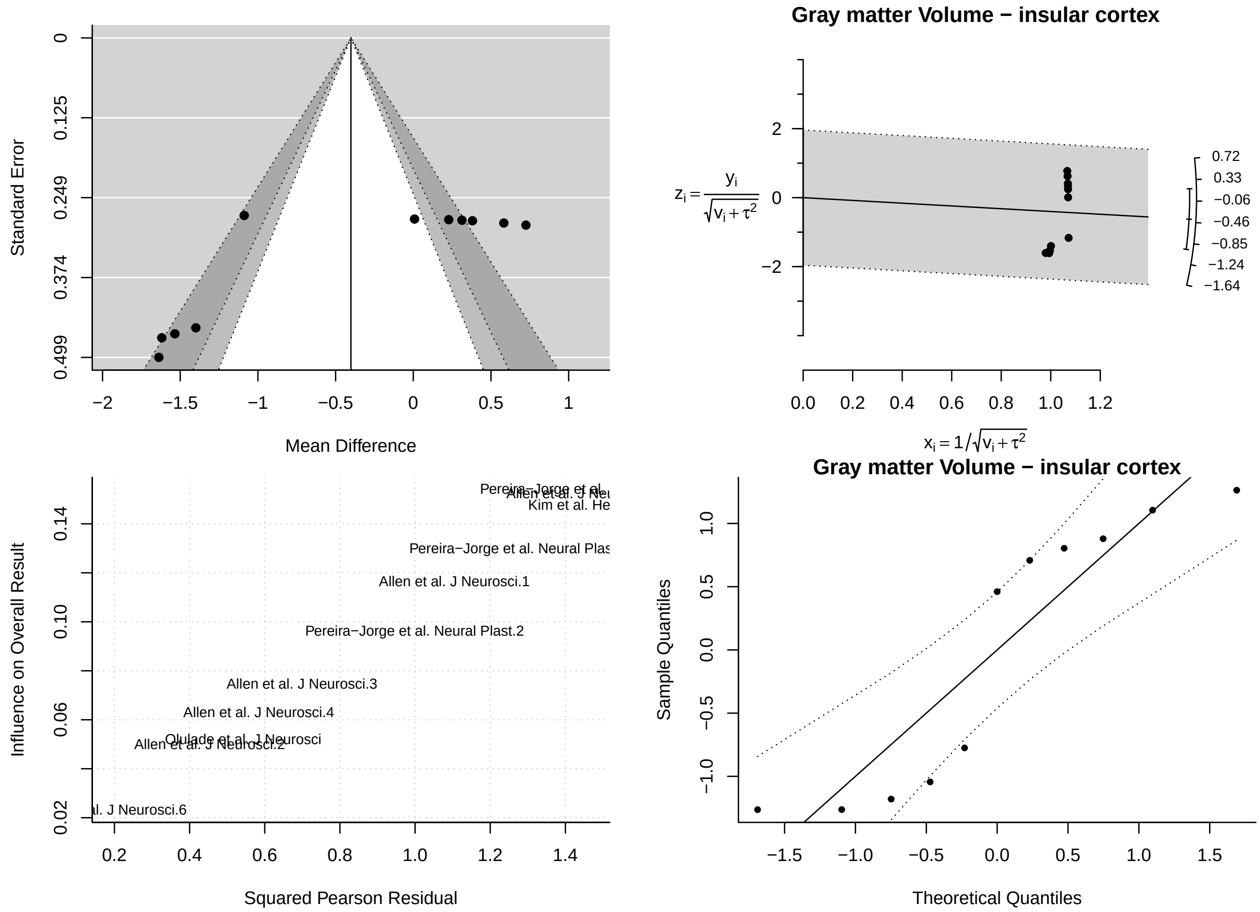

Gray matter Volume − cerebellum
Standard Error
Mean Difference
Influence on Overall Result
Squared Pearson Residual
Olulade et al. J Neurosci.2
Sample Quantiles
Theoretical Quantiles
Gray matter Volume − cerebellum



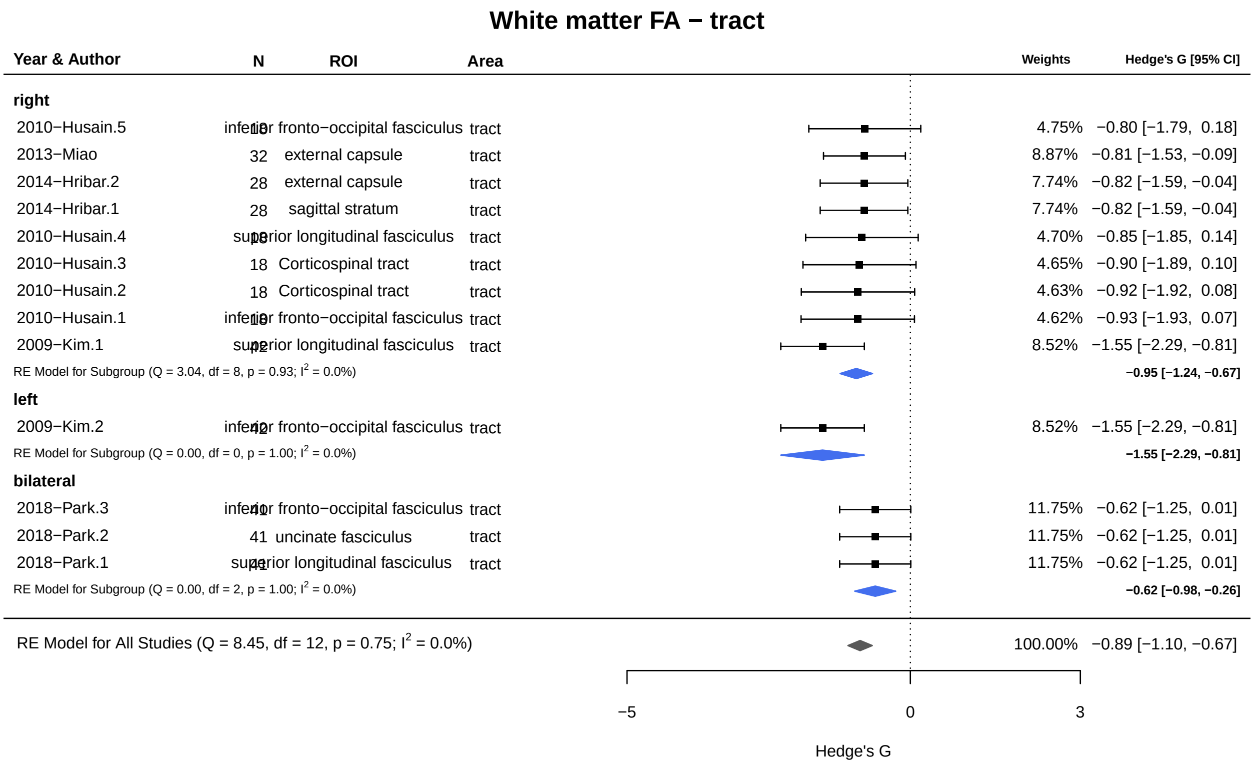
Gray matter Volume − occipital
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2018−Pereira−Jorge.2 25 Lingual gyrus occipital 5.72% −1.13 [−1.98, −0.27]
2010−Li,.3 32 occipital occipital 5.86% −1.23 [−1.99, −0.47]
2018−Pereira−Jorge.1 25 Lateral occipital gyrus occipital 5.67% −1.38 [−2.26, −0.49]
2013−Boyen.2 40 occipital lobe occipital 5.87% −1.79 [−2.53, −1.04]
2013−Boyen.1 40 occipital lobe occipital 5.87% −1.80 [−2.55, −1.05]
2014−Kim 19 Cuneus occipital 5.15% −2.31 [−3.50, −1.11]
RE Model for Subgroup (Q = 4.13, df = 5, p = 0.53; I2 = 0.0%) −1.55 [−1.89, −1.21]
left
2007−Shibata 104 occipital occipital 6.17% 2.52 [2.01, 3.04]
2011−Smith 42 mid−occipital occipital 5.97% 1.23 [0.55, 1.90]
2014−Olulade 60 lingual gyrus occipital 6.15% −0.87 [−1.40, −0.34]
2010−Li,.2 32 fusiform gyrus occipital 5.85% −1.27 [−2.03, −0.51]
2010−Li,.1 32 occipital occipital 5.83% −1.39 [−2.17, −0.62]
2018−Pereira−Jorge.3 25 Middle occipital gyrus occipital 5.67% −1.40 [−2.28, −0.51]
2013−Pénicaud.2 66 occipital −V3a/V7 occipital 6.07% −1.84 [−2.44, −1.24]
2013−Pénicaud.1 66 occipital −V1/V2 occipital 6.04% −2.14 [−2.77, −1.52]
RE Model for Subgroup (Q = 215.68, df = 7, p = 0.00; I2 = 96.0%) −0.64 [−1.78, 0.51]
bilateral
2000−Bavelier 20 V1 occipital 5.68% 0.09 [−0.80, 0.97]
2014−Profant 54 V1 occipital 6.13% −0.23 [−0.79, 0.32]
2014−Lin 126 occipital lobe occipital 6.31% −0.55 [−0.91, −0.18]
RE Model for Subgroup (Q = 2.14, df = 2, p = 0.34; I2 = 12.3%) −0.38 [−0.70, −0.06]
RE Model for All Studies (Q = 256.56, df = 16, p = 0.00; I2 = 92.8%) 100.00% −0.89 [−1.49, −0.29]
−5
0
3
Hedge's G

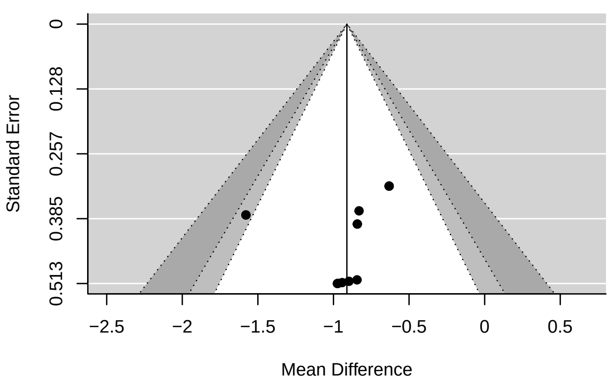

Standard Error
Mean Difference
Gray matter Volume − occipital
$z_i = \frac{y_i}{\sqrt{v_i + \tau^2}}$
$x_i = 1/\sqrt{v_i + \tau^2}$
Gray matter Volume − occipital
Influence on Overall Result
Shibata DK. Am J
Smith et al. Cereb Cortex
Squared Pearson Residual
Sample Quantiles
Theoretical Quantiles

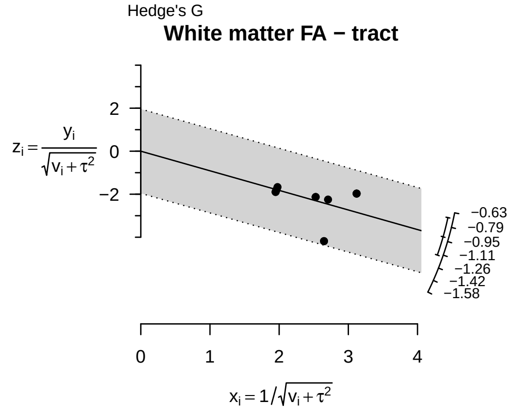

Gray matter Volume − insular cortex
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2008−Allen.4 50 anterior insula insular cortex 9.59% 0.31 [−0.25, 0.87]
2008−Allen.2 50 insula insular cortex 9.59% 0.22 [−0.33, 0.78]
2008−Allen.6 50 posterior insula insular cortex 9.60% 0.01 [−0.55, 0.56]
2014−Olulade 60 claustrum insular cortex 9.64% −1.07 [−1.62, −0.53]
2018−Pereira−Jorge.1 25 Insula insular cortex 8.29% −1.48 [−2.38, −0.59]
2018−Pereira−Jorge.3 25 Claustrum insular cortex 8.24% −1.57 [−2.48, −0.66]
RE Model for Subgroup (Q = 30.86, df = 5, p = 0.00; I2 = 85.5%) −0.54 [−1.23, 0.14]
left
2008−Allen.5 50 posterior insula insular cortex 9.54% 0.71 [0.14, 1.29]
2008−Allen.1 50 insula insular cortex 9.56% 0.57 [0.01, 1.14]
2008−Allen.3 50 anterior insula insular cortex 9.58% 0.37 [−0.18, 0.93]
2018−Pereira−Jorge.2 25 Insula insular cortex 8.36% −1.35 [−2.23, −0.47]
2014−Kim 22 insula insular cortex 8.01% −1.58 [−2.54, −0.61]
RE Model for Subgroup (Q = 29.88, df = 4, p = 0.00; I2 = 90.0%) −0.20 [−1.15, 0.75]
RE Model for All Studies (Q = 67.44, df = 10, p = 0.00; I2 = 87.4%) 100.00% −0.38 [−0.93, 0.17]
−5
0
3
Hedge's G

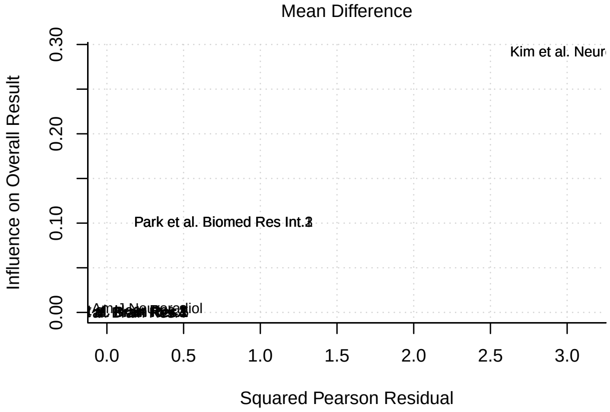

Gray matter Volume − insular cortex
Gray matter Volume − insular cortex
Standard Error
Mean Difference
Influence on Overall Result
Squared Pearson Residual
Pereira−Jorge et al. Neural Plast.2
Allen et al. J Neurosci.1
Allen et al. J Neurosci.3
Allen et al. J Neurosci.4
Sample Quantiles
Theoretical Quantiles

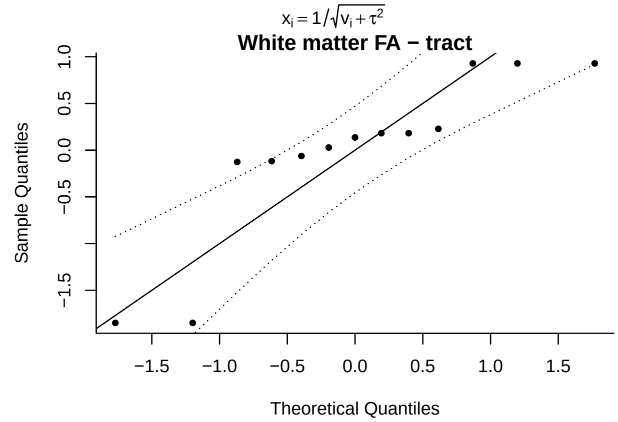
Meta-regressions of White Matter FA & Brain Areas: Random effects model no intercept covariated by Side

