

## Temporal lobe

### Introduction

The temporal lobe is structurally divided into the superior, middle, inferior and medial gyri. The superior temporal gyrus comprises the primary auditory cortex, while nearby temporal regions function in higher level auditory processing, including speech and language. Inferior temporal regions are involved in higher level visual processing. Associated regions include the fusiform gyrus (involved in face processing) and the parahippocampal gyrus, which processes scenes. The medial temporal lobe comprises the hippocampus and is thought to be involved in the formation and propagation of memory.

Schizophrenia has been associated with altered structure and function of the temporal lobe. Understanding of any brain alterations in people with schizophrenia may provide insight into changes in brain development associated with the illness onset or progression. Reviews contained in this technical summary reflect both structural (MRI, DTI, CT), and functional imaging studies (fMRI, PET, SPECT), as well as metabolic investigations (MRS) of the temporal lobe in schizophrenia.

### Method

We have included only systematic reviews (systematic literature search, detailed methodology with inclusion/exclusion criteria) published in full text, in English, from the year 2000 that report results separately for people with a diagnosis of schizophrenia, schizoaffective disorder, schizophreniform disorder or first episode schizophrenia. Reviews were identified by searching the databases MEDLINE, EMBASE, CINAHL, Current Contents, PsycINFO and the Cochrane library. Hand searching reference lists of identified reviews was also conducted. When multiple copies of reviews were found, only the most recent version was included. Reviews with pooled data are prioritised for inclusion.

Review reporting assessment was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses ([PRISMA](#)) checklist, which describes a preferred way to present a meta-analysis<sup>1</sup>. Reviews rated as having less than 50% of items checked have been excluded from the library. The PRISMA flow diagram is a suggested way of providing information about studies included and excluded with reasons for exclusion. Where no flow diagram has been presented by individual reviews, but identified studies have been described in the text, reviews have been checked for this item. Note that early reviews may have been guided by less stringent reporting checklists than the PRISMA, and that some reviews may have been limited by journal guidelines.

Evidence was graded using the Grading of Recommendations Assessment, Development and Evaluation ([GRADE](#)) Working Group approach where high quality evidence such as that gained from randomised controlled trials (RCTs) may be downgraded to moderate or low if review and study quality is limited, if there is inconsistency in results, indirect comparisons, imprecise or sparse data and high probability of reporting bias. It may also be downgraded if risks associated with the intervention or other matter under review are high. Conversely, low quality evidence such as that gained from observational studies may be upgraded if effect sizes are large, there is a dose dependent response or if results are reasonably consistent, precise and direct with low associated risks (see end of table for an explanation of these terms)<sup>2</sup>. The resulting table represents an objective summary of the available evidence, although the conclusions are solely the opinion of staff of NeuRA (Neuroscience Research Australia).



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### Results

We found 45 systematic reviews that met our inclusion criteria<sup>3-47</sup>.

#### *Structural changes*

- Moderate to high quality evidence suggests reduced grey matter in the temporal lobe in people with schizophrenia, particularly in the superior temporal gyrus, medial temporal gyrus, and occipito-temporal gyrus. People with first-episode schizophrenia showed the greatest reductions in the superior and inferior temporal and transverse gyri.
- Moderate quality evidence found common decreases in grey matter volume in the left superior temporal gyrus of antipsychotic-naïve and treated first-episode patients compared to controls. Grey matter in the left middle temporal gyrus was increased in antipsychotic-naïve patients compared to controls but decreased in treated patients compared to controls.
- Moderate quality evidence suggests schizophrenia is associated with significant reductions in white matter integrity in the temporal lobe, including middle and superior temporal gyri, as well as the entorhinal and fusiform gyri.
- Moderate quality evidence found people with schizophrenia show an absence of normal leftward asymmetry in the planum temporale and excess rightward asymmetry in the superior temporal gyrus (particularly posterior).
- High quality evidence suggests significantly greater reductions over time in temporal grey matter and white matter in people with schizophrenia compared to controls.
- Moderate quality evidence found the severity of auditory hallucinations was associated with grey matter volume reductions in the left superior temporal gyri, (including the rolandic operculum and Heschl's gyri), and a trend effect for the right superior temporal gyri (including the medial temporal gyrus and Heschl's gyri).
- Moderate quality evidence found decreases in the right superior temporal gyri of people at high genetic or clinical risk of psychosis compared to controls. People at clinical high risk showed increases in the right fusiform gyrus and the left superior temporal gyrus compared to controls. People at high genetic risk showed reductions in the left inferior temporal gyrus, and greater right superior temporal gyrus reductions than people at high clinical risk.
- People at high genetic or clinical risk of schizophrenia showed increases in the middle temporal gyrus compared to people with psychosis. People at high genetic or clinical risk who developed a psychotic episode showed decreases in the right superior temporal gyrus compared to those who did not develop psychosis.

#### *Functional changes*

- Moderate to low quality evidence found increased activation in the superior and middle temporal gyri during auditory hallucinations, and decreased activation in the superior temporal gyrus during auditory stimulation in people with schizophrenia.
- Moderate quality evidence found increased functional activity in people with schizophrenia in the left middle temporal gyrus during episodic memory encoding; the medial temporal gyri during episodic memory retrieval; the superior temporal gyrus and medial temporal cortex during working memory tasks; the right superior temporal gyrus during executive functioning tasks; and the right middle temporal gyrus during timing tasks. Reduced activations during memory retrieval tasks were found in the medial temporo-occipital gyrus (fusiform gyrus) and found in the lateral and middle temporal regions during linguistic (mostly semantic reading) and theory of mind tasks. Reduced activation was found in the superior temporal gyrus of people with



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schizophrenia during reward anticipation tasks.

- Moderate to high quality evidence found first-degree relatives showed increased activation in the right posterior and anterior superior temporal gyrus compared to controls during cognitive tasks. Moderate to low quality evidence also found increased activation in the right middle temporal gyrus of relatives during emotion tasks.
- Moderate quality evidence found decreased activation in schizophrenia compared to autism in bilateral superior temporal gyri during face emotion recognition.
- Moderate to low quality evidence suggests dopamine receptor occupancy is significantly different depending on whether people are taking first or second-generation antipsychotics. There were no differences in D2/D3 receptor availability between unmedicated patients and controls.
- Moderate to high quality evidence finds a medium-sized increase in phosphodiesterases (PDE) in the temporal lobe of people with schizophrenia. There were no differences in temporal phosphomonoesters (PME) levels. Moderate to low quality evidence suggests reduced PME and increased PDE levels in the temporal cortex of people with first-episode psychosis.
- Moderate to high quality evidence found decreased NAA levels in the temporal cortex of people with first-episode or chronic schizophrenia. There may also be NAA reductions in people at high-risk of schizophrenia.
- Moderate quality evidence finds reduced translocator protein in the temporal cortex of people with schizophrenia.