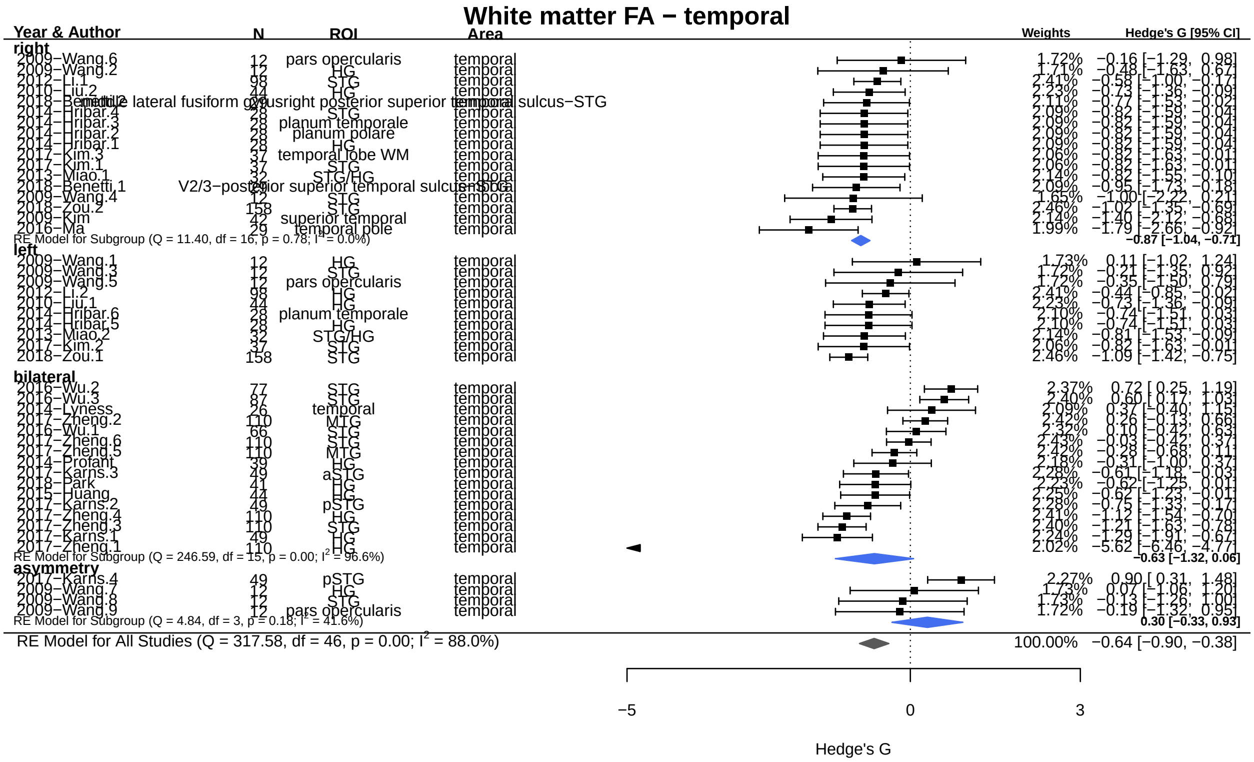




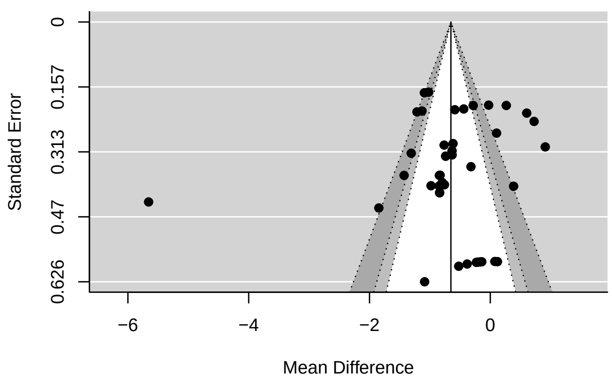


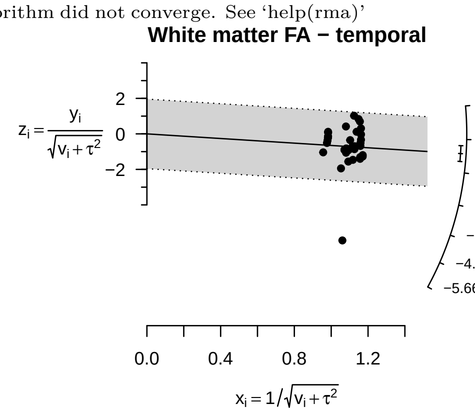


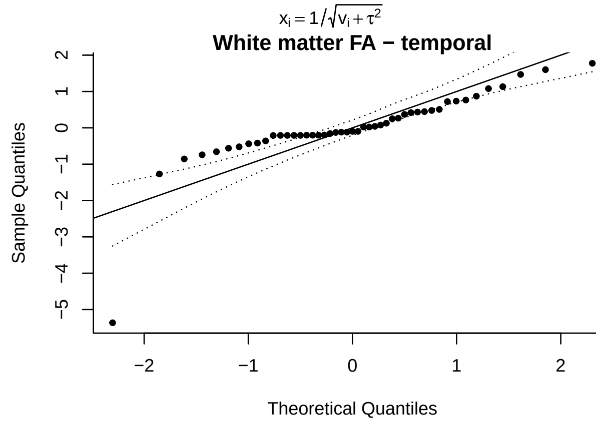




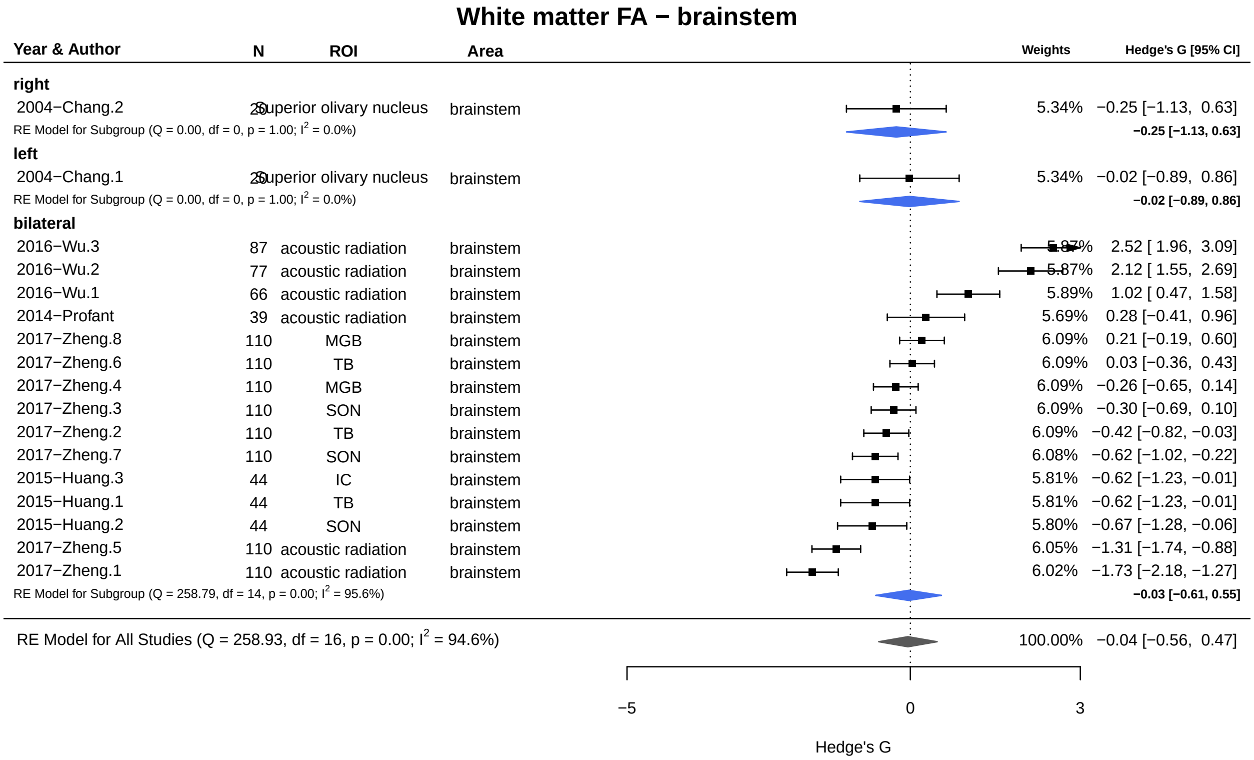
Error in rma(yi = hedgesG, vi = varG, data = meta.mod, measure = "MD", : Fisher scoring algorithm did not converge. See 'help(rma)'



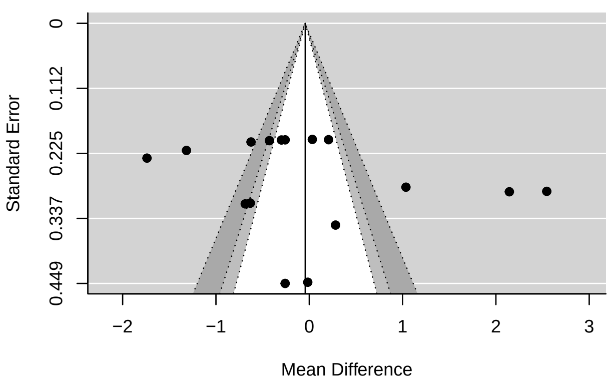




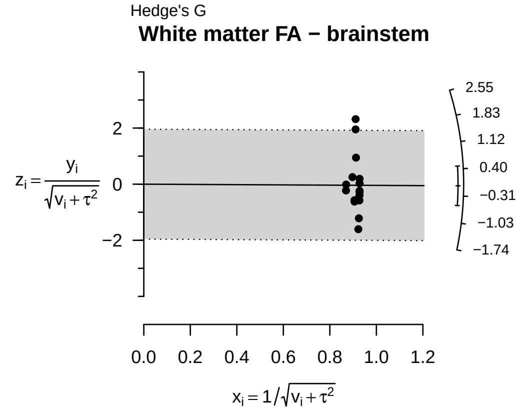
for possible remedies.



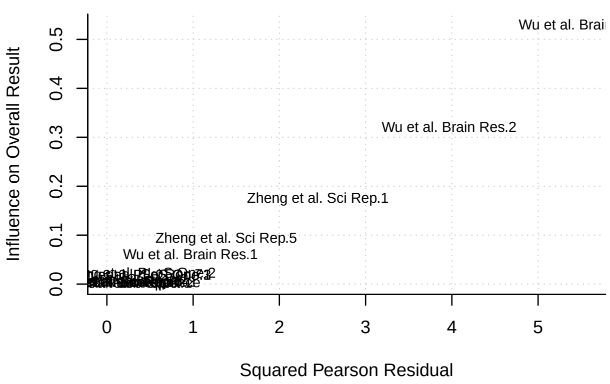
White matter FA − brainstem
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2004−Chang.2
Superior olivary nucleus
brainstem
5.34%
−0.25 [−1.13, 0.63]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%)
−0.25 [−1.13, 0.63]
left
2004−Chang.1
Superior olivary nucleus
brainstem
5.34%
−0.02 [−0.89, 0.86]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%)
−0.02 [−0.89, 0.86]
bilateral
2016−Wu.3 87 acoustic radiation brainstem 2.52 [1.96, 3.09]
2016−Wu.2 77 acoustic radiation brainstem 5.87% 2.12 [1.55, 2.69]
2016−Wu.1 66 acoustic radiation brainstem 5.89% 1.02 [0.47, 1.58]
2014−Profant 39 acoustic radiation brainstem 5.69% 0.28 [−0.41, 0.96]
2017−Zheng.8 110 MGB brainstem 6.09% 0.21 [−0.19, 0.60]
2017−Zheng.6 110 TB brainstem 6.09% 0.03 [−0.36, 0.43]
2017−Zheng.4 110 MGB brainstem 6.09% −0.26 [−0.65, 0.14]
2017−Zheng.3 110 SON brainstem 6.09% −0.30 [−0.69, 0.10]
2017−Zheng.2 110 TB brainstem 6.09% −0.42 [−0.82, −0.03]
2017−Zheng.7 110 SON brainstem 6.08% −0.62 [−1.02, −0.22]
2015−Huang.3 44 IC brainstem 5.81% −0.62 [−1.23, −0.01]
2015−Huang.1 44 TB brainstem 5.81% −0.62 [−1.23, −0.01]
2015−Huang.2 44 SON brainstem 5.80% −0.67 [−1.28, −0.06]
2017−Zheng.5 110 acoustic radiation brainstem 6.05% −1.31 [−1.74, −0.88]
2017−Zheng.1 110 acoustic radiation brainstem 6.02% −1.73 [−2.18, −1.27]
RE Model for Subgroup (Q = 258.79, df = 14, p = 0.00; I2 = 95.6%)
−0.03 [−0.61, 0.55]
RE Model for All Studies (Q = 258.93, df = 16, p = 0.00; I2 = 94.6%)
100.00%
−0.04 [−0.56, 0.47]
−5
0
3
Hedge's G



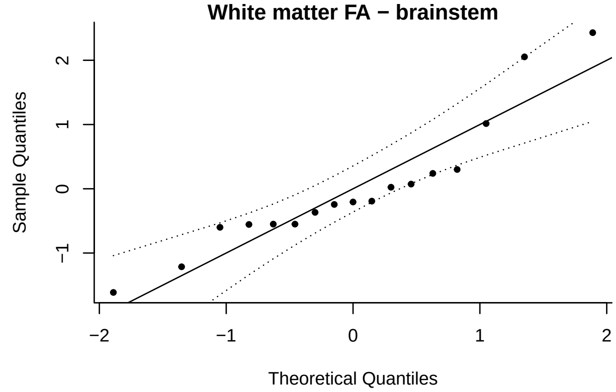
Standard Error
0
0.112
0.225
0.337
0.449
−2
−1
0
1
2
3
Mean Difference



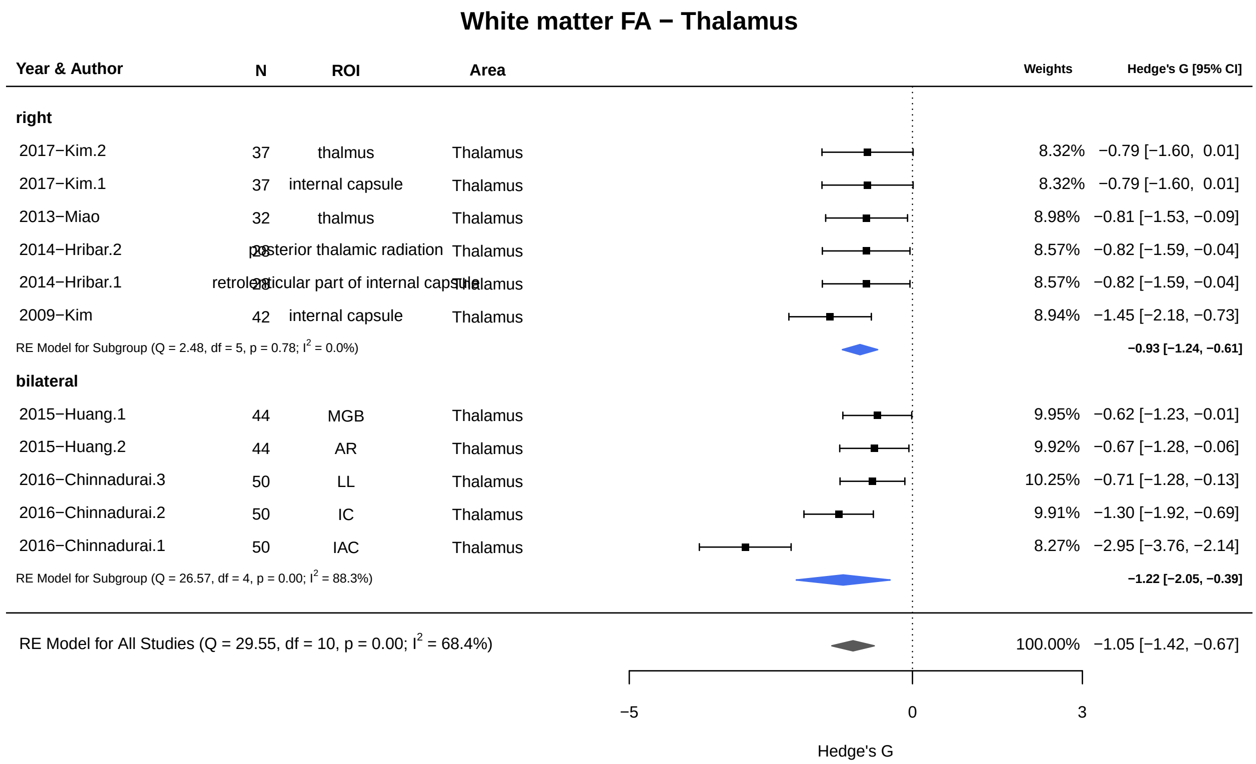
White matter FA − brainstem
$z_i = \frac{y_i}{\sqrt{v_i + \tau^2}}$
2
0
−2
2.55
1.83
1.12
0.40
−0.31
−1.03
−1.74
0.0
0.2
0.4
0.6
0.8
1.0
1.2
$x_i = 1/\sqrt{v_i + \tau^2}$

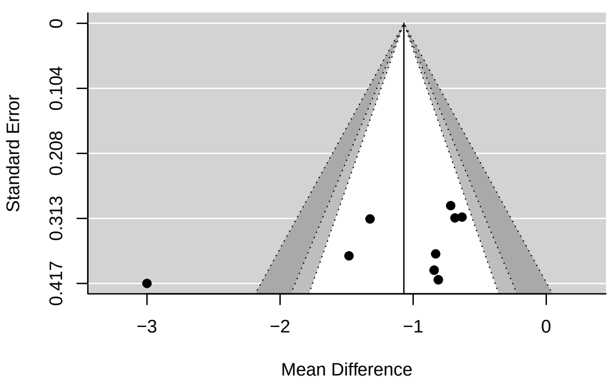


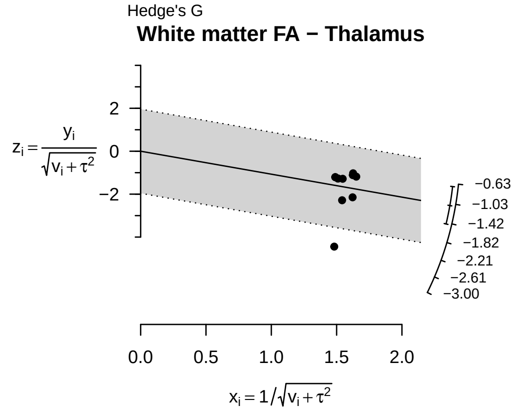
Influence on Overall Result
0.0
0.1
0.2
0.3
0.4
0.5
Wu et al. Brai
Wu et al. Brain Res.2
Zheng et al. Sci Rep.1
Zheng et al. Sci Rep.5
Wu et al. Brain Res.1
0
1
2
3
4
5
Squared Pearson Residual

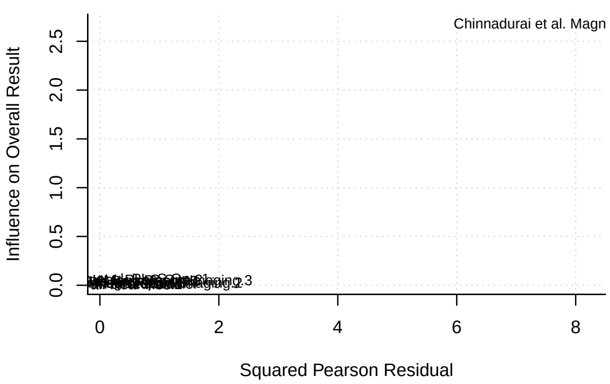


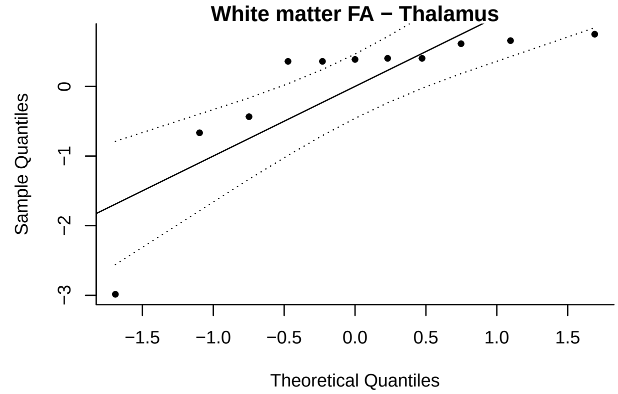
White matter FA − brainstem
Sample Quantiles
−1
0
1
2
−2
−1
0
1
2
Theoretical Quantiles