### *Structural and functional changes*

- Moderate quality evidence found decreased grey matter volume and decreased functional activity in the right temporal pole/superior temporal gyrus of people with

schizophrenia. There was also decreased grey matter volume and increased functional activity in bilateral superior temporal gyri.

- Moderate to low quality evidence found increased activation in the superior temporal gyrus and reduced white matter in the right middle temporal gyrus correlated with increased severity of neurological soft signs.



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*Achim AM, Lepage M*

**Episodic memory-related activation in schizophrenia: meta-analysis**

British Journal of Psychiatry 2005; 187: 500-509

[View review abstract online](#)

<b>Comparison</b>	Functional activation during episodic memory tasks in people with schizophrenia vs. controls.
<b>Summary of evidence</b>	Moderate quality evidence (medium-sized sample, direct, unable to assess precision and consistency) suggests increases in functional activation in the medial temporal gyrus and reductions in the medial temporo-occipital gyrus (fusiform gyrus) during episodic memory retrieval.
<b>Functional activation</b>	
<p>11 studies, N = 298</p> <p><i>Reduced activation in people with schizophrenia in;</i></p> <p>Right fusiform gyrus (medial temporo-occipital gyrus): Talairach coordinates (26, -74, -8), ALE: 0.0054, Voxel probability: 0.000004</p> <p><i>Increased activation in people with schizophrenia in;</i></p> <p>Right anterior medial temporal gyrus: Talairach coordinates (28, -8, -10), ALE: 0.004105, Voxel probability: 0.000004</p>	
<b>Consistency in results<sup>†</sup></b>	No measure of heterogeneity is provided.
<b>Precision in results<sup>§</sup></b>	No confidence intervals are reported.
<b>Directness of results<sup>  </sup></b>	Direct

*Alustiza I, Radua J, Pla M, Martin R, Ortuno F*

**Meta-analysis of functional magnetic resonance imaging studies of timing and cognitive control in schizophrenia and bipolar disorder: Evidence of a primary time deficit**

Schizophrenia Research 2017; 188: 21-32



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<b>Comparison</b>	<b>Brain activation during timing tasks in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large samples, direct, unable to assess consistency or precision) finds increased activation during timing tasks in the right middle temporal gyrus.</b>
<b>Functional activation</b>	
8 studies, N = 395 <i>Significant, increased activation in people with schizophrenia was found in;</i> Right middle temporal gyrus (BA 38)	
<b>Consistency in results</b>	Unable to assess; no measure of consistent is reported.
<b>Precision in results</b>	Unable to assess; no measure of precision is reported (CIs).
<b>Directness of results</b>	Direct

*Berger GE, Wood SJ, Pantelis C, Velakoulis D, Wellard RM, McGorry PD*

**Implications of lipid biology for the pathogenesis of schizophrenia**

**Australian & New Zealand Journal of Psychiatry 2002; 36(3): 355-366**

[View review abstract online](#)

<b>Comparison</b>	<b>Phospholipid levels in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (small to medium-sized samples, unable to assess precision or consistency, direct) suggests reduced PME and increased PDE levels in the temporal cortex of people with first-episode psychosis. Data for chronic patients shows no difference in PME levels and inconsistent evidence for PDE levels.</b>
<b>PME and PDE levels</b>	





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<p><u>Drug naive first-episode psychosis</u></p> <p>3 studies (N = 84) reported decreased PME levels and increased PDE levels.</p> <p><u>Chronic schizophrenia</u></p> <p>7 studies (N = 246) reported no significant difference in PME levels. 3 of 7 studies (130/246 patients) reported increased PDE levels.</p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Brugger S, Davis JM, Leucht S, Stone JM*

**Proton magnetic resonance spectroscopy and illness stage in schizophrenia – a systematic review and meta-analysis**

**Biological Psychiatry 2011; 69: 495-503**

[View review abstract online](#)

<b>Comparison</b>	Comparison of metabolic N-acetyl aspartate (NAA) activity measured by <sup>1</sup> H-MRS in people at high risk of schizophrenia (clinical and genetic), first-episode schizophrenia, and chronic schizophrenia patients vs. controls.
<b>Summary of evidence</b>	Moderate to high quality evidence (medium to large samples, inconsistent, precise, direct) found decreased NAA levels in the temporal lobes of people with first-episode or chronic schizophrenia. There may also be NAA reductions in people at high-risk of schizophrenia.
<b>NAA</b>	
<u>Temporal lobe</u>	
<p><i>Significant, large reductions of NAA in people with chronic schizophrenia;</i></p> <p>22 studies, N = 1,054, <i>d</i> = -0.60, 95%CI -0.85 to -0.35, <i>p</i> &lt; 0.0001, <i>Q</i> = 110.73, <i>p</i> &lt; 0.0001, <i>I</i><sup>2</sup> = 69%</p> <p><i>Significant, medium-sized reductions of NAA in people with first-episode schizophrenia;</i></p> <p>11 studies, N = 421, <i>d</i> = -0.53, 95%CI -0.69 to -0.07, <i>p</i> = 0.0025, <i>Q</i> = 48.11, <i>p</i> &lt; 0.0001, <i>I</i><sup>2</sup> = 62%</p>	



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*Trend level, small to medium-sized reduction of NAA in people at high-risk of psychosis; 4 studies, N = 182, d = -0.38, 95%CI -0.79 to 0.03, p = 0.07, Q = 7.08, p = 0.13, I<sup>2</sup> = 43%*

<b>Consistency in results</b>	Inconsistent
<b>Precision in results</b>	Precise
<b>Directness of results</b>	Direct

*Brugger SP, Howes OD*

**Heterogeneity and Homogeneity of Regional Brain Structure in Schizophrenia: A Meta-analysis**

JAMA Psychiatry 2017; 74: 1104-11  
[View review abstract online](#)

<b>Comparison</b>	<b>Whole brain volume in people with first-episode schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to high quality evidence (large samples, mostly inconsistent, precise, direct) finds small reductions in the temporal lobe of people with first-episode schizophrenia.</b>
<b>Brain regions</b>	
<i>Significant, small reductions in first-episode schizophrenia in;</i> Temporal lobe: 22 studies, N = 1,458, g = -0.22, 95%CI -0.36 to -0.09, p = 0.001, I <sup>2</sup> = 44%	
<b>Consistency in results</b>	Inconsistent, apart from frontal lobe and the third ventricle.
<b>Precision in results</b>	Precise
<b>Directness of results</b>	Direct

*Chan RCK, Di X, McAlonan GM, Gong Q*

**Brain Anatomical Abnormalities in High-Risk Individuals, First-Episode, and Chronic Schizophrenia: An Activation Likelihood Estimation Meta-**



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**analysis of Illness Progression**

Schizophrenia Bulletin 2011; 37(1) 177-188

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<p><b>Comparison</b></p>	<p><b>Grey matter changes in people with schizophrenia, first-episode schizophrenia or people at high-risk vs. healthy controls. People at high risk of schizophrenia were defined as first or second-degree relatives of people with schizophrenia, those meeting the Personal Assessment and Crisis Evaluation clinic criteria, or those with a modification of the catechol-O-methyltransferase gene.</b></p>
<p><b>Summary of evidence</b></p>	<p><b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests people with first-episode schizophrenia have grey matter reductions in bilateral superior temporal gyrus and left transverse gyrus. People with chronic schizophrenia have grey matter reductions in the right superior temporal gyrus.</b></p>

**Temporal grey matter volume**

*Areas with reduced grey matter volume in chronic schizophrenia;*

19 studies, N = 1,664

Right superior temporal gyrus: Talairach coordinates (54, 4, 0), cluster 2336mm<sup>3</sup>, ALE 0.0145

*Areas with reduced grey matter volume in first-episode schizophrenia;*

14 studies, N = 1082

Left transverse temporal gyrus: Talairach coordinates (-46, -20, 12), cluster 2616mm<sup>3</sup>, ALE 0.0187

Left superior temporal gyrus: Talairach coordinates (-52, -8, 6), cluster 2616mm<sup>3</sup>, ALE 0.0162

Left superior temporal gyrus: Talairach coordinates (-58, -28, 12), cluster 2616mm<sup>3</sup>, ALE 0.0151

Left superior temporal gyrus: Talairach coordinates (-54, 2, -4), cluster 976mm<sup>3</sup>, ALE 0.0159

Right superior temporal gyrus: Talairach coordinates (52, -8, -8), cluster 504mm<sup>3</sup>, ALE 0.0173

No temporal lobe areas had reduced grey matter volume in high-risk groups.

*Subtraction analysis found greater grey matter reduction in the first-episode group than the high-risk group;*

Left superior temporal gyrus: Talairach coordinates (-52, -8, 6), cluster 1728mm<sup>3</sup>, ALE 0.01614

Left transverse temporal gyrus: Talairach coordinates (-46, -20, 12), cluster 1728mm<sup>3</sup>, ALE 0.0116

*Subtraction analysis found greater grey matter reduction in the first-episode group than the chronic group;*





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Left superior temporal gyrus: Talairach coordinates (-52, -8, 6), cluster 944mm <sup>3</sup> , ALE -0.0154	
Left transverse temporal gyrus: Talairach coordinates (-46, -18, 10), cluster 944mm <sup>3</sup> , ALE -0.0154	
Left superior temporal gyrus: Talairach coordinates (-58, -28, 12), cluster 448mm <sup>3</sup> , ALE -0.0149	
Right superior temporal gyrus: Talairach coordinates (52, -8, -8), cluster 408mm <sup>3</sup> , ALE -0.0172	
Left superior temporal gyrus: Talairach coordinates (-56, 2, -4), cluster 320mm <sup>3</sup> , ALE -0.0142	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Cooper D, Barker V, Radua J, Fusar-Poli P, Lawrie SM*

**Multimodal voxel-based meta-analysis of structural and functional magnetic resonance imaging studies in those at elevated genetic risk of developing schizophrenia**

Psychiatry Research - Neuroimaging 2014; 221(1): 69-77

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activity in relatives of people with schizophrenia vs. controls during various tasks.</b>
<b>Summary of evidence</b>	<b>Moderate to high quality evidence (large sample, consistent, direct, unable to assess precision) suggest relatives show increased activation in the right posterior and anterior superior temporal gyrus.</b>
<b>Functional activation</b>	
13 studies, N = 561 <i>Relatives showed increased activation in;</i> Right posterior superior temporal gyrus: Talairach coordinates (50, -54, 10), <i>p</i> = 0.00008 Right anterior superior temporal gyrus: Talairach coordinates (52, 6, 2), <i>p</i> = 0.001	
<b>Consistency in results</b>	Authors report the results are consistent.
<b>Precision in results</b>	No confidence intervals are reported.



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Directness of results	Direct
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Crossley NA, Mechelli A, Ginestet C, Rubinov M, Bullmore ET, McGuire P

**Altered Hub Functioning and Compensatory Activations in the Connectome: A Meta-Analysis of Functional Neuroimaging Studies in Schizophrenia**

Schizophrenia Bulletin 2016; 42: 434-42

[View review abstract online](#)

Comparison	Comparison of functional activity in people with schizophrenia vs. controls.
Summary of evidence	Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests over-activations in the medial temporal cortex during working memory tasks and over-activations in the right medial temporal cortex during episodic memory tasks. During linguistic (mostly semantic reading) and theory of mind tasks there were under-activations in lateral temporal regions.
<b>Functional activation</b>	
<p>314 studies, N = 10,942</p> <p><u>Working memory tasks</u></p> <p>Over-activations in medial temporal cortex.</p> <p><u>Episodic memory tasks</u></p> <p>Over-activations in right medial temporal cortex.</p> <p><u>Linguistic tasks (mostly semantic reading)</u></p> <p>Under-activations in the lateral temporal regions.</p> <p><u>Theory of mind tasks</u></p> <p>Under-activations in the lateral temporal cortical.</p>	
Consistency in results	Unable to assess; no measure of consistency is reported.
Precision in results	Unable to assess; no measure of precision is reported.
Directness of results	Direct