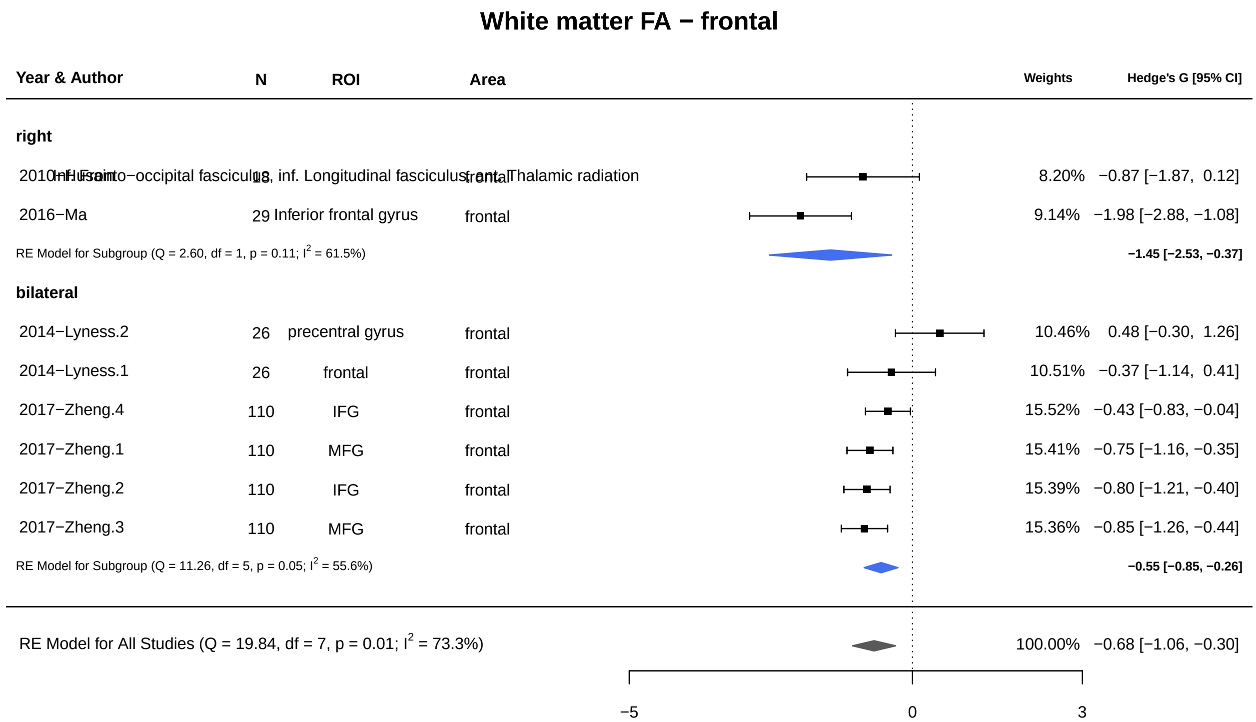

White matter FA − Thalamus
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2017−Kim.2 37 thalmus Thalamus 8.32% −0.79 [−1.60, 0.01]
2017−Kim.1 37 internal capsule Thalamus 8.32% −0.79 [−1.60, 0.01]
2013−Miao 32 thalmus Thalamus 8.98% −0.81 [−1.53, −0.09]
2014−Hribar.2 28 posterior thalamic radiation Thalamus 8.57% −0.82 [−1.59, −0.04]
2014−Hribar.1 28 retrolenticular part of internal capsule Thalamus 8.57% −0.82 [−1.59, −0.04]
2009−Kim 42 internal capsule Thalamus 8.94% −1.45 [−2.18, −0.73]
RE Model for Subgroup (Q = 2.48, df = 5, p = 0.78; I^2 = 0.0%) −0.93 [−1.24, −0.61]
bilateral
2015−Huang.1 44 MGB Thalamus 9.95% −0.62 [−1.23, −0.01]
2015−Huang.2 44 AR Thalamus 9.92% −0.67 [−1.28, −0.06]
2016−Chinnadurai.3 50 LL Thalamus 10.25% −0.71 [−1.28, −0.13]
2016−Chinnadurai.2 50 IC Thalamus 9.91% −1.30 [−1.92, −0.69]
2016−Chinnadurai.1 50 IAC Thalamus 8.27% −2.95 [−3.76, −2.14]
RE Model for Subgroup (Q = 26.57, df = 4, p = 0.00; I^2 = 88.3%) −1.22 [−2.05, −0.39]
RE Model for All Studies (Q = 29.55, df = 10, p = 0.00; I^2 = 68.4%) 100.00% −1.05 [−1.42, −0.67]
−5
0
3
Hedge's G

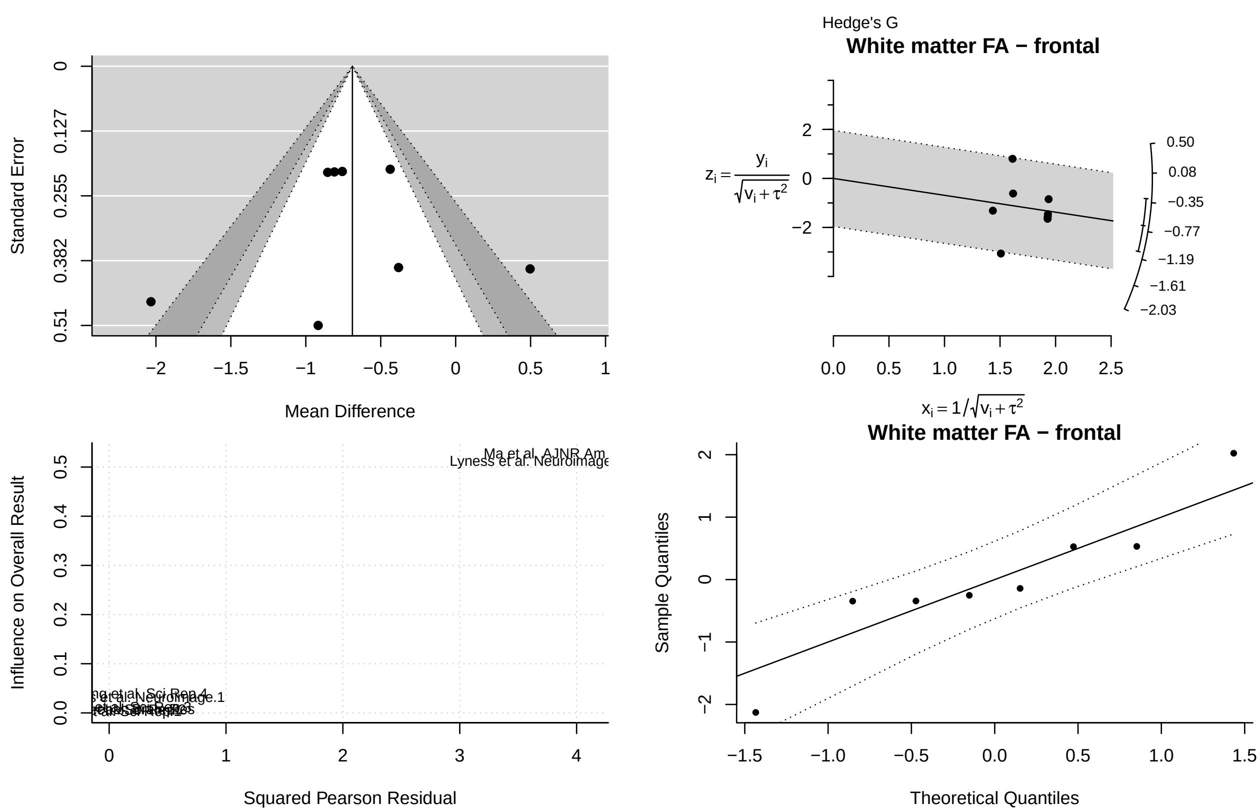

Standard Error
0
0.104
0.208
0.313
0.417
−3
−2
−1
0
Mean Difference

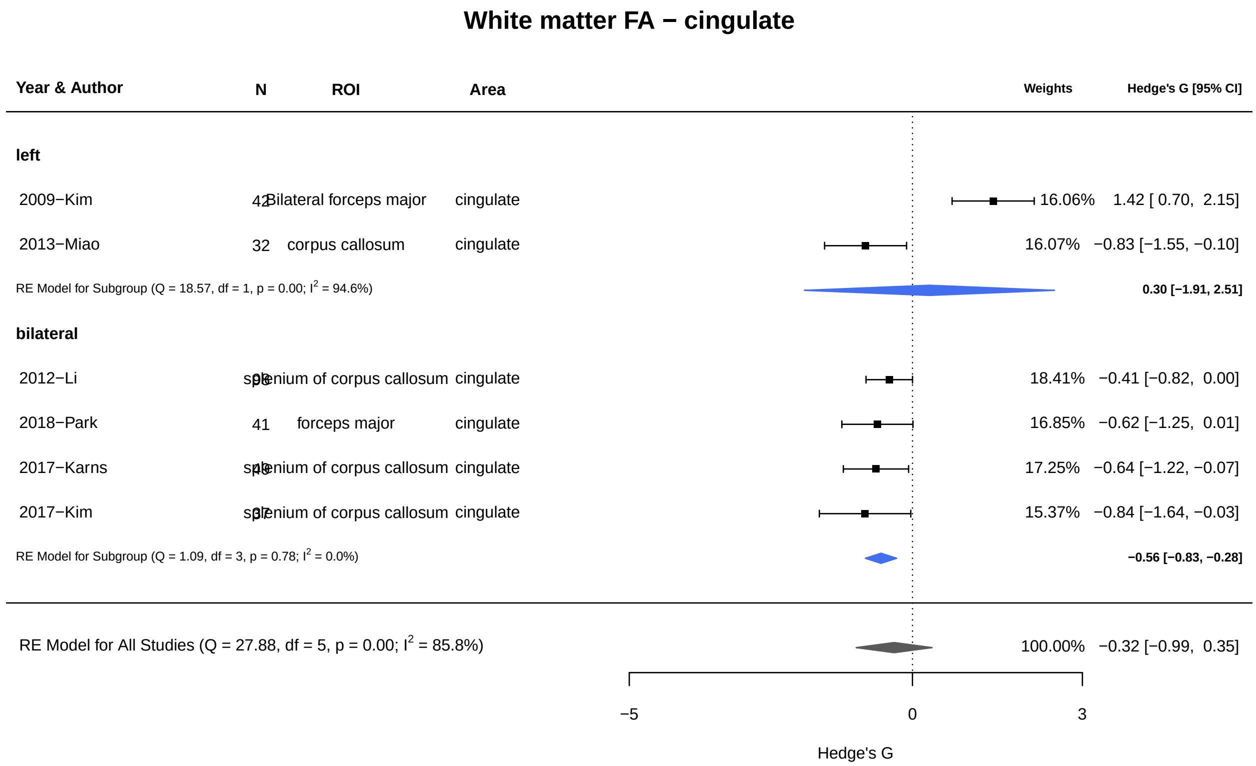

White matter FA − Thalamus
2
0
−2
−0.63
−1.03
−1.42
−1.82
−2.21
−2.61
−3.00
0.0
0.5
1.0
1.5
2.0

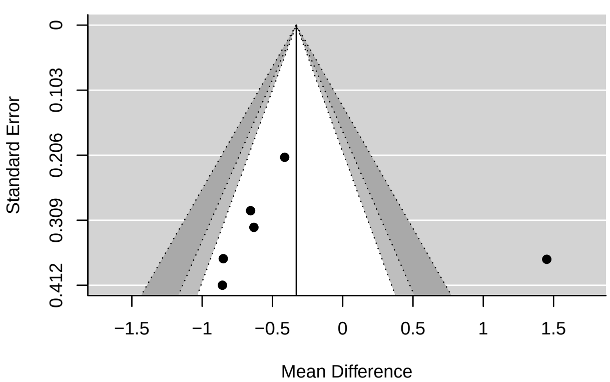

Chinnadurai et al. Magn
Influence on Overall Result
0.0
0.5
1.0
1.5
2.0
2.5
0
2
4
6
8
Squared Pearson Residual

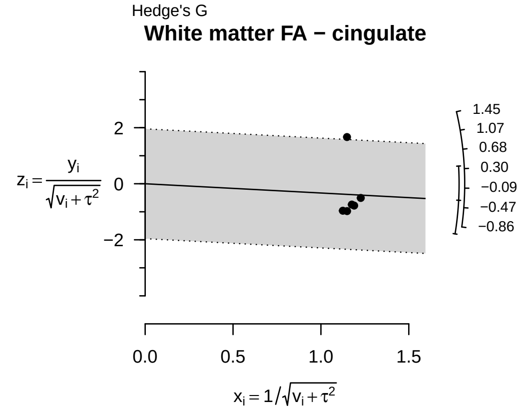

White matter FA − Thalamus
Sample Quantiles
0
−1
−2
−3
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles


White matter FA − frontal
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
Inf. Fronto−occipital fasciculus, inf. Longitudinal fasciculus, ant. Thalamic radiation
18
frontal
8.20% −0.87 [−1.87, 0.12]
2016−Ma
29
Inferior frontal gyrus
frontal
9.14% −1.98 [−2.88, −1.08]
RE Model for Subgroup (Q = 2.60, df = 1, p = 0.11; I2 = 61.5%)
−1.45 [−2.53, −0.37]
bilateral
2014−Lyness.2 26 precentral gyrus frontal 10.46% 0.48 [−0.30, 1.26]
2014−Lyness.1 26 frontal frontal 10.51% −0.37 [−1.14, 0.41]
2017−Zheng.4 110 IFG frontal 15.52% −0.43 [−0.83, −0.04]
2017−Zheng.1 110 MFG frontal 15.41% −0.75 [−1.16, −0.35]
2017−Zheng.2 110 IFG frontal 15.39% −0.80 [−1.21, −0.40]
2017−Zheng.3 110 MFG frontal 15.36% −0.85 [−1.26, −0.44]
RE Model for Subgroup (Q = 11.26, df = 5, p = 0.05; I2 = 55.6%)
−0.55 [−0.85, −0.26]
RE Model for All Studies (Q = 19.84, df = 7, p = 0.01; I2 = 73.3%)
100.00% −0.68 [−1.06, −0.30]
−5
0
3
Hedge's G


Standard Error
Mean Difference
White matter FA − frontal
Influence on Overall Result
Squared Pearson Residual
Ma et al. AJNR Am
Lyness et al. Neuroimage
Sample Quantiles
Theoretical Quantiles
White matter FA − frontal