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Davidson LL, Heinrichs RW

**Quantification of frontal and temporal lobe brain-imaging findings in schizophrenia: a meta-analysis**

Psychiatry Research 2003; 122(2): 69-87

[View review abstract online](#)

<b>Comparison</b>	<b>Grey matter volume in people with schizophrenia vs. healthy controls.</b>
<b>Summary of evidence</b>	<b>Moderate to high quality evidence (large samples, mostly inconsistent, precise, direct) suggests grey matter volume is reduced in the bilateral temporal lobe in people with schizophrenia, of greatest magnitude in the superior temporal gyrus.</b>
<b>Temporal grey matter volume</b>	
<p><u>Left temporal lobe</u></p> <p><i>Small effect size suggests reduced volume in schizophrenia;</i>                      N = 2,030, <math>d = -0.32</math>, 95%CI -0.46 to -0.19, <math>p</math> not reported, SD = 0.37, FSN = 68</p> <p><u>Right temporal lobe</u></p> <p><i>Small effect size suggests reduced volume in schizophrenia;</i>                      N = 1,945, <math>d = -0.30</math>, 95%CI -0.42 to -0.17, <math>p</math> not reported, SD = 0.34, FSN = 60</p> <p><u>Total temporal lobe</u></p> <p><i>Small effect size suggests reduced volume in schizophrenia;</i>                      N = 2,718, <math>d = -0.29</math>, 95%CI -0.40 to -0.18, <math>p</math> not reported, SD = 0.34, FSN = 74</p> <p><u>Left Superior temporal gyrus</u></p> <p><i>Medium effect size suggests reduced volume in schizophrenia;</i>                      N = 1,152, <math>d = -0.55</math>, 95%CI -0.72 to -0.38, <math>p</math> not reported, SD = 0.33, FSN = 76</p> <p><u>Right Superior temporal gyrus</u></p> <p><i>Small effect size suggests reduced volume in schizophrenia;</i>                      N = 1,122, <math>d = -0.40</math>, 95%CI -0.40 to -0.65, <math>p</math> not reported, SD = 0.47, FSN = 48</p>	
<b>Consistency in results</b>	Consistent for left, right and total temporal cortex. Significant heterogeneity is reported in the superior temporal gyrus analysis.



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<b>Precision in results</b>	Precise
<b>Directness of results</b>	Direct
<b>Comparison 2</b>	<b>Functional activation during episodic memory tasks in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to high quality evidence (large sample, direct, precise, inconsistent) suggests increased functional activity in the left temporal lobe of people with schizophrenia during cognitive tasks, with no differences at rest.</b>
<b>Functional activation during cognitive tasks</b>	
<p><u>Left temporal lobe</u>  <i>Small effect size suggests increased activity in schizophrenia;</i>                      N = 480, <math>d = 0.43</math>, 95%CI -0.16 to 1.01, <math>p</math> not reported, SD = 0.82, FSN = 33</p>	
<b>Functional activation at rest</b>	
<p><u>Left temporal lobe</u>  <i>No effect on activity in schizophrenia;</i>                      N = 608, <math>d = -0.13</math>, 95%CI -0.50 to 0.23, <math>p</math> not reported, SD = 0.76, FSN = 6</p> <p><u>Right temporal lobe</u>  <i>No effect on activity in schizophrenia;</i>                      N = 608, <math>d = -0.05</math>, 95%CI -0.49 to 0.38, <math>p</math> not reported, SD = 0.90, FSN &lt;0.1</p>	
<b>Consistency in results</b>	Significant heterogeneity reported for all outcomes.
<b>Precision in results</b>	Precise for all outcomes.
<b>Directness of results</b>	Direct

Ding Y, Ou Y, Pan P, Shan X, Chen J, Liu F, Zhao J, Guo W

**Brain structural abnormalities as potential markers for detecting individuals with ultra-high risk for psychosis: A systematic review and meta-analysis**



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Schizophrenia Research 2019; 209: 22-31 <a href="#">View review abstract online</a>	
<b>Comparison</b>	Grey matter volume in people at clinical high risk of psychosis vs. controls.
<b>Summary of evidence</b>	Moderate to high quality evidence (large sample, consistent, direct, unable to assess precision) found increased grey matter volume in the right fusiform gyrus and left superior temporal gyrus of high-risk individuals.
<b>Grey matter volume</b>	
14 VBM studies, N = 1,331 <i>Increased grey matter volumes were found in people at high risk in;</i> Right fusiform gyrus (Z = 1.051) Left superior temporal gyrus (Z = 1.048)	
<b>Consistency in results</b>	Authors report consistent results.
<b>Precision in results</b>	Unable to assess; no measure of precision is reported.
<b>Directness of results</b>	Direct

*Ellison-Wright I, Glahn DC, Laird AR, Thelen SM, Bullmore E*

**The anatomy of first-episode and chronic schizophrenia: an anatomical likelihood estimation meta-analysis**

American Journal of Psychiatry 2008; 165(8): 1015-23

[View review abstract online](#)

<b>Comparison</b>	Grey matter changes in people with chronic or first-episode schizophrenia vs. controls.
<b>Summary of evidence</b>	Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests reduced grey matter in the superior temporal and fusiform gyri in chronic schizophrenia.





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<b>Temporal grey matter volume</b>	
<p><u>Chronic schizophrenia</u> 27 studies, N = 1,556</p> <p>Significant reduction of volume was seen in the superior temporal gyrus, <math>p = 0.0018</math>, and the left temporal fusiform gyrus, <math>p &lt; 0.0002</math>.</p> <p><u>First-episode schizophrenia</u> No significant reductions were reported.</p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

<p><i>Ellison-Wright I, Bullmore E</i></p> <p><b>Meta-analysis of diffusion tensor imaging studies in schizophrenia</b></p> <p>Schizophrenia Research 2009; 108(1-3): 3-10</p> <p><a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>White matter integrity in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess precision and consistency) suggests schizophrenia is associated with significant reductions in white matter integrity in the temporal lobe.</b>
<b>Temporal white matter integrity</b>	
<p>15 studies, N = 790</p> <p><i>White matter reduction in schizophrenia;</i></p> <p>Talairach coordinates (-30, -32, -2), <math>p &lt; 0.0001</math>, Voxel cluster size 2264mm<sup>3</sup></p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.



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<b>Directness of results</b>	Direct
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*Fornito A, Yucel M, Patti J, Wood SJ, Pantelis C*

**Mapping grey matter reductions in schizophrenia: An anatomical likelihood estimation analysis of voxel-based morphometry studies**

*Schizophrenia Research* 2009; 108(1-3): 104-113

[View review abstract online](#)

<b>Comparison</b>	<b>Grey matter volume in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests reductions in grey matter in the bilateral medial temporal lobe, occipito-temporal gyrus, and left fusiform gyrus of people with schizophrenia.</b>

**Temporal grey matter volume**

37 studies, N = 3,336

*Pooled analysis identified 15 clusters of reduced grey matter, encompassing foci in the frontal, temporal, limbic and subcortical regions;*

Decreased grey matter reported bilaterally in the medial temporal lobe.

Decreased grey matter was also reported in the left fusiform gyrus.

*Clusters where grey matter concentration reductions were significantly more frequent than grey matter volume reductions;*

Left occipito-temporal gyrus: Talairach coordinates (-52.58, -62.73, -7.35), Voxel cluster size 296mm<sup>3</sup>, ALE 0.72 x 10<sup>-3</sup>

As GMC had fewer foci available for comparison, a random subset was initially selected for comparison with GMV. To increase validity of this comparison, four additional GMC/GMV contrasts were performed with different GMC subsets, and demonstrated high consistency between randomisations.

*Both cluster size and ALE statistic were larger for comparisons using concentration measures compared to volume measures;*

Cluster size t = 2.54, p = 0.02

ALE statistic t = 2.82, p = 0.01

<b>Consistency in results</b>	No measure of heterogeneity is reported.
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<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Fusar-Poli P, Borgwardt S, Crescini A, Deste G, Kempton MJ, Lawrie S, McGuire P, Sacchetti E*

**Neuroanatomy of vulnerability to psychosis: a voxel-based meta-analysis**

Neuroscience and Biobehavioural Reviews 2011; 35: 1175-1185

[View review abstract online](#)

<b>Comparison</b>	<b>Grey matter volume in people at high-risk of schizophrenia (both clinical high-risk and genetic high-risk) vs. controls and vs. people with psychosis.</b>
<b>Summary of evidence</b>	<p><b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) found decreases in the right superior temporal gyrus of people at high genetic or clinical risk of schizophrenia compared to controls. People at high genetic risk showed greater decreases than people at high clinical risk.</b></p> <p><b>People at high genetic or clinical risk of schizophrenia showed increases in the middle temporal gyrus compared to people with psychosis. People at high genetic or clinical risk who developed a psychotic episode showed decreases in the right superior temporal gyrus compared to those who did not develop psychosis.</b></p>

**Temporal grey matter volume**

19 studies, N = 1,601

*All clinical and genetic high-risk of psychosis vs. controls;*

Decreases were reported in the right superior temporal gyrus.

*All clinical and genetic high-risk of psychosis vs. people with psychosis;*

Increases were reported in the middle temporal gyrus.

*Genetic high-risk of psychosis vs. clinical high-risk of psychosis;*

People at high genetic risk showed decreases in the right superior temporal gyrus.

*People at high-risk who developed a psychotic episode vs. those who did not develop psychosis;*

People at high-risk who developed psychosis showed decreases in the right superior temporal



**Temporal lobe**

gyrus.	
<b>Consistency in results</b>	No measure of consistency is reported.
<b>Precision in results</b>	No measure of precision is reported.
<b>Directness of results</b>	Direct

Gao X, Zhang W, Yao L, Xiao Y, Liu L, Liu J, Li S, Tao B, Shah C, Gong Q, Sweeney JA, Lui S

**Association between structural and functional brain alterations in drug-free patients with schizophrenia: A multimodal meta-analysis**

Journal of Psychiatry and Neuroscience 2018; 43: 131-42

[View review abstract online](#)

<b>Comparison</b>	<b>Overlap between regions of functional and structural alteration in drug-free people with first-episode schizophrenia vs. controls.</b> <b>Note; most patients were drug naïve.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, mostly consistent, direct, unable to assess precision) suggests decreased grey matter volume and decreased functional activity in the right temporal pole/superior temporal gyrus. There was decreased grey matter volume and increased functional activity in the bilateral superior temporal gyrus.</b>

**Structural and functional alteration**

15 structural MRI studies, N = 971, 16 functional MRI studies, N = 831

*Significant decreased grey matter volume and decreased functional activity in;*

Right temporal pole/superior temporal gyrus: 1,446 voxels, MNI coordinates (34, 8, -22),  $p < 0.001$

*Significant decreased grey matter volume and increased functional activity in;*

Left superior temporal gyrus: 4,575 voxels, MNI coordinates (-56, -32, 20),  $p < 0.001$

Right superior temporal gyrus: 1,583 voxels, MNI coordinates (46, -16, -2),  $p < 0.001$



**Temporal lobe**

<b>Consistency in results</b>	Authors report most findings were consistent.
<b>Precision in results</b>	Unable to assess; no measure of precision is reported.
<b>Directness of results</b>	Direct

*Haszto CS, Stanley JA, Iyengar S, Prasad KM*

**Regionally Distinct Alterations in Membrane Phospholipid Metabolism in Schizophrenia: A Meta-analysis of Phosphorus Magnetic Resonance Spectroscopy Studies**

**Biological Psychiatry: Cognitive Neuroscience and Neuroimaging 2019; 5: 264–80**

[View review abstract online](#)

<b>Comparison</b>	<b>Temporal PME and PDE levels measured by <sup>1</sup>H-MRS in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to high quality evidence (large samples, some inconsistency, precise, direct, some publication bias) finds a medium-sized increase in PDE in the temporal lobe of people with schizophrenia. There were no differences in temporal PME levels.</b>

**PME and PDE**

*A significant, medium-sized effect of increased PDE levels in the temporal regions of people with schizophrenia;*

9 studies, N = 319,  $g = 0.55$ , 95%CI 0.28 to 0.82,  $p < 0.0001$ ,  $I^2 = 68\%$

Authors report possible publication bias.