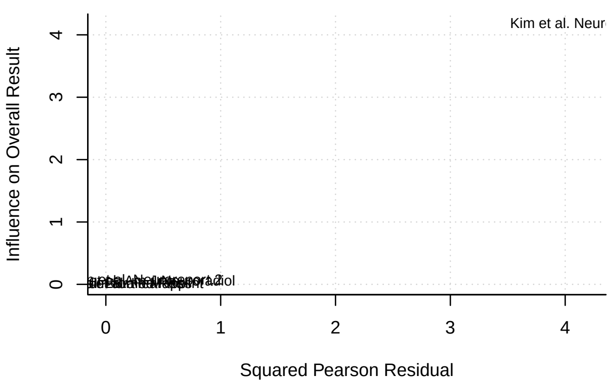


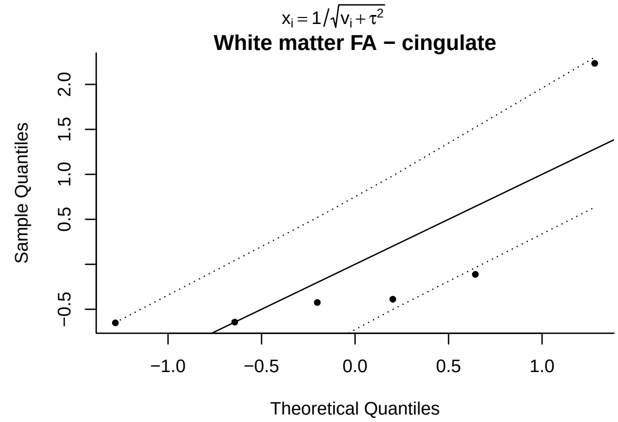


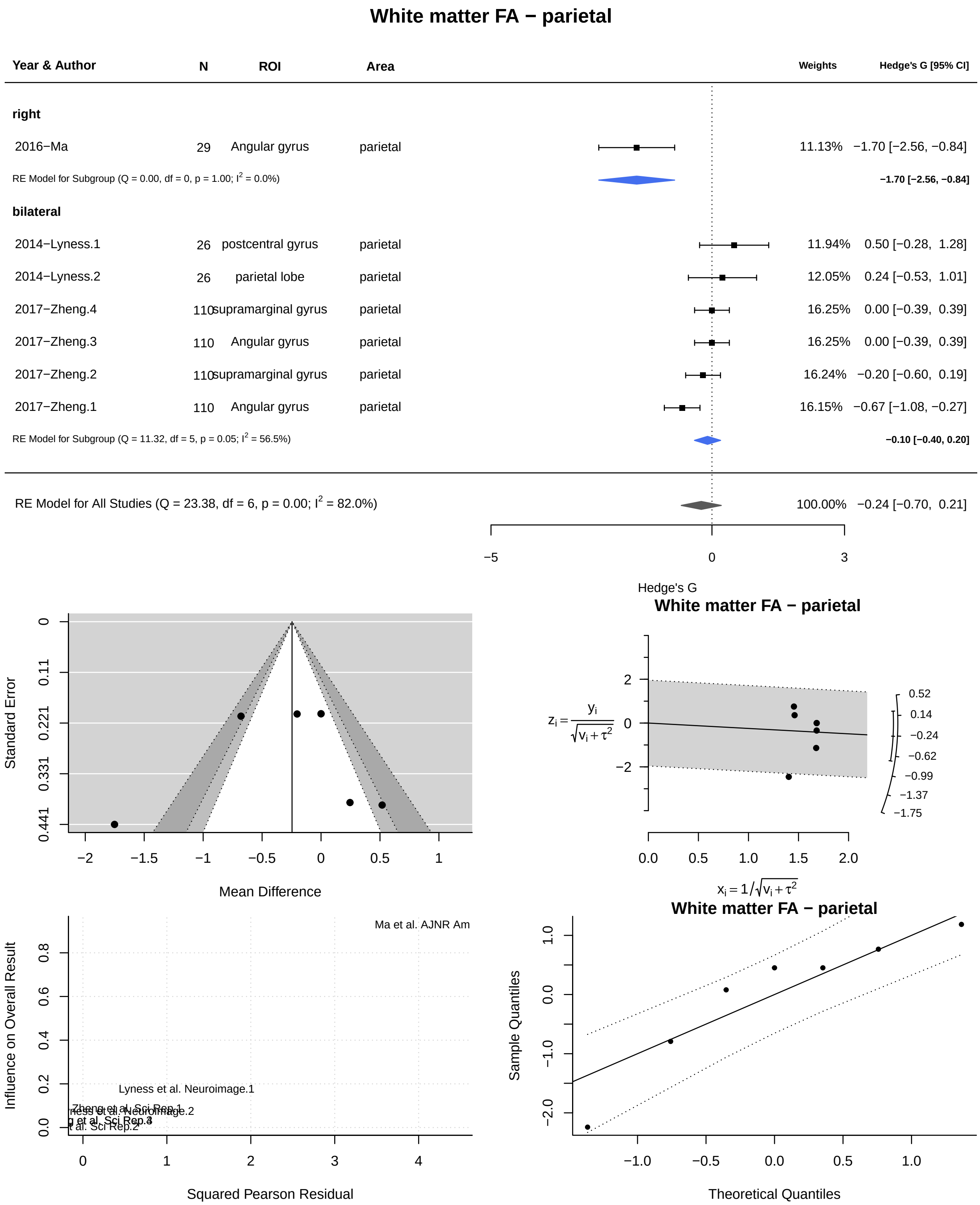


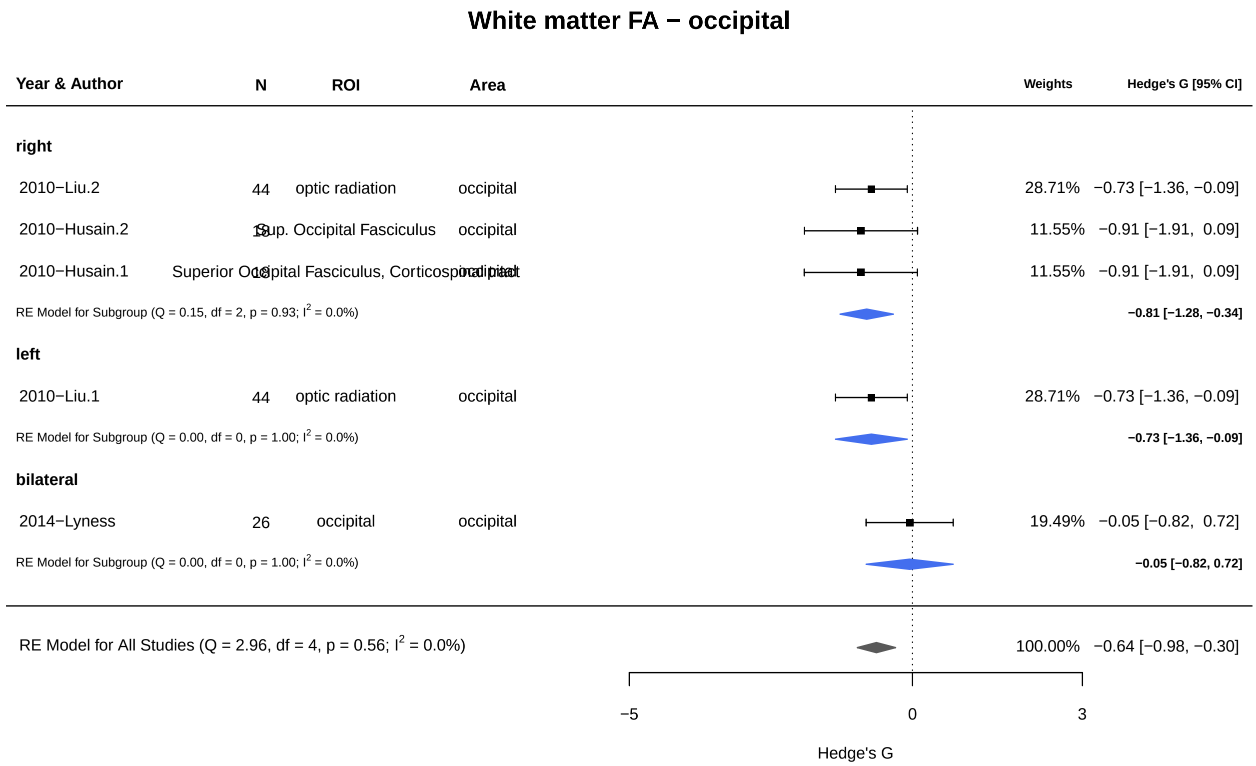
$$z_i = \frac{y_i}{\sqrt{v_i + \tau^2}}$$

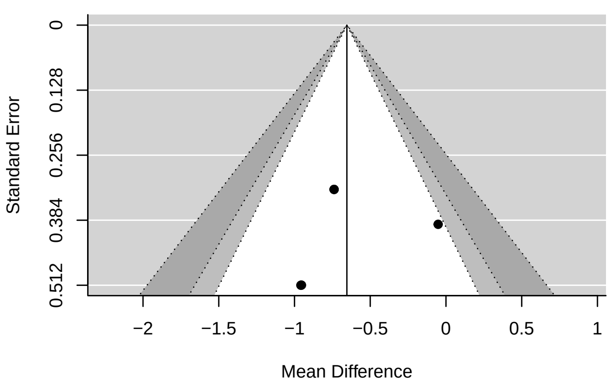
$$x_i = 1/\sqrt{v_i + \tau^2}$$

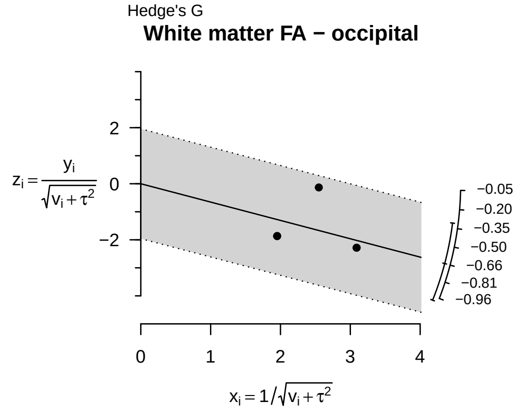


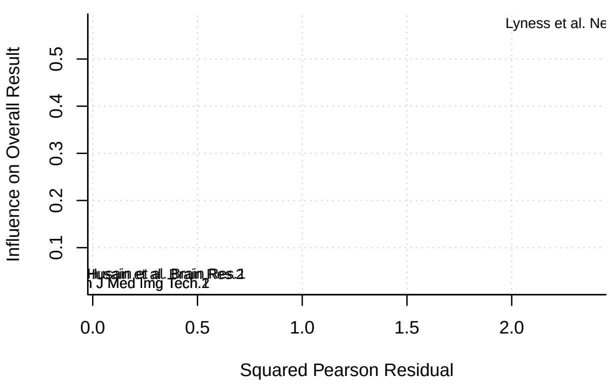


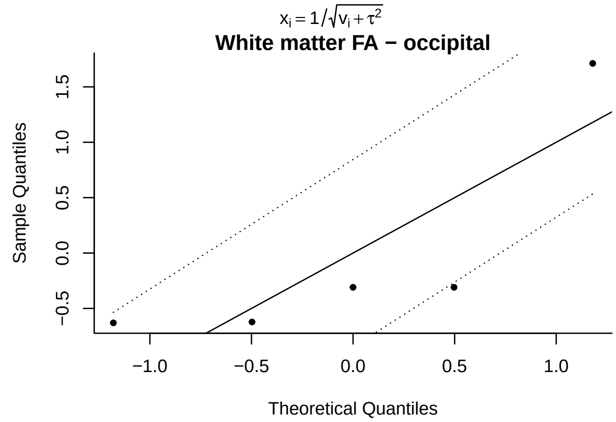

White matter FA − parietal
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2016−Ma 29 Angular gyrus parietal 11.13% −1.70 [−2.56, −0.84]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%) −1.70 [−2.56, −0.84]
bilateral
2014−Lyness.1 26 postcentral gyrus parietal 11.94% 0.50 [−0.28, 1.28]
2014−Lyness.2 26 parietal lobe parietal 12.05% 0.24 [−0.53, 1.01]
2017−Zheng.4 110 supramarginal gyrus parietal 16.25% 0.00 [−0.39, 0.39]
2017−Zheng.3 110 Angular gyrus parietal 16.25% 0.00 [−0.39, 0.39]
2017−Zheng.2 110 supramarginal gyrus parietal 16.24% −0.20 [−0.60, 0.19]
2017−Zheng.1 110 Angular gyrus parietal 16.15% −0.67 [−1.08, −0.27]
RE Model for Subgroup (Q = 11.32, df = 5, p = 0.05; I2 = 56.5%) −0.10 [−0.40, 0.20]
RE Model for All Studies (Q = 23.38, df = 6, p = 0.00; I2 = 82.0%) 100.00% −0.24 [−0.70, 0.21]
−5
0
3
Hedge's G
Standard Error
0
0.11
0.221
0.331
0.441
−2
−1.5
−1
−0.5
0
0.5
1
Mean Difference
White matter FA − parietal
2
0
−2
0.52
0.14
−0.24
−0.62
−0.99
−1.37
−1.75
0.0
0.5
1.0
1.5
2.0
Influence on Overall Result
0.0
0.2
0.4
0.6
0.8
Ma et al. AJNR Am
Lyness et al. Neuroimage.1
0
1
2
3
4
Squared Pearson Residual
White matter FA − parietal
Sample Quantiles
1.0
0.0
−1.0
−2.0
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles


White matter FA − occipital
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2010−Liu.2 44 optic radiation occipital 28.71% −0.73 [−1.36, −0.09]
2010−Husain.2 18 Sup. Occipital Fasciculus occipital 11.55% −0.91 [−1.91, 0.09]
2010−Husain.1 18 Superior Occipital Fasciculus, Corticospinal tract occipital 11.55% −0.91 [−1.91, 0.09]
RE Model for Subgroup (Q = 0.15, df = 2, p = 0.93; I2 = 0.0%) −0.81 [−1.28, −0.34]
left
2010−Liu.1 44 optic radiation occipital 28.71% −0.73 [−1.36, −0.09]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%) −0.73 [−1.36, −0.09]
bilateral
2014−Lyness 26 occipital occipital 19.49% −0.05 [−0.82, 0.72]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%) −0.05 [−0.82, 0.72]
RE Model for All Studies (Q = 2.96, df = 4, p = 0.56; I2 = 0.0%) 100.00% −0.64 [−0.98, −0.30]
−5
0
3
Hedge's G

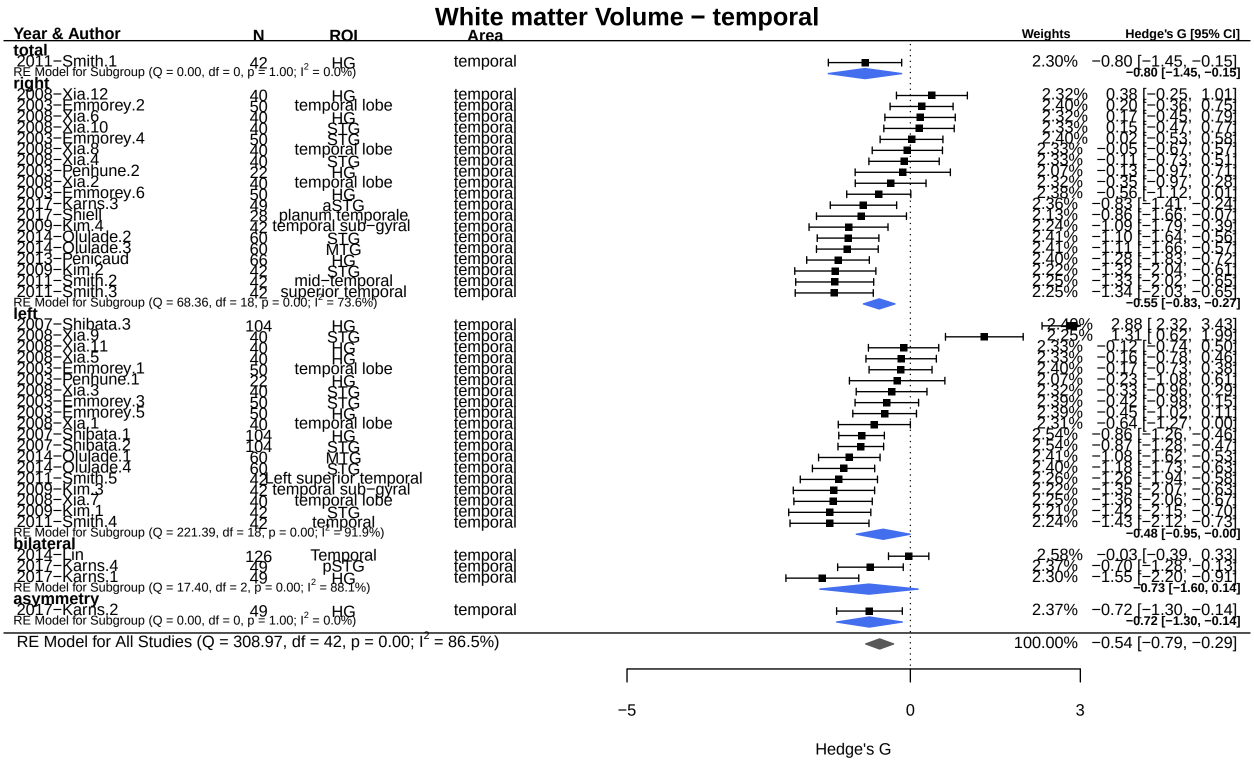

Standard Error
0
0.128
0.256
0.384
0.512
−2
−1.5
−1
−0.5
0
0.5
1
Mean Difference

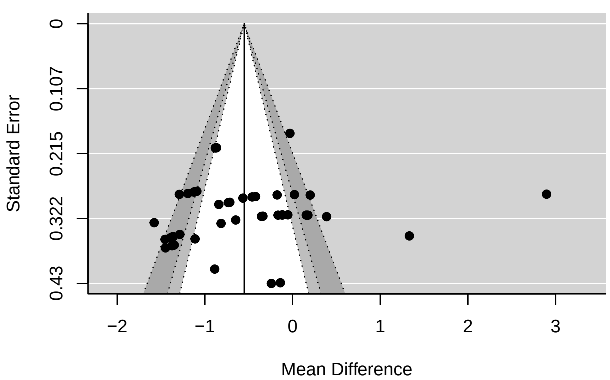

White matter FA − occipital
2
0
−2
−0.05
−0.20
−0.35
−0.50
−0.66
−0.81
−0.96
0
1
2
3
4

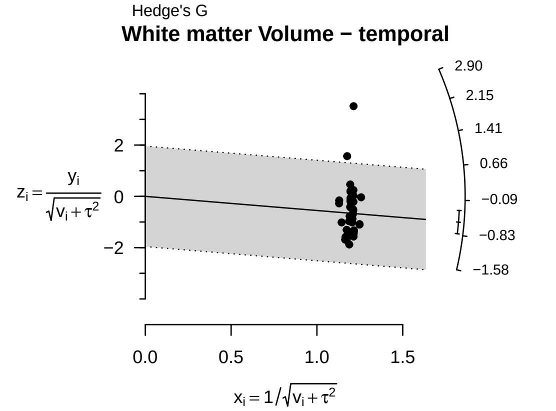

Influence on Overall Result
0.1
0.2
0.3
0.4
0.5
Lyness et al. Ne
Husain et al. Brain Res.1
Husain et al. Brain Res.2
n J Med Img Tech.2
0.0
0.5
1.0
1.5
2.0
Squared Pearson Residual

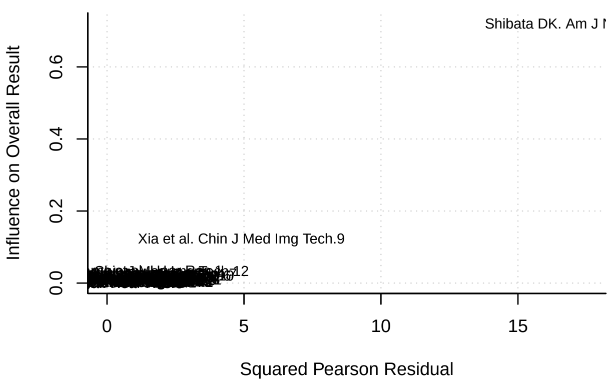

White matter FA − occipital
Sample Quantiles
−0.5
0.0
0.5
1.0
1.5
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles

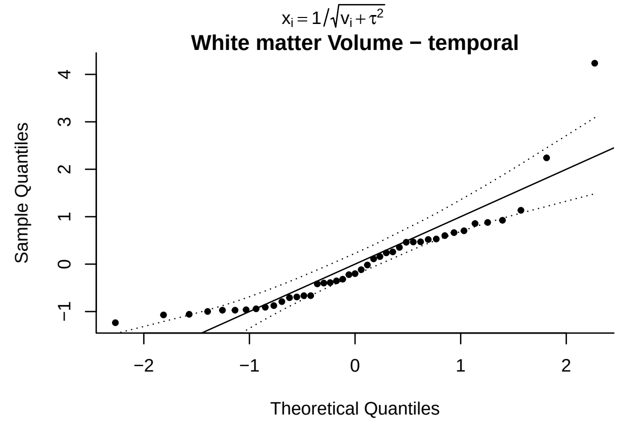
Meta-regressions of White Matter Volume & Brain Areas: Random effects model no intercept covariated by Side