*There were no differences in PME levels;*

8 studies, N = 270,  $g = -0.08$ , 95%CI -0.27 to 0.10,  $p = 0.37$ ,  $I^2 = 25\%$

No publication bias was detected.

<b>Consistency in results</b>	Inconsistent, apart from PME.
<b>Precision in results</b>	Precise
<b>Directness of results</b>	Direct





Temporal lobe

Honea R, Crow TJ, Passingham D, Mackay CE

**Regional deficits in brain volume in schizophrenia: a meta-analysis of voxel-based morphometry studies**

American Journal of Psychiatry 2005; 162(12): 2233-2245

[View review abstract online](#)

<b>Comparison</b>	<b>Grey matter volume in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests schizophrenia is associated with significant reductions in the grey matter density in the superior and medial temporal lobes.</b>
<b>Temporal grey matter volume</b>	
<p>15 studies, N = 754, varying FWHM smoothing kernel (range 4-12mm)</p> <p><i>Regions showing reduced grey matter density in schizophrenia;</i></p> <p>Left medial temporal lobe: reduced in 9/15 studies</p> <p>Left superior temporal gyrus: reduced in 8/15 studies</p> <p>Right superior temporal gyrus: reduced in around 50% of studies</p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

Kambeitz J, Abi-Dargham A, Kapur S, Howes OD

**Alterations in cortical and extrastriatal subcortical dopamine function in schizophrenia: Systematic review and meta-analysis of imaging studies**

British Journal of Psychiatry 2014; 204(6): 240-249

[View review abstract online](#)

<b>Comparison</b>	<b>D2/D3 receptor availability in unmedicated people with</b>
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**Temporal lobe**

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	<b>schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (small to medium-sized sample, some inconsistency and imprecision, direct) suggests no differences in D2/D3 receptor availability in the temporal cortex of people with schizophrenia compared to controls.</b>
<b>D2/D3 receptor availability</b>	
<p><u>Temporal cortex</u></p> <p><i>No significant differences between groups in D<sub>2</sub>/D<sub>3</sub> receptor availability;</i>          6 studies, N = 170, <i>d</i> = -0.23, 95%CI -0.54 to 0.07, <i>p</i> = 1.00, <i>I</i><sup>2</sup> = 0%          Effect sizes in studies of drug-free or drug-naïve patients ranged from -0.42 to 0.49.          Meta-regression showed no effect of publication year, gender, or age.          There was no evidence of publication bias.</p>	
<b>Consistency in results</b>	Some inconsistency.
<b>Precision in results</b>	Some imprecision.
<b>Directness of results</b>	Direct

*Kanaan RA, Kim JS, Kaufmann WE, Pearlson GD, Barker GJ, McGuire PK*

**Diffusion tensor imaging in schizophrenia**

**Biological Psychiatry 2005; 58(12): 921-929**

[View review abstract online](#)

<b>Comparison</b>	<b>White matter integrity in people with schizophrenia vs. healthy controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess precision and consistency) suggests decreased white matter integrity in the middle temporal gyrus in people with schizophrenia.</b>
<b>Temporal white matter integrity</b>	



**Temporal lobe**

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19 studies, N = 640	
Middle temporal gyrus and superior temporal gyrus illustrated decreased white matter integrity in at least one study between schizophrenia and controls.	
Temporo-parietal cortex did not show decreased white matter integrity, no significant difference between schizophrenia and controls	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Kompus K, Westerhausan R, Hugdahl K*

**The “paradoxical” engagement of primary auditory cortex in patients with auditory verbal hallucinations: a meta-analysis of functional neuroimaging studies**

**Neuropsychologia 2011; 49: 3361-9**

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activation during auditory verbal hallucinations and during auditory stimulation tasks in people with schizophrenia.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (small sample, direct, unable to assess precision or consistency) found increased activation in the superior and middle temporal gyri during auditory hallucinations, and decreased activation in the superior temporal gyrus during auditory stimulation in people with schizophrenia.</b>
<b>During hallucinations (endogenously evoked)</b>	
<p><i>12 studies, N = 103, showed increased activation during hallucinations in;</i></p> <p>Superior temporal gyrus: Talairach coordinates (-52, -22, 16), cluster volume 952mm<sup>3</sup></p> <p>Middle temporal gyrus: Talairach coordinates (54, -32, -4), cluster volume 368mm<sup>3</sup></p> <p>Middle temporal gyrus: Talairach coordinates (58 -44 14), cluster volume 200mm<sup>3</sup></p>	
<b>Auditory tasks</b>	
<p><i>11 studies, N = 384, showed reduced activation during auditory stimulation tasks in people with</i></p>	



**Temporal lobe**

<i>schizophrenia;</i> Superior temporal gyrus: Talairach coordinates (-54, -8, 0), cluster volume 1824mm <sup>3</sup>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

<p><i>Kraguljac NV, Reid M, White D, Jones R, den Hollander J, Lowman D, Lahti AC</i>  <b>Neurometabolites in schizophrenia and bipolar disorder – a systematic review and meta-analysis</b></p> <p>Psychiatry Research: Neuroimaging 2012; 203: 111-25  <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	Metabolite levels in people with schizophrenia vs. controls.
<b>Summary of evidence</b>	Moderate quality evidence (unclear sample sizes, inconsistent, some imprecision, direct) suggests reduced NAA/Cr in the temporal lobe of people with schizophrenia, and NAA may also be reduced. There were no differences in Cr or Cho.
<b>Metabolite levels</b>	
<p><i>Significant, medium-sized reduction in NAA/Cr ratio;</i>            7 studies, <math>d = -0.64</math>, 95%CI -1.09 to -0.19, <math>p &lt; 0.01</math>, <math>I^2 = 77\%</math>  <i>There was a trend-level reduction in;</i>            NAA levels: 7 studies, <math>d = -0.82</math>, 95%CI -1.69 to 0.05, <math>p = 0.06</math>, <math>I^2 = 92\%</math>  <i>There were no differences in;</i>            Cr levels: 7 studies, <math>d = -0.12</math>, 95%CI -1.22 to 0.99, <math>p = 0.84</math>, <math>I^2 = 95\%</math>            Cho levels: 7 studies, <math>d = -0.19</math>, 95%CI -1.09 to 0.71, <math>p = 0.68</math>, <math>I^2 = 93\%</math></p>	
<b>Consistency in results</b>	Inconsistent
<b>Precision in results</b>	Precise for NAA/Cr only.
<b>Directness of results</b>	Direct