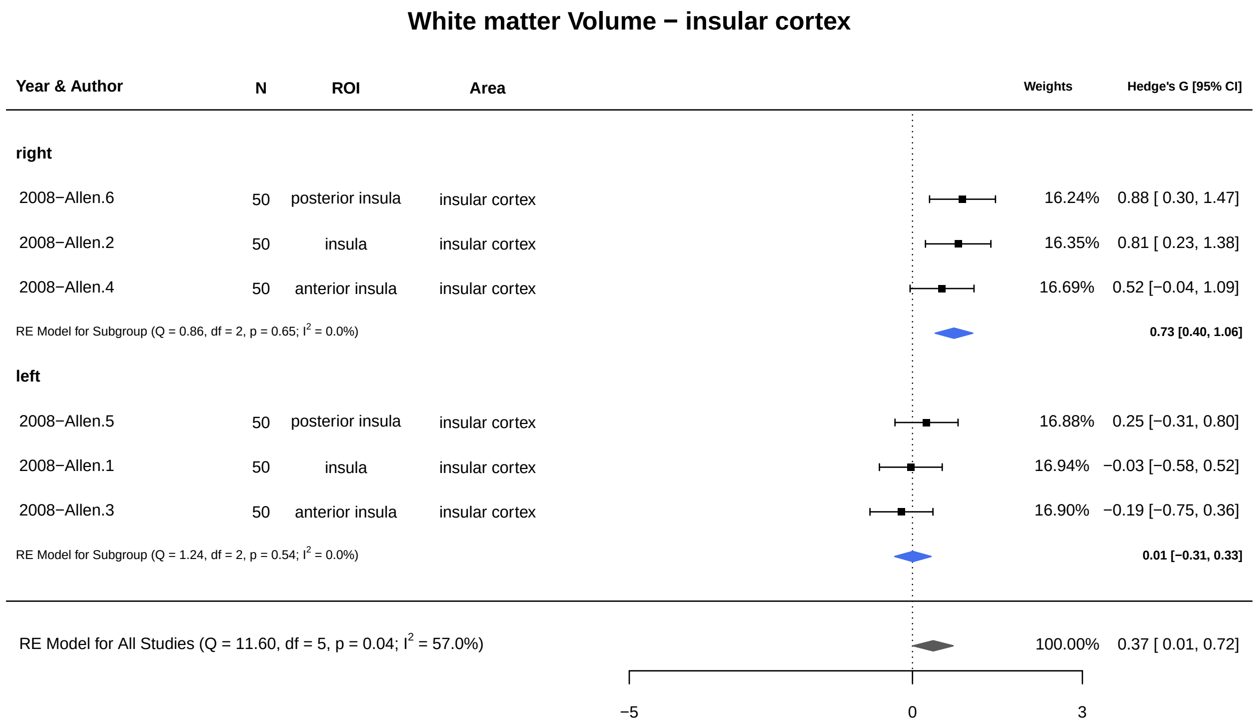


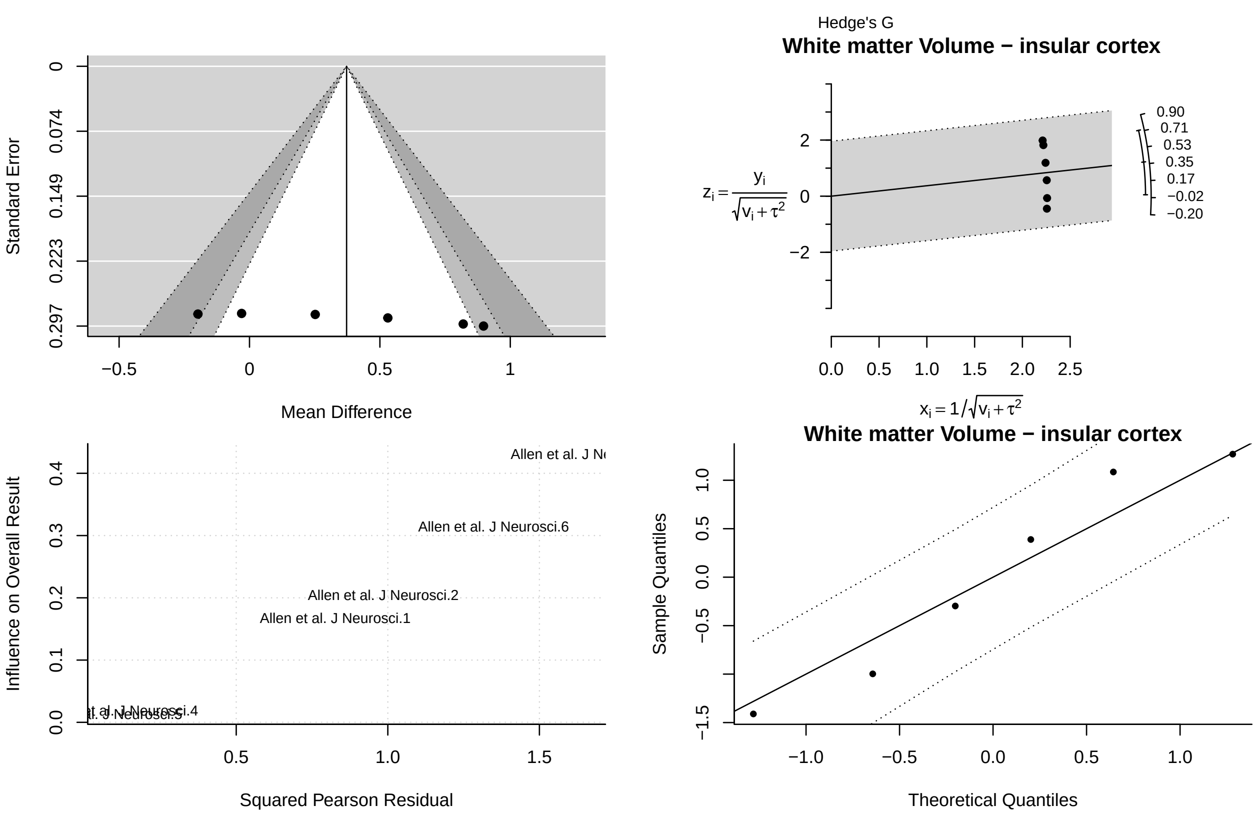


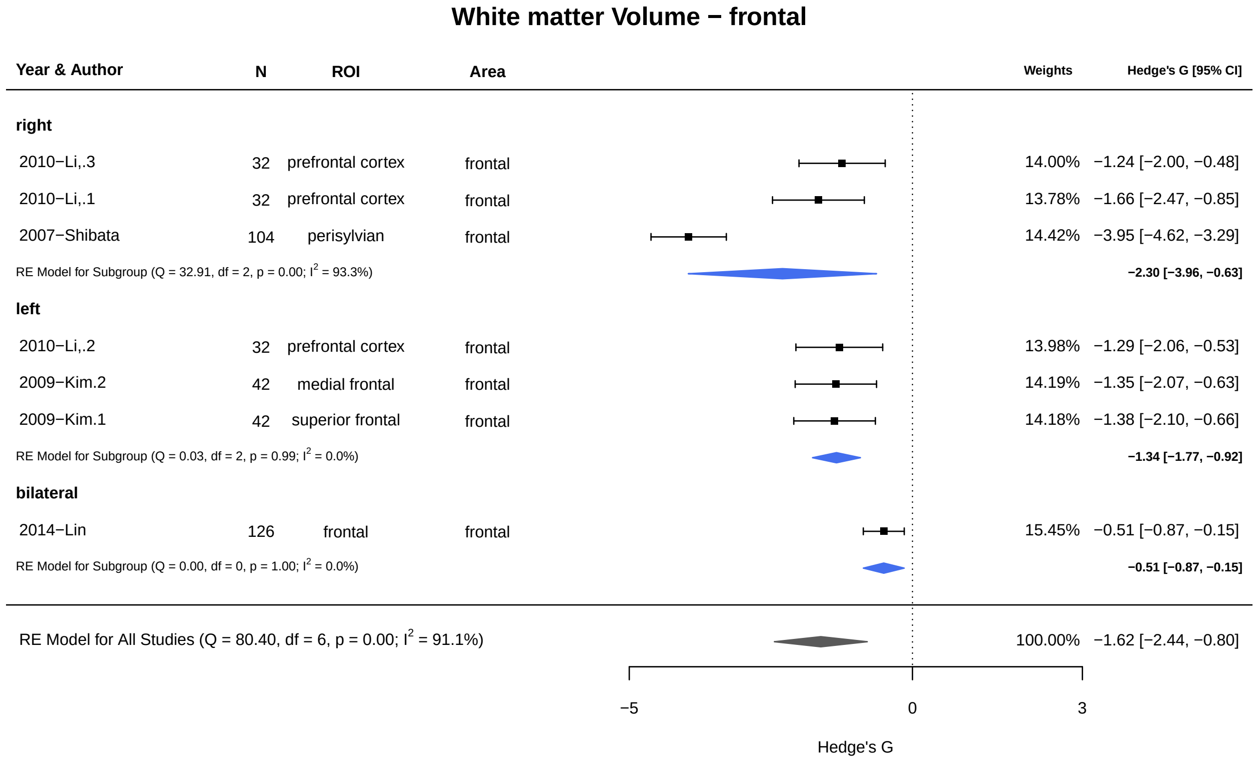


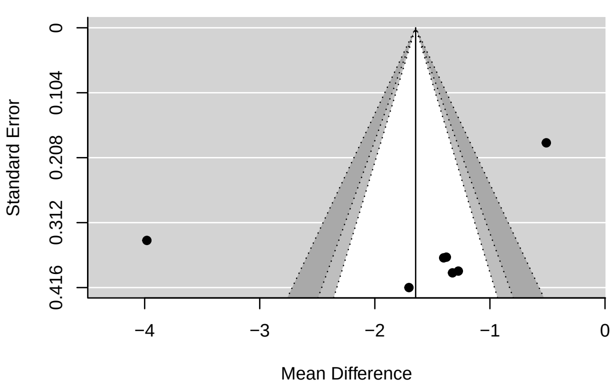


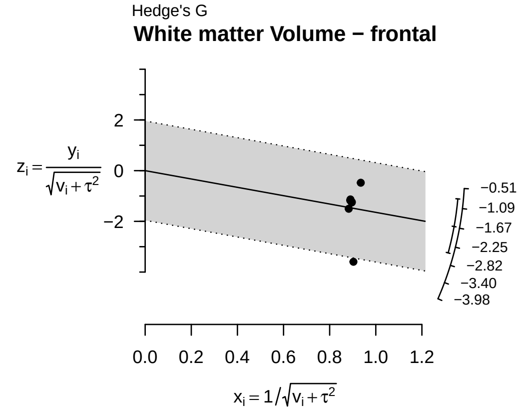



White matter Volume − insular cortex
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
right
2008−Allen.6 50 posterior insula insular cortex 16.24% 0.88 [0.30, 1.47]
2008−Allen.2 50 insula insular cortex 16.35% 0.81 [0.23, 1.38]
2008−Allen.4 50 anterior insula insular cortex 16.69% 0.52 [−0.04, 1.09]
RE Model for Subgroup (Q = 0.86, df = 2, p = 0.65; I2 = 0.0%) 0.73 [0.40, 1.06]
left
2008−Allen.5 50 posterior insula insular cortex 16.88% 0.25 [−0.31, 0.80]
2008−Allen.1 50 insula insular cortex 16.94% −0.03 [−0.58, 0.52]
2008−Allen.3 50 anterior insula insular cortex 16.90% −0.19 [−0.75, 0.36]
RE Model for Subgroup (Q = 1.24, df = 2, p = 0.54; I2 = 0.0%) 0.01 [−0.31, 0.33]
RE Model for All Studies (Q = 11.60, df = 5, p = 0.04; I2 = 57.0%) 100.00% 0.37 [0.01, 0.72]
−5
0
3
Hedge's G

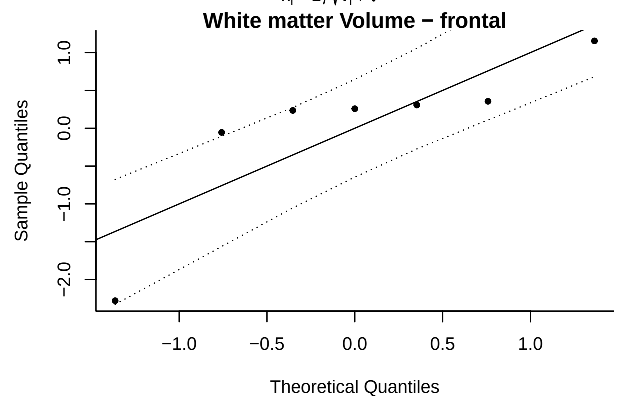

Standard Error
0
0.074
0.149
0.223
0.297
−0.5
0
0.5
1
Mean Difference
White matter Volume − insular cortex
2
0
−2
0.0
0.5
1.0
1.5
2.0
2.5
0.90
0.71
0.53
0.35
0.17
−0.02
−0.20
Influence on Overall Result
0.0
0.1
0.2
0.3
0.4
Allen et al. J Neurosci.6
Allen et al. J Neurosci.2
Allen et al. J Neurosci.1
0.5
1.0
1.5
Squared Pearson Residual
White matter Volume − insular cortex
Sample Quantiles
−1.5
−0.5
0.0
0.5
1.0
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles

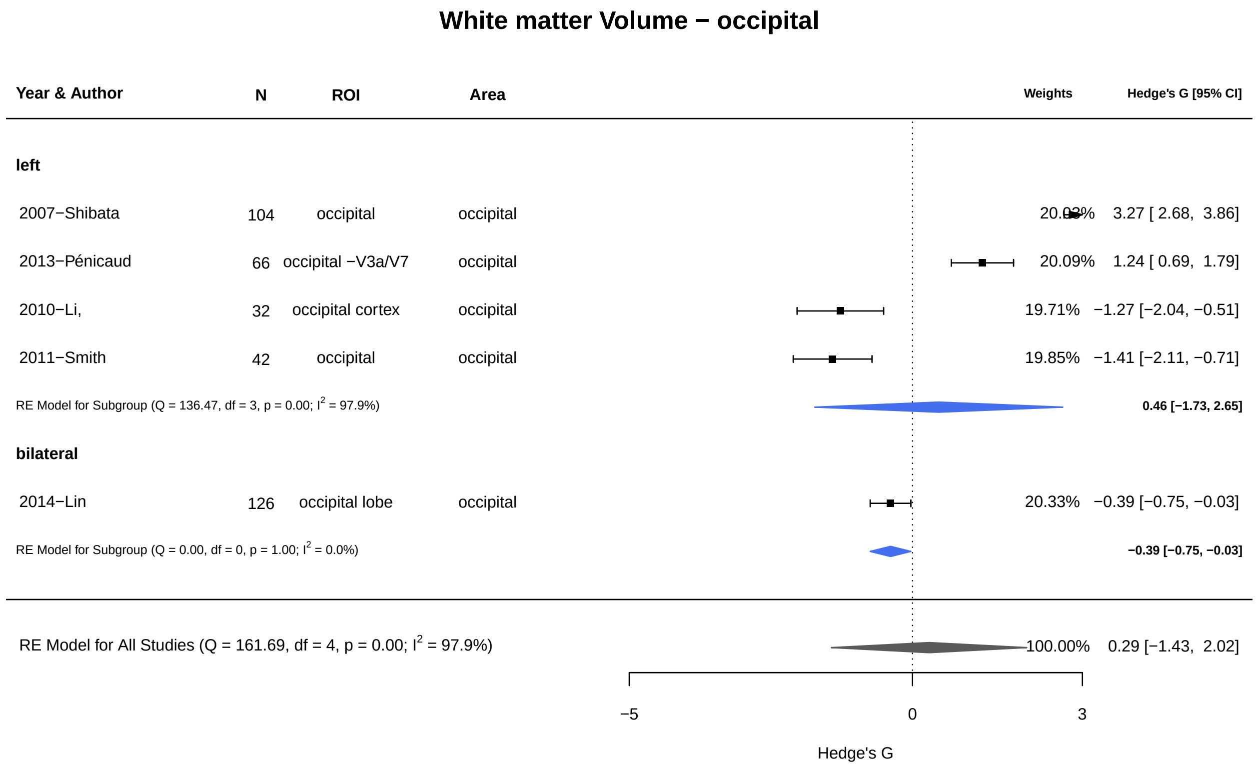

White matter Volume − frontal
Year & Author | N | ROI | Area | Weights | Hedge's G [95% CI]
right
2010−Li,.3 32 prefrontal cortex frontal 14.00% −1.24 [−2.00, −0.48]
2010−Li,.1 32 prefrontal cortex frontal 13.78% −1.66 [−2.47, −0.85]
2007−Shibata 104 perisylvian frontal 14.42% −3.95 [−4.62, −3.29]
RE Model for Subgroup (Q = 32.91, df = 2, p = 0.00; I² = 93.3%) −2.30 [−3.96, −0.63]
left
2010−Li,.2 32 prefrontal cortex frontal 13.98% −1.29 [−2.06, −0.53]
2009−Kim.2 42 medial frontal frontal 14.19% −1.35 [−2.07, −0.63]
2009−Kim.1 42 superior frontal frontal 14.18% −1.38 [−2.10, −0.66]
RE Model for Subgroup (Q = 0.03, df = 2, p = 0.99; I² = 0.0%) −1.34 [−1.77, −0.92]
bilateral
2014−Lin 126 frontal frontal 15.45% −0.51 [−0.87, −0.15]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I² = 0.0%) −0.51 [−0.87, −0.15]
RE Model for All Studies (Q = 80.40, df = 6, p = 0.00; I² = 91.1%) 100.00% −1.62 [−2.44, −0.80]
−5
0
3
Hedge's G

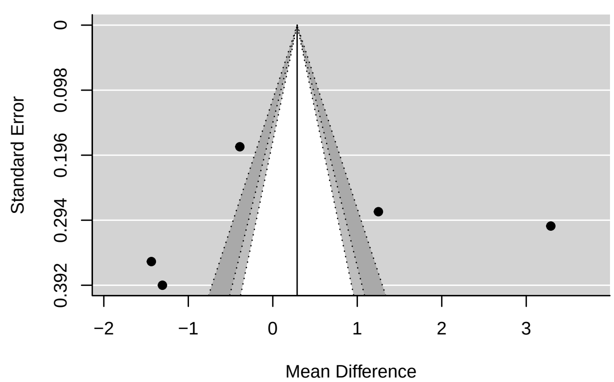

Standard Error
0
0.104
0.208
0.312
0.416
−4
−3
−2
−1
0
Mean Difference

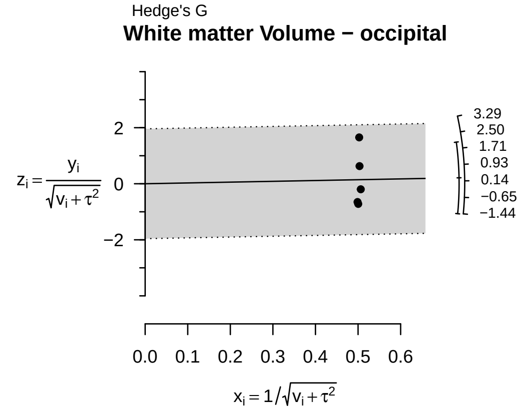

White matter Volume − frontal
2
0
−2
−0.51
−1.09
−1.67
−2.25
−2.82
−3.40
−3.98
0.0
0.2
0.4
0.6
0.8
1.0
1.2

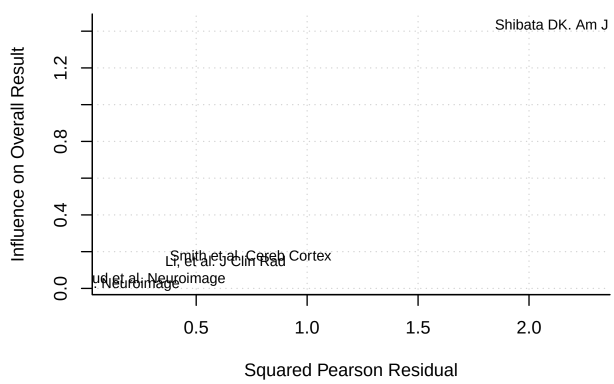

Influence on Overall Result
Shibata DK. Am J
Lin et al. Neuroimage
0
1
2
3
4
Squared Pearson Residual

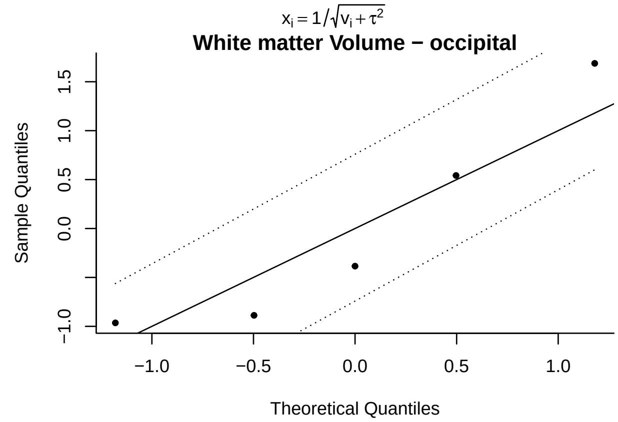

White matter Volume − frontal
Sample Quantiles
1.0
0.0
−1.0
−2.0
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles

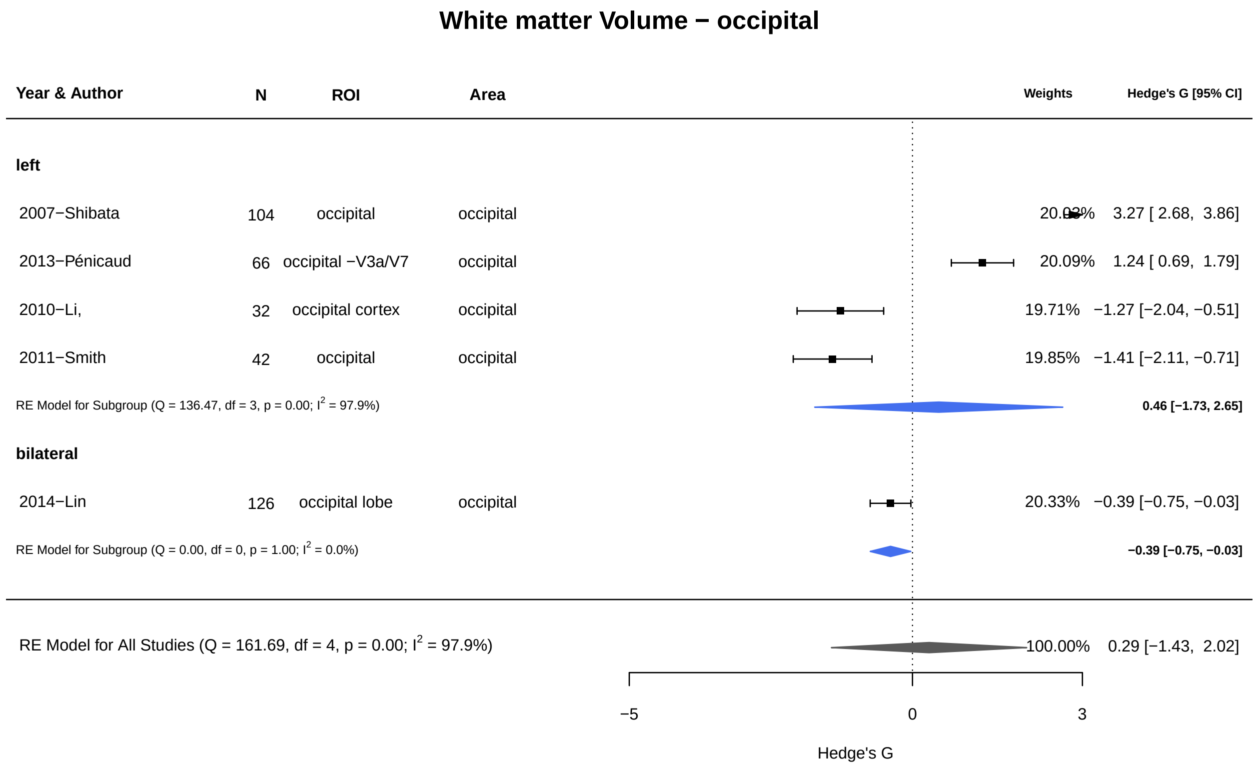

White matter Volume − occipital
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
left
2007−Shibata 104 occipital occipital 20.02% 3.27 [2.68, 3.86]
2013−Pénicaud 66 occipital −V3a/V7 occipital 20.09% 1.24 [0.69, 1.79]
2010−Li, 32 occipital cortex occipital 19.71% −1.27 [−2.04, −0.51]
2011−Smith 42 occipital occipital 19.85% −1.41 [−2.11, −0.71]
RE Model for Subgroup (Q = 136.47, df = 3, p = 0.00; I2 = 97.9%) 0.46 [−1.73, 2.65]
bilateral
2014−Lin 126 occipital lobe occipital 20.33% −0.39 [−0.75, −0.03]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%) −0.39 [−0.75, −0.03]
RE Model for All Studies (Q = 161.69, df = 4, p = 0.00; I2 = 97.9%) 100.00% 0.29 [−1.43, 2.02]
−5
0
3
Hedge's G

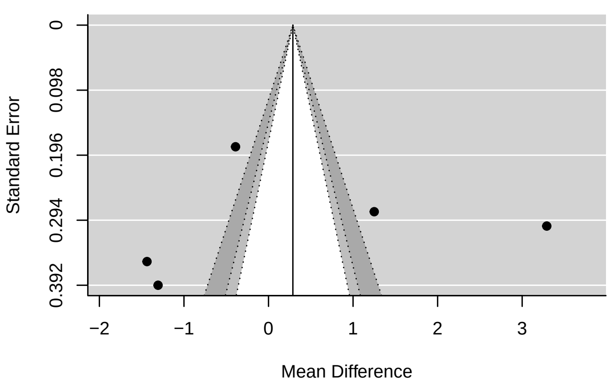

Standard Error
0
0.098
0.196
0.294
0.392
−2
−1
0
1
2
3
Mean Difference

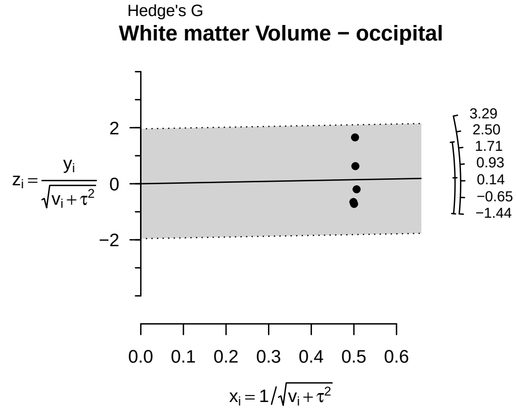

White matter Volume − occipital
zi = yi / √(vi + τ2)
2
0
−2
3.29
2.50
1.71
0.93
0.14
−0.65
−1.44
0.0
0.1
0.2
0.3
0.4
0.5
0.6
xi = 1/√(vi + τ2)

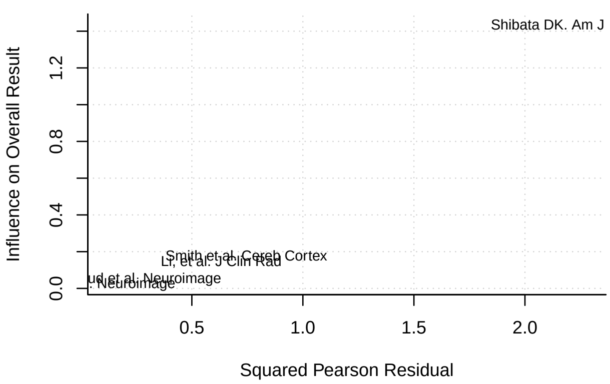

Influence on Overall Result
0.0
0.4
0.8
1.2
Shibata DK. Am J
Smith et al. Cereb Cortex
Li, et al. J Clin Rad
ud et al. Neuroimage
: Neuroimage
0.5
1.0
1.5
2.0
Squared Pearson Residual

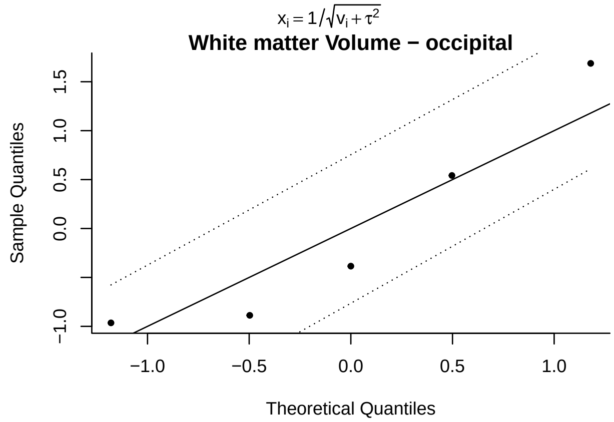

White matter Volume − occipital
Sample Quantiles
−1.0
0.0
0.5
1.0
1.5
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles

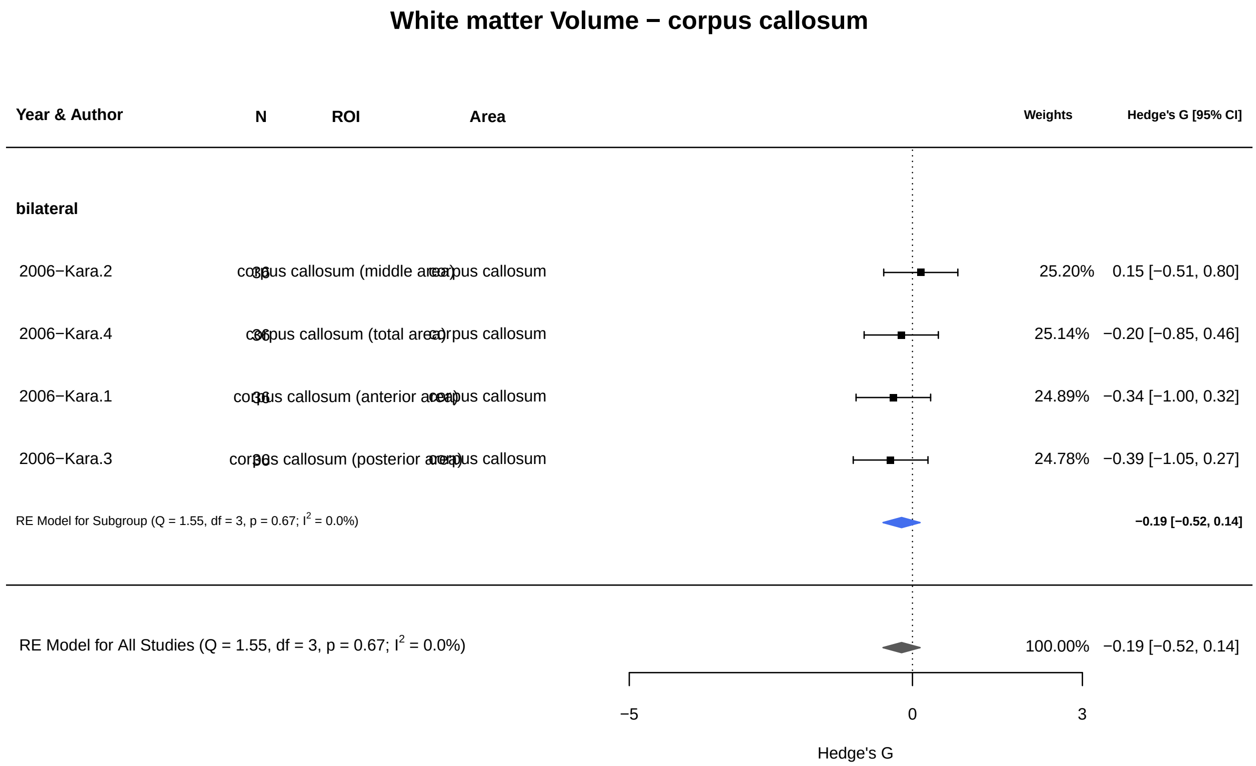

White matter Volume − occipital
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
left
2007−Shibata
104
occipital
occipital
20.02%
3.27 [2.68, 3.86]
2013−Pénicaud
66
occipital −V3a/V7
occipital
20.09%
1.24 [0.69, 1.79]
2010−Li,
32
occipital cortex
occipital
19.71%
−1.27 [−2.04, −0.51]
2011−Smith
42
occipital
occipital
19.85%
−1.41 [−2.11, −0.71]
RE Model for Subgroup (Q = 136.47, df = 3, p = 0.00; I2 = 97.9%)
0.46 [−1.73, 2.65]
bilateral
2014−Lin
126
occipital lobe
occipital
20.33%
−0.39 [−0.75, −0.03]
RE Model for Subgroup (Q = 0.00, df = 0, p = 1.00; I2 = 0.0%)
−0.39 [−0.75, −0.03]
RE Model for All Studies (Q = 161.69, df = 4, p = 0.00; I2 = 97.9%)
100.00%
0.29 [−1.43, 2.02]
−5
0
3
Hedge's G

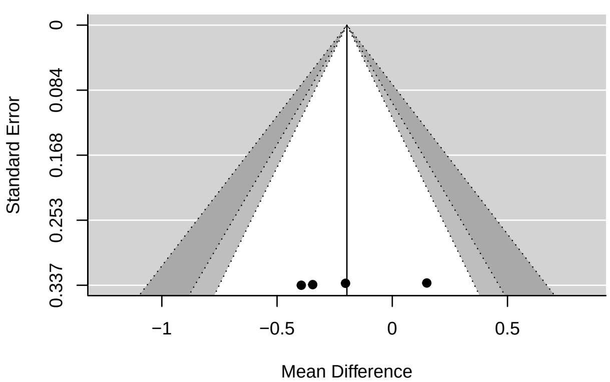

Standard Error
0
0.098
0.196
0.294
0.392
−2
−1
0
1
2
3
Mean Difference

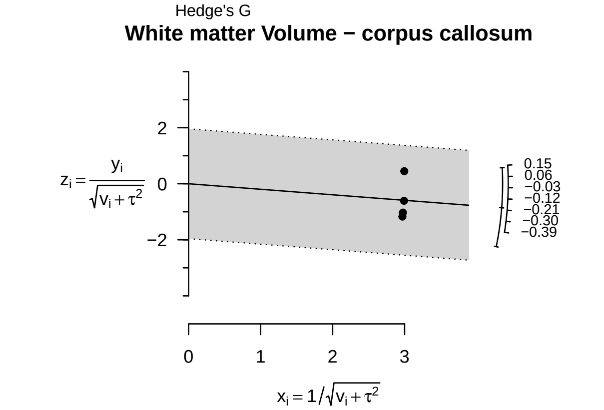

White matter Volume − occipital
2
0
−2
3.29
2.50
1.71
0.93
0.14
−0.65
−1.44
0.0
0.1
0.2
0.3
0.4
0.5
0.6

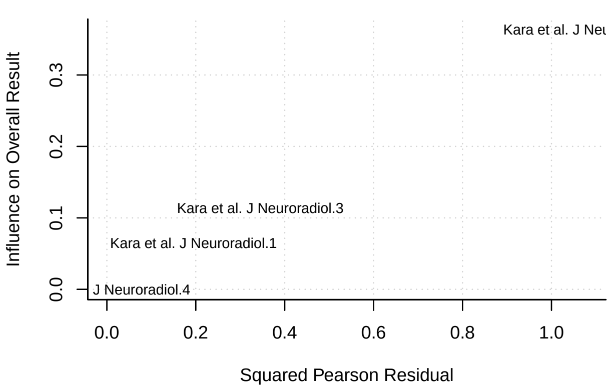

Influence on Overall Result
0.0
0.4
0.8
1.2
Shibata DK. Am J
Smith et al. Cereb Cortex
Li, et al. J Clin Rad
ud et al. Neuroimage
: Neuroimage
0.5
1.0
1.5
2.0
Squared Pearson Residual