**Temporal lobe**

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*Kyriakopoulos M, Bargiotas T, Barker GJ, Frangou S*

**Diffusion tensor imaging in schizophrenia**

**European Psychiatry: the Journal of the Association of European Psychiatrists 2008; 23(4): 255-273**

[View review abstract online](#)

<b>Comparison</b>	<b>White matter integrity in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, direct, unable to assess precision and consistency) suggests decreased white matter integrity in the temporal lobe.</b>
<b>Temporal white matter integrity</b>	
<p>15 studies, N = unclear</p> <p>Voxel-based analysis: 12 studies showed decreased white matter integrity in schizophrenia</p> <p>17 studies, N = unclear</p> <p>Regions-of-interest analysis: 8 studies report decreases in white matter integrity in temporal regions (hippocampus, entorhinal gyrus, fusiform gyrus, temporal lobe) in schizophrenia.</p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Lahuis B, Kemne, C, Van Engeland H*

**Magnetic resonance imaging studies on autism and childhood-onset schizophrenia in children and adolescents – a review**

**Acta Neuropsychiatrica 2003; 15(3): 140-147**

[View review abstract online](#)

<b>Comparison</b>	<b>Brain volume in childhood-onset schizophrenia (COS) vs. healthy controls.</b>
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**Temporal lobe**

<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, unable to assess consistency or precision, direct) suggests children with schizophrenia show volume reductions in the temporal lobe.</b>
<b>Temporal lobe volume</b>	
12 studies, N unclear Reduced volume was observed in the temporal lobe.	
<b>Consistency in results</b>	No measure of heterogeneity provided
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Leroy A, Amad A, D'Hondt F, Pins D, Jaafari N, Thomas P, Jardri R*

**Reward anticipation in schizophrenia: A coordinate-based meta-analysis**

Schizophrenia Research 2020; Jan: doi.org/10.1016/j.schres.2019.12.041

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activity during reward anticipation in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) found reduced activation in the superior temporal gyrus of people with schizophrenia during reward anticipation tasks.</b>
<b>Functional activation</b>	
11 studies, N = 488 <i>Schizophrenia was characterised by;</i> Reduced activation in the superior temporal gyrus.	
<b>Consistency in results</b>	Unable to assess; no measure of consistency is reported.
<b>Precision in results</b>	Unable to assess; no measure of precision is reported.
<b>Directness of results</b>	Direct



Temporal lobe

Leung M, Cheung C, Yu K, Yip B, Sham P, Li Q, Chua S, McAlonan G

**Gray Matter in First-Episode Schizophrenia Before and After Antipsychotic Drug Treatment. Anatomical Likelihood Estimation Meta-analyses With Sample Size Weighting**

Schizophrenia Bulletin 2011; 37(1): 199-211

[View review abstract online](#)

<b>Comparison</b>	Grey matter volume in people with first-episode schizophrenia vs. controls.
<b>Summary of evidence</b>	Moderate quality evidence (medium to large samples, direct, unable to assess consistency or precision) suggests greater reduction in the inferior and superior temporal gyri of people with treatment naïve first-episode schizophrenia than treated first-episode schizophrenia. Greater reductions in treated patients were observed in the superior temporal gyrus.

**Temporal grey matter volume**

Treatment-naïve patients

6 studies, N = 327

Right superior temporal gyrus: Talairach coordinates (46, -30, 16), cluster 864mm<sup>3</sup>, ALE 0.005

Right superior temporal gyrus: Talairach coordinates (50, -26, 0), cluster 816mm<sup>3</sup>, ALE 0.0051

Left superior temporal gyrus: Talairach coordinates (-56, 4, -4), cluster 256mm<sup>3</sup>, ALE 0.0024

Right inferior temporal gyrus: Talairach coordinates (52, -20, -32), cluster 384mm<sup>3</sup>, ALE 0.0026

Left inferior temporal gyrus: Talairach coordinates (-52, -22, -34), cluster 320mm<sup>3</sup>, ALE 0.0028

Treated patients

9 studies, N = 820

Right superior temporal gyrus: Talairach coordinates (52, -8, -8), cluster 560mm<sup>3</sup>, ALE 0.0085

Left superior temporal gyrus: Talairach coordinates (-52, -8, 4), cluster 1088mm<sup>3</sup>, ALE 0.0089

*Regions where grey matter reductions were larger in magnitude in treatment-naïve patients than treated patients;*

Right superior temporal gyrus: Talairach coordinates (50, -26, 0), cluster 352mm<sup>3</sup>, ALE 0.0143

Right superior temporal gyrus: Talairach coordinates (46, -30, 16), cluster 248mm<sup>3</sup>, ALE 0.0130



**Temporal lobe**

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<p>Right inferior temporal gyrus: Talairach coordinates (52, -20, -32), cluster 384mm<sup>3</sup>, ALE 0.0130                  Left inferior temporal gyrus: Talairach coordinates (-52, -22, -34), cluster 312mm<sup>3</sup>, ALE 0.0142  <i>Regions where grey matter reductions were larger in magnitude in treated patients than treatment naïve patients;</i>                  Right superior temporal gyrus: Talairach coordinates (52, -8, -8), cluster 472mm<sup>3</sup>, ALE 0.0154                  Left superior temporal gyrus: Talairach coordinates (-52, -8, 4), cluster 792mm<sup>3</sup>, ALE 0.0156</p>	
<b>Consistency in results</b>	No measure of heterogeneity provided
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

<p><i>Minzenberg MJ, Laird AR, Thelen S, Carter CS, Glahn DC</i>  <b>Meta-analysis of 41 functional neuroimaging studies of executive function in schizophrenia</b>                  Archives of General Psychiatry 2009; 66(8): 811-822  <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Functional activation in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess precision or consistency) suggests people with schizophrenia show increased activity in the right superior temporal gyrus during executive functioning tasks.</b>
<b>Functional activation</b>	
<p>41 studies, N = 1,217  <i>Significantly increased activity in people with schizophrenia in;</i>                  Right superior temporal gyrus: Talairach centre of mass (38, -36, 6), cluster volume 584mm<sup>3</sup></p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct