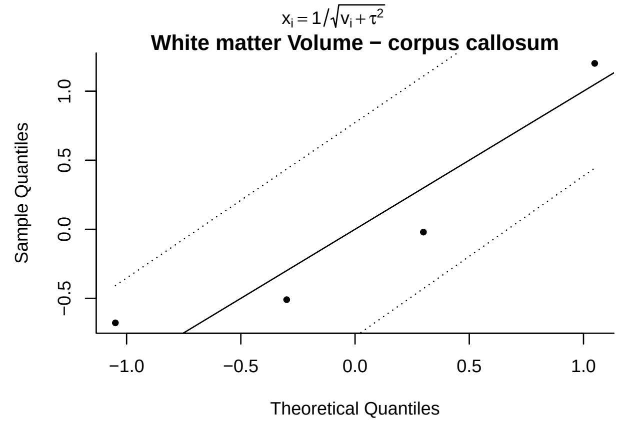

White matter Volume − occipital
Sample Quantiles
−1.0
0.0
0.5
1.0
1.5
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles


White matter Volume − corpus callosum
Year & Author
N
ROI
Area
Weights
Hedge's G [95% CI]
bilateral
2006−Kara.2 | 38 | corpus callosum (middle area) | corpus callosum | 25.20% | 0.15 [−0.51, 0.80]
2006−Kara.4 | 36 | corpus callosum (total area) | corpus callosum | 25.14% | −0.20 [−0.85, 0.46]
2006−Kara.1 | 36 | corpus callosum (anterior area) | corpus callosum | 24.89% | −0.34 [−1.00, 0.32]
2006−Kara.3 | 36 | corpus callosum (posterior area) | corpus callosum | 24.78% | −0.39 [−1.05, 0.27]
RE Model for Subgroup (Q = 1.55, df = 3, p = 0.67; I² = 0.0%) −0.19 [−0.52, 0.14]
RE Model for All Studies (Q = 1.55, df = 3, p = 0.67; I² = 0.0%) 100.00% −0.19 [−0.52, 0.14]
−5
0
3
Hedge's G


Standard Error
0
0.084
0.168
0.253
0.337
−1
−0.5
0
0.5
Mean Difference

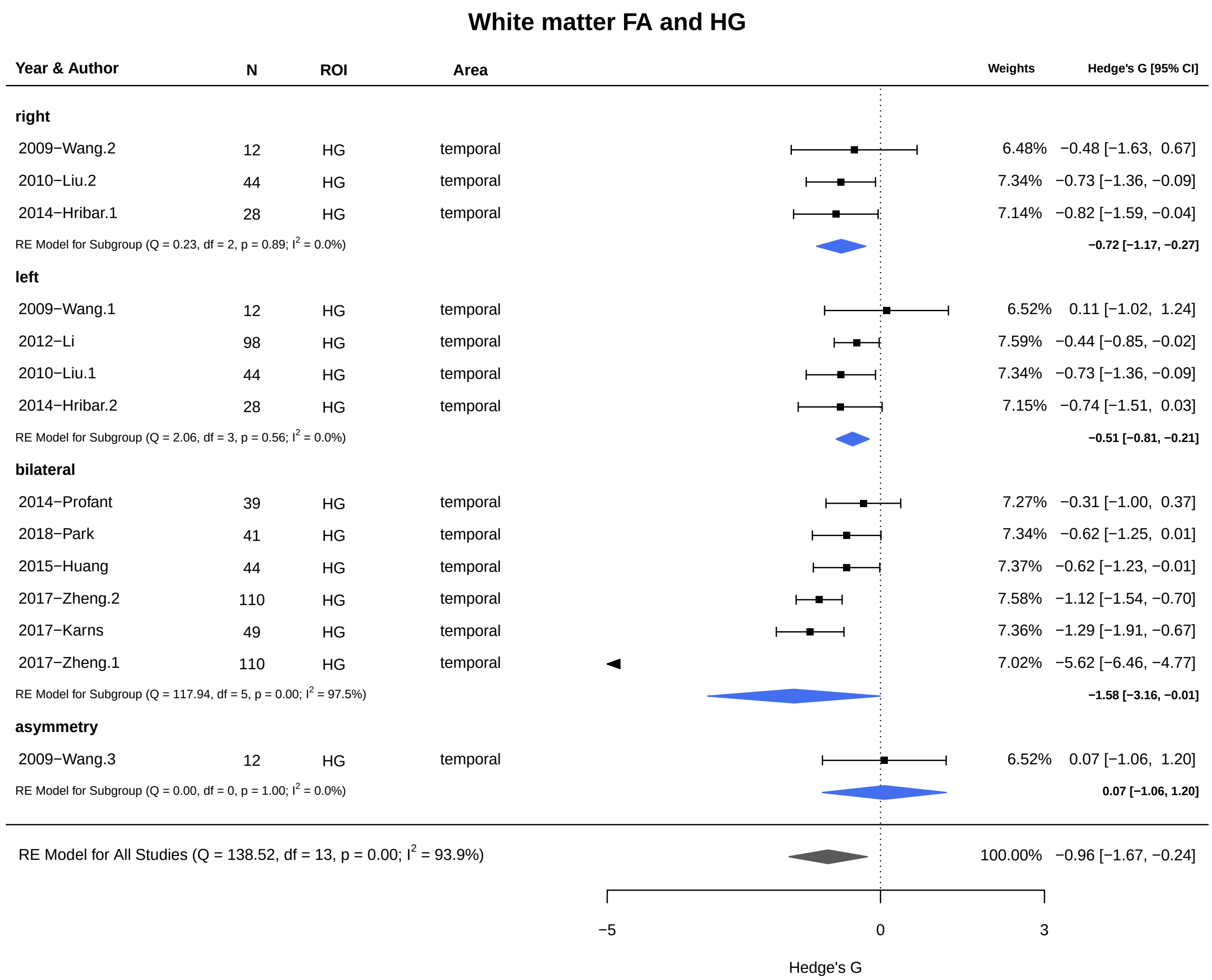

White matter Volume − corpus callosum
z_i = y_i / √(v_i + τ²)
2
0
−2
0.15
0.06
−0.03
−0.12
−0.21
−0.30
−0.39
0
1
2
3
x_i = 1/√(v_i + τ²)


Influence on Overall Result
0.0
0.1
0.2
0.3
Kara et al. J Neu
Kara et al. J Neuroradiol.3
Kara et al. J Neuroradiol.1
J Neuroradiol.4
0.0
0.2
0.4
0.6
0.8
1.0
Squared Pearson Residual

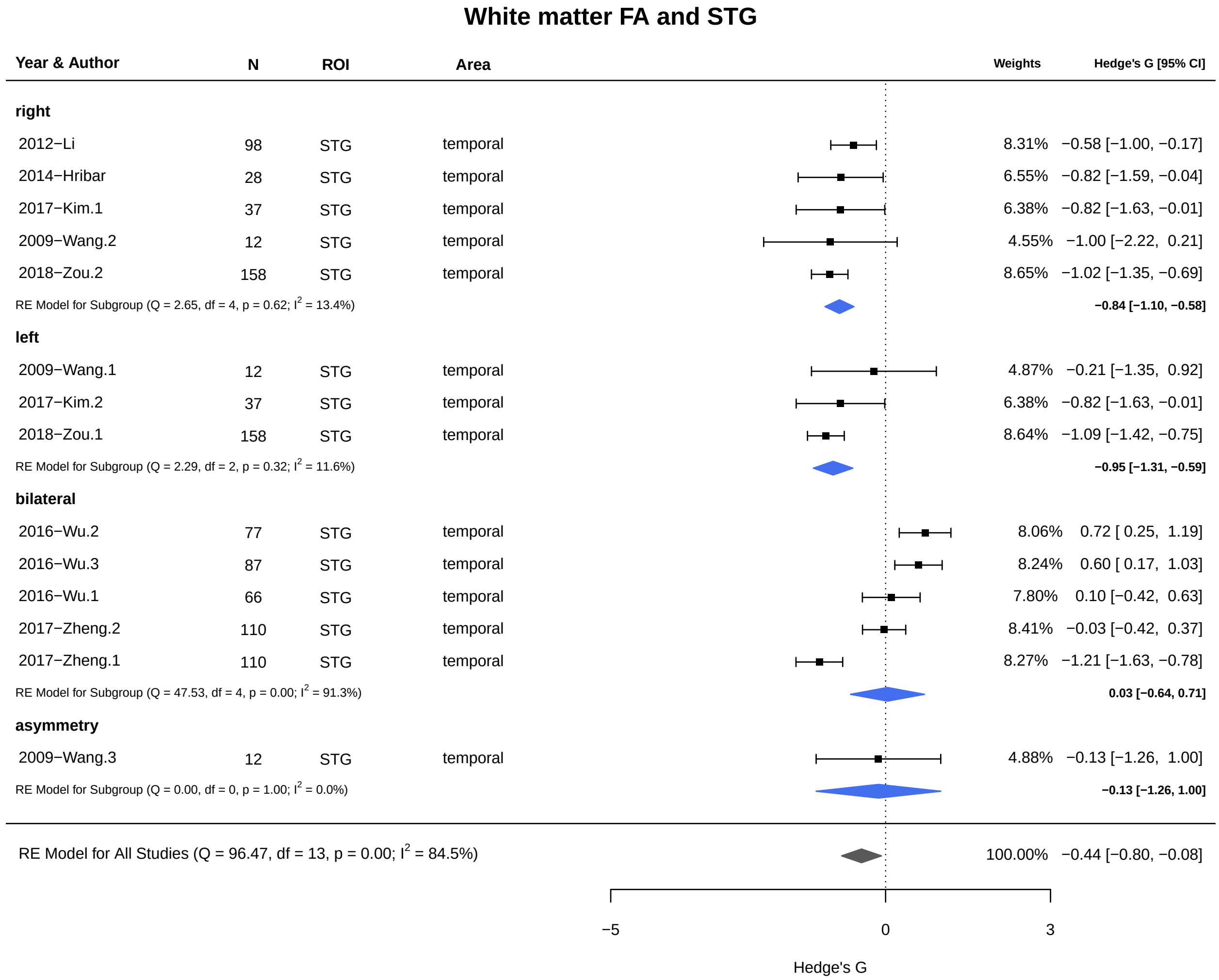

White matter Volume − corpus callosum
Sample Quantiles
−0.5
0.0
0.5
1.0
−1.0
−0.5
0.0
0.5
1.0
Theoretical Quantiles

Supplementary material: Forest-plots of other Measures

Hesch gyrus FA white matter

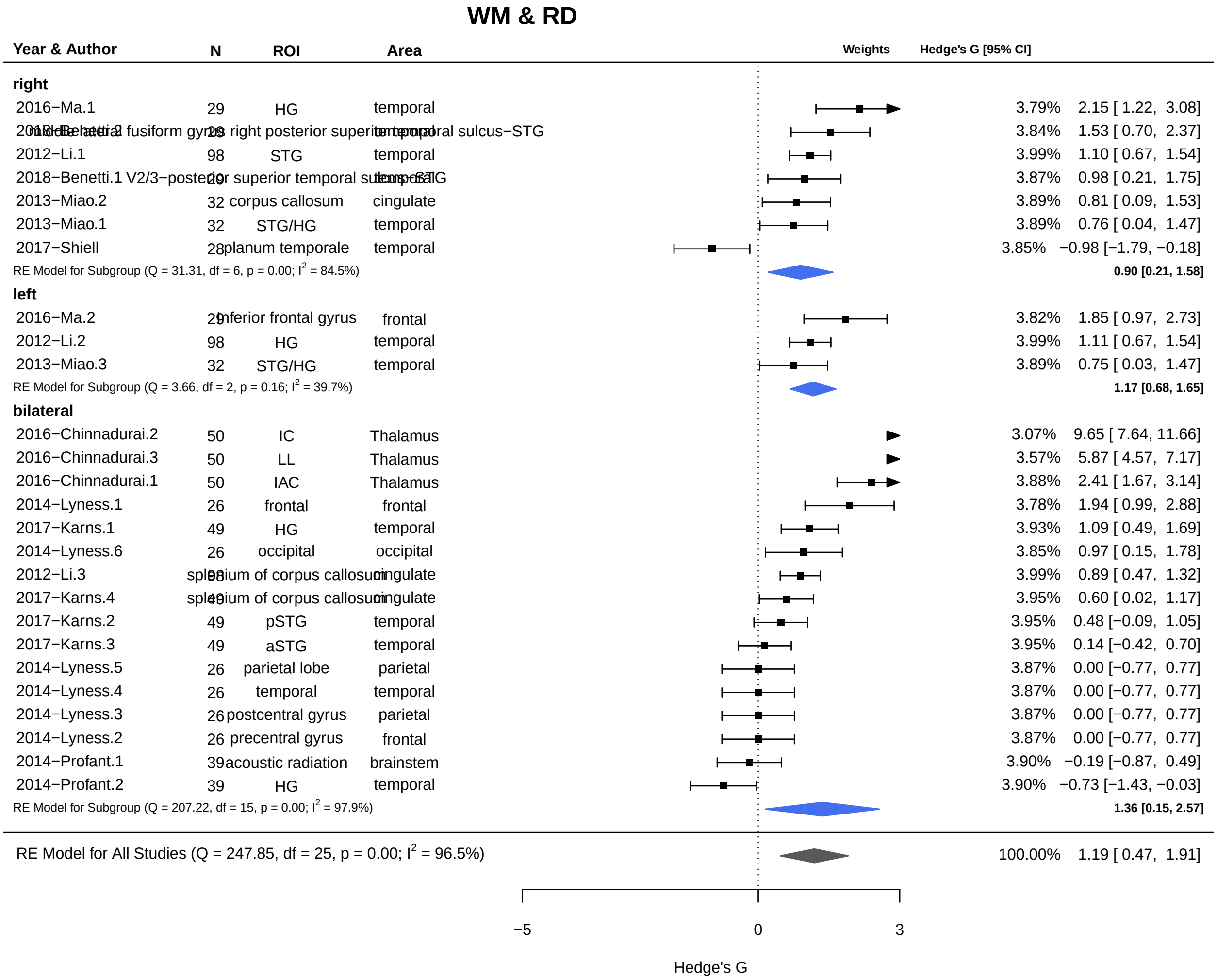


STG Volume White matter

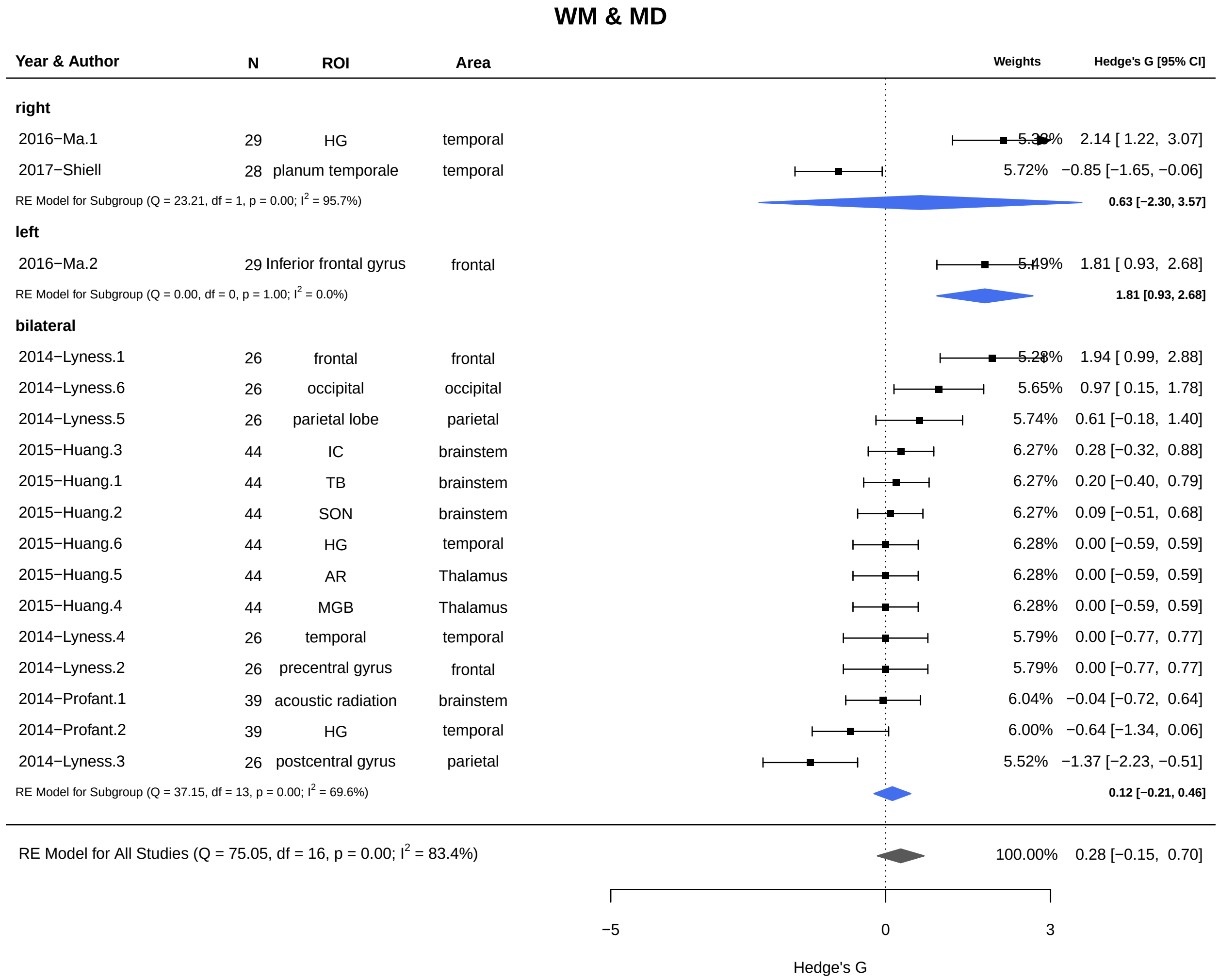


Measures of White matter Integrity

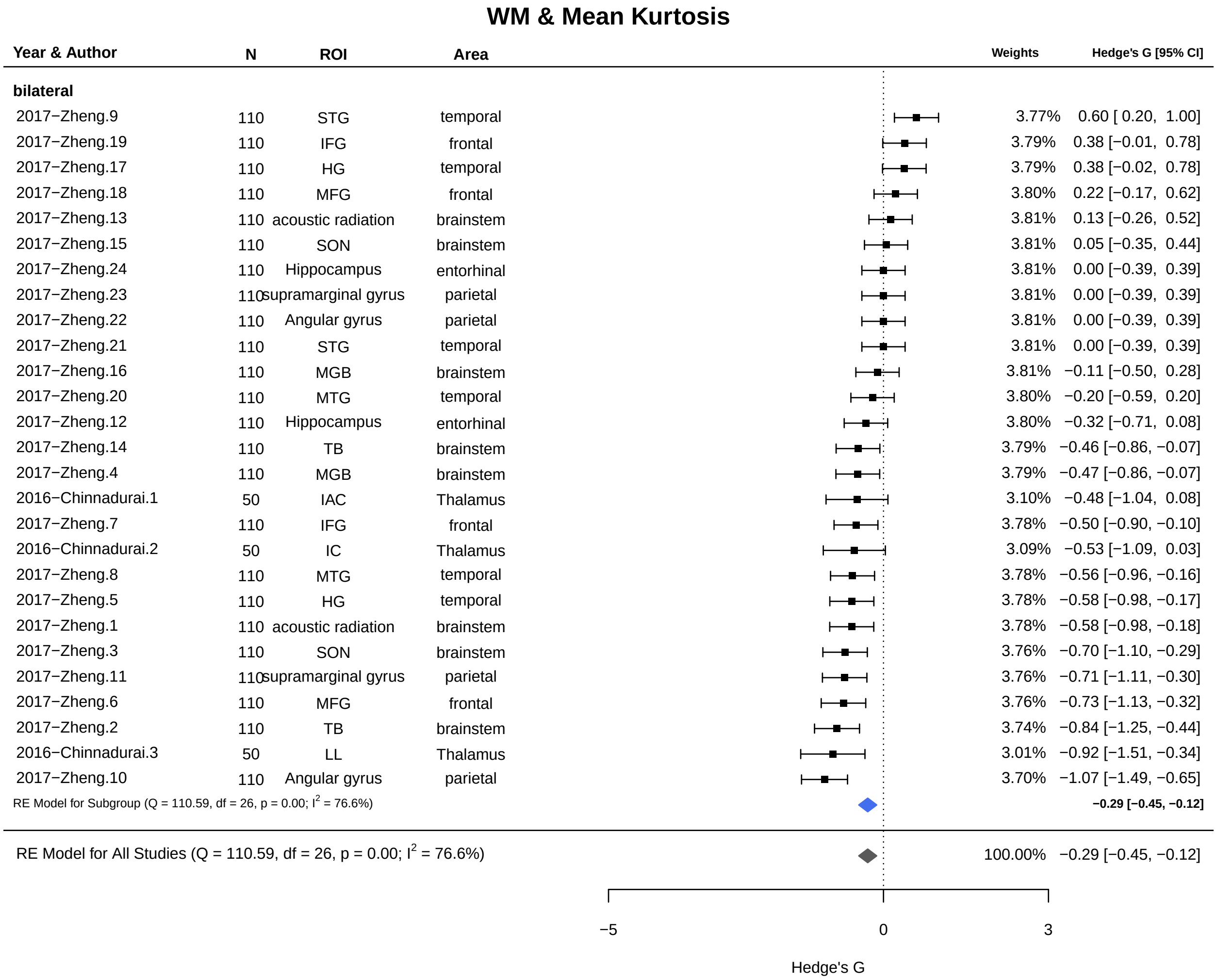
White matter: RD



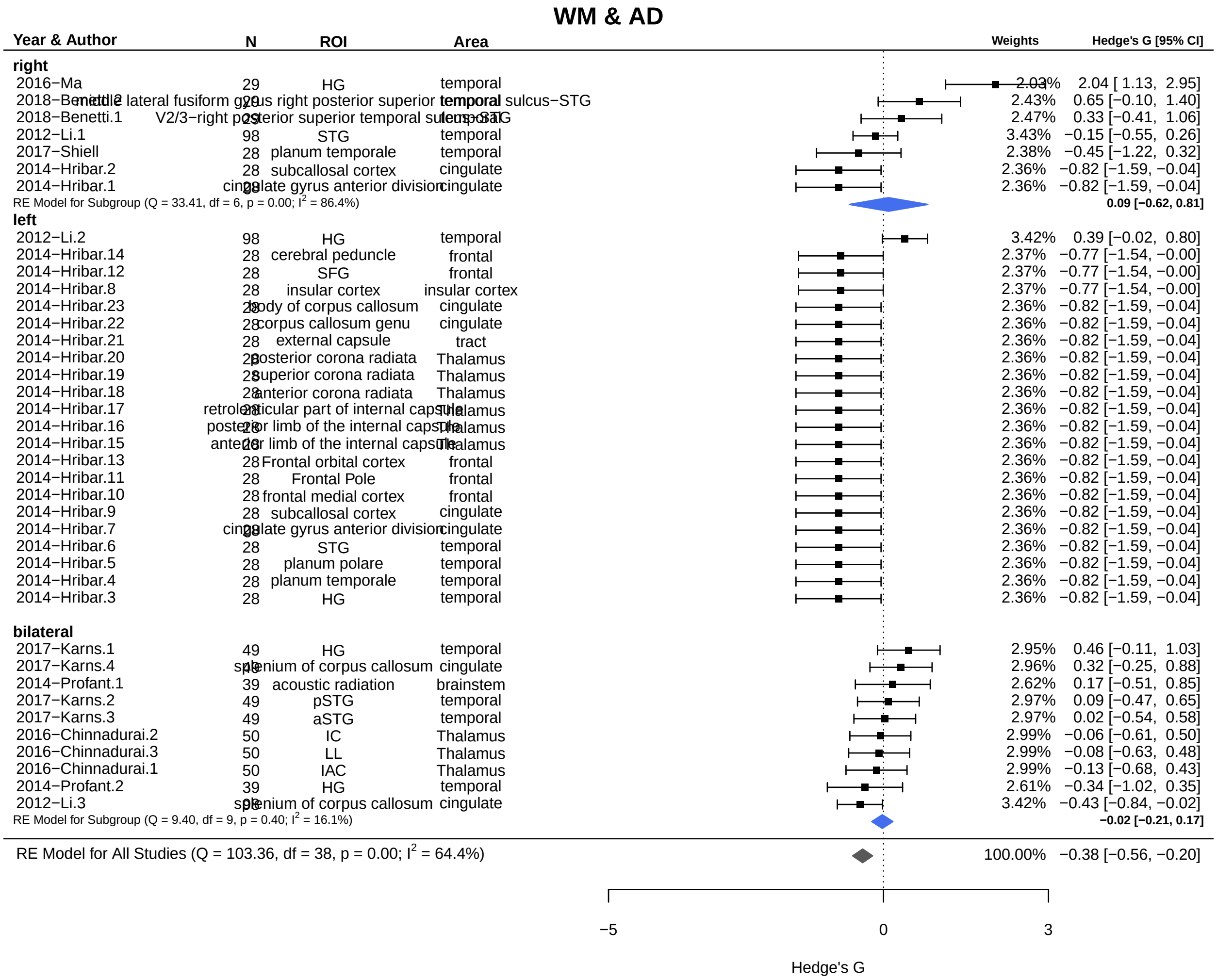
White matter: MD



White matter: Mean Kurtosis



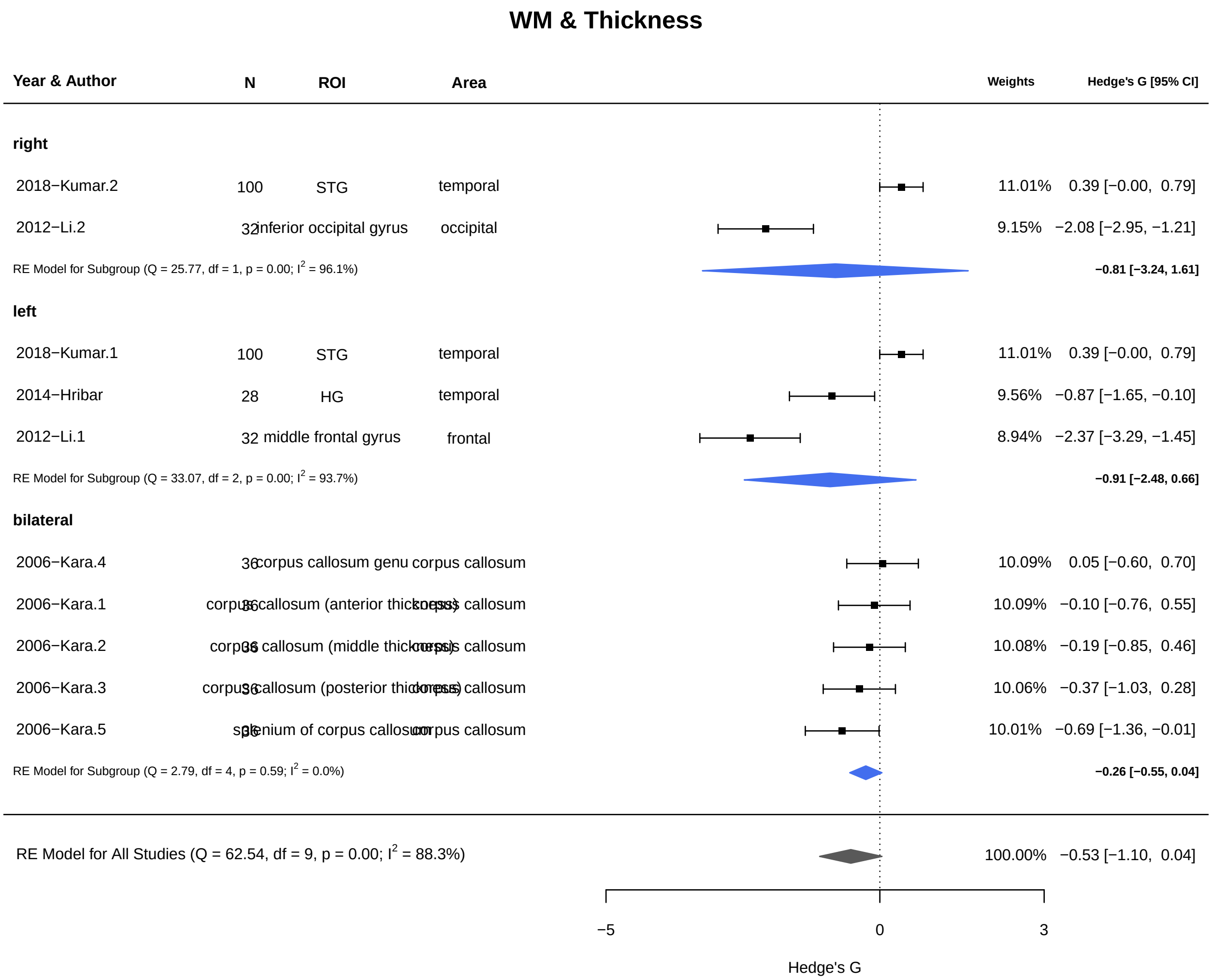
White matter: AD



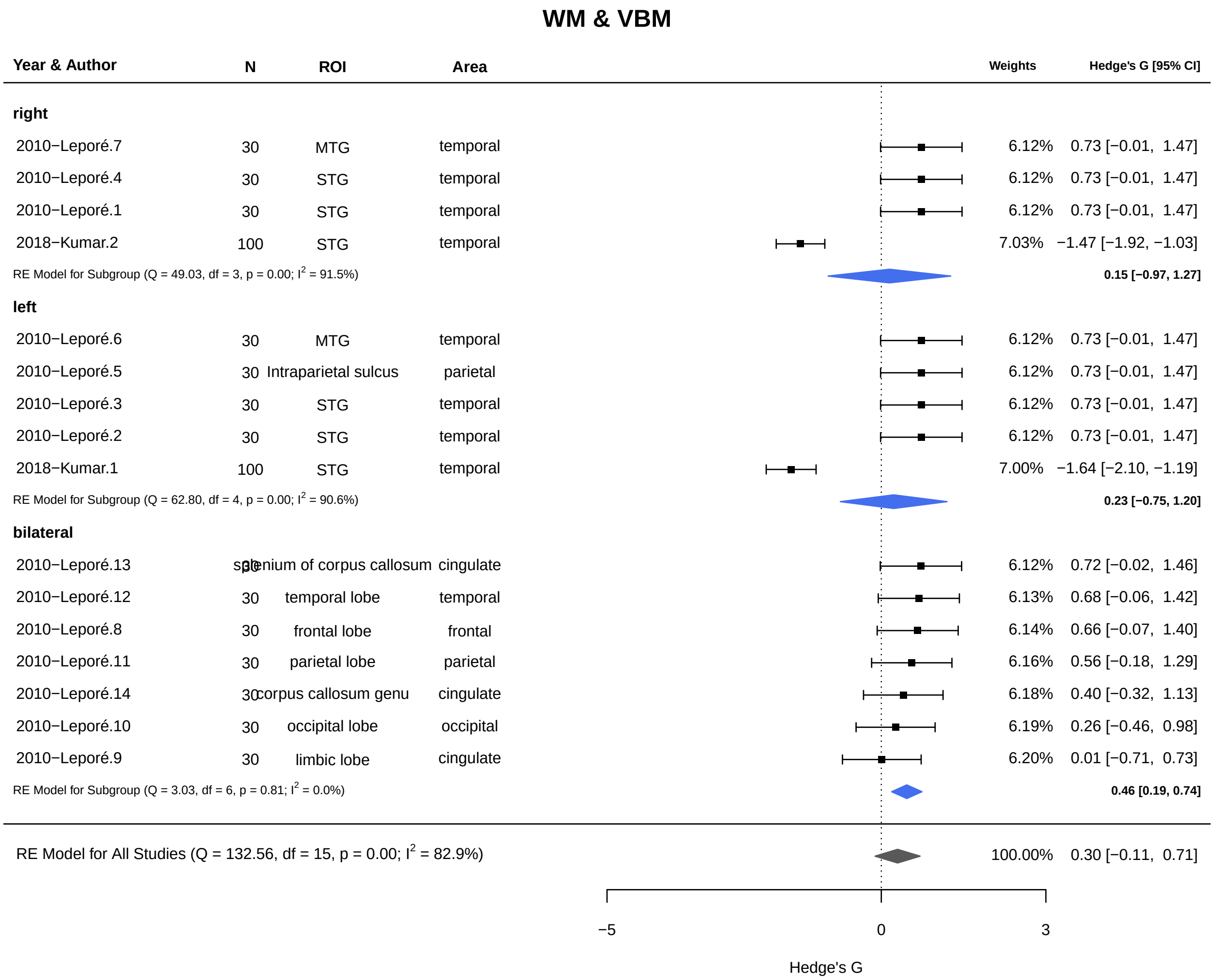
Error in rma(yi = hedgesG, vi = varG, data = meta.mod, measure = "MD", : Fisher scoring algorithm did not converge. See 'help(rma)' for possible remedies.

Other Measures of White Matter

White matter: Thickness



White matter: VBM



Meta Plots

The L'Abbé plot

In a L'Abbé plot (based on L'Abbé, Detsky, & O'Rourke, 1987), the arm-level outcomes for two experimental groups (e.g., treatment and control group) are plotted against each other. is treatment versus effect, since you have the cohen's d this should be relatively simple.
> WE DON'T HAVE TWO EXPERIMENTAL GROUPS

Baujat plot to identify studies contributing to heterogeneity

The plot shows the contribution of each study to the overall Q-test statistic for heterogeneity on the horizontal axis versus the influence of each study (defined as the standardized squared difference between the overall estimate based on a fixed-effects model with and without the ith study included in the model) on the vertical axis 2.17. Funnel plot to illustrate publication bias

Galbraith plot

Radial plot (radial) of variables and cohen's d - Galbraith, Rex (1988). "Graphical display of estimates having differing standard errors". Technometrics. Technometrics, Vol. 30, No. 3. 30 (3): 271–281.
2.18.2. We want to see this type of error plot over time for our patient cohorts by age. we want this for each measure WM and GM versus age on the x-axis so we can see GM and WM over time! Do a monte carlo simulation to connect different age population and create the error.

For a fixed-effects model, the plot shows the inverse of the standard errors on the horizontal axis against the individual observed effect sizes or outcomes standardized by their corresponding standard errors on the vertical axis. On the right hand side of the plot, an arc is drawn corresponding to the individual observed effect sizes or outcomes. A line projected from (0,0) through a particular point within the plot onto this arc indicates the value of the individual observed effect size or outcome for that point.

Resources

We are following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines: Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., and Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 6:e1000097. doi: 10.1371/journal.pmed.1000097 AND https://www.bmj.com/content/339/bmj.b2535

- https://stackoverflow.com/questions/14426637/how-to-do-bubble-plot
- https://www.researchgate.net/publication/296680807_Menstrual_hygiene_management_among_adolescent_girls_in_India_A_Systematic_review_and_meta-analysis/figures?lo=1

Good explanation of some of the plots:

- https://ora.ox.ac.uk/objects/uuid:ff78831d-6f82-4187-97cc-349058e9abde/download_file?file_format=pdf&safe_filename=Rahimi%2Bet%2Bal%252C%2BData%2Bvisualisation%2Bfor%2Bmeta-analysis.pdf&type_of_work=Journal+article