**Temporal lobe**

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*Modinos G, Costafreda SG, van Tol M-J, McGuire PK, Aleman A, Allen P*

**Neuroanatomy of auditory verbal hallucinations in schizophrenia: a quantitative meta-analysis of voxel-based morphometry studies**

**Cortex 2013; 49(4): 1046-55**

[View review abstract online](#)

<b>Comparison</b>	<b>Association between brain structure and auditory verbal hallucinations in people with schizophrenia.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (medium-sized sample, consistent, direct, unable to assess precision) suggests the severity of auditory hallucinations is significantly associated with grey matter volume reductions in the left superior temporal gyri, (including the rolandic operculum and Heschl’s gyri), and a trend effect for the right superior temporal gyri (including the medial temporal gyrus and Heschl’s gyri).</b>
<b>Temporal grey matter volume</b>	
8 studies, N = 322	
<i>Reduced grey matter volume in two clusters were associated with severity of hallucinations;</i>	
1. Left superior temporal gyrus: Talairach coordinates (-52, -18, 2), cluster volume 1680mm <sup>3</sup> , <i>p</i> = 0.022, including the left rolandic operculum: Talairach coordinates (-44, -22, 12), and the left Heschl’s gyrus: Talairach coordinates (-46, -14, 6).	
Authors report that 48.6% of the studies report an effect within 10mm of the -52 -18 2 cluster.	
2. Right superior temporal gyrus: Talairach coordinates (46, -16, -8) cluster volume 1248mm <sup>3</sup> , <i>p</i> = 0.062 (trend), including the right Heschl’s gyrus: Talairach coordinates (50, -14, 6), and the right medial temporal gyrus: Talairach coordinates (50, -14, -10).	
Authors report that 34.2% of the studies report an effect within 10mm of the -52 -18 2 cluster.	
<b>Consistency in results</b>	Authors report the concordance across studies.
<b>Precision in results</b>	No measure of precision is reported.
<b>Directness of results</b>	Direct

*Niu Y, Li Z, Cheng R, Peng B, Liu B, Ma Y*



**Temporal lobe**

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**Altered gray matter and brain activity in patients with schizophrenia and their unaffected relatives: A multimodal meta-analysis of voxel-based structural MRI and resting-state fMRI studies**

International Journal of Clinical and Experimental Medicine 2017; 10: 1866-78

[View review abstract online](#)

<b>Comparison</b>	<b>Structural alteration in relatives of people with schizophrenia vs. people with schizophrenia and vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large samples, direct, unable to assess consistency or precision) found relatives showed decreased grey matter in the left inferior temporal gyrus.</b>
<b>Temporal grey matter volume</b>	
9 studies, N = 953 <i>Compared to controls, relatives had decreased grey matter in;</i> Left inferior temporal gyrus: 53 voxels, MNI coordinates (-58, -46, -22), $p = 0.00072$	
<b>Consistency in results</b>	Unable to assess; no measure of consistency is reported.
<b>Precision in results</b>	Unable to assess; no measure of precision is reported.
<b>Directness of results</b>	Direct

*Olabi B, Ellison-Wright I, McIntosh AM, Wood SJ, Bullmore E, Lawrie SM*

**Are There Progressive Brain Changes in Schizophrenia? A Meta-Analysis of Structural Magnetic Resonance Imaging Studies**

Biological Psychiatry 2011; 70(1): 88-96

[View review abstract online](#)

<b>Comparison</b>	<b>Progressive changes in brain grey matter volume in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>High quality evidence (large sample, consistent, precise, direct) suggests greater reductions over time in temporal grey and white matter volume in people with schizophrenia.</b>





**Temporal lobe**

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<b>Temporal grey and white matter volume</b>	
<p>Progressive changes in grey matter volume reported across longitudinal MRI scans over 1-10 years. 31 studies, N = 1,867</p> <p><i>Significantly greater reductions were reported over time in people with schizophrenia;</i></p> <p>Temporal grey matter: N = 439, 10 studies, <math>d = -0.204</math>, 95%CI -0.58 to 0.17, <math>p = 0.289</math>, <math>I^2 = 68\%</math> Temporal white matter: N = 259, 6 studies, <math>d = -0.485</math>, 95%CI -0.76 to -0.21, <math>p = 0.001</math>, <math>I^2 = 0\%</math></p>	
<b>Consistency in results</b>	Consistent
<b>Precision in results</b>	Precise
<b>Directness of results</b>	Direct

<p><i>Palaniyappan L, Balain V, Radua J, Liddle PF</i></p> <p><b>Structural correlates of auditory hallucinations in schizophrenia: a meta-analysis</b></p> <p>Schizophrenia Research 2012; 137:169-173 <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Correlations between grey matter volume and auditory hallucinations in people with schizophrenia.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (medium to large sample, unable to assess consistency or precision, direct) suggests reductions in grey matter volume in the superior temporal gyrus correlated with increased severity of auditory hallucinations.</b>
<b>Temporal grey matter volume</b>	
<p>7 studies, N = 350</p> <p><i>Reduced volume was associated with increased severity of auditory hallucinations;</i></p> <p>Right superior temporal gyrus cluster: Talairach coordinates (58, -6, 10), uncorrected <math>p = 0.0008</math>, 318 voxels</p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.



**Temporal lobe**

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<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Plaven-Sigra P, Matheson GJ, Collste K, Ashok AH, Coughlin JM, Howes OD, Mizrahi R, Pomper MG, Rusjan P, Veronese M, Wang Y, Cervenka S*

**Positron Emission Tomography Studies of the Glial Cell Marker Translocator Protein in Patients With Psychosis: A Meta-analysis Using Individual Participant Data**

**Biological Psychiatry 2018; 84: 433-42**

[View review abstract online](#)

<b>Comparison</b>	<b>Translocator protein in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (small sample, consistent, imprecise, direct) finds reduced translocator protein in the temporal cortex of people with schizophrenia.</b>
<b>Translocator protein</b>	
<p><i>A significant decrease in translocator protein in the temporal cortex of people with schizophrenia;</i>                      5 studies, N = 152, total distribution volume = -0.47, 95%CredInt -0.87 to -0.07, <math>p &lt; 0.05</math>                      There were no moderating effects of medication (drug free vs. medicated).</p>	
<b>Consistency in results</b>	Authors report results were consistent.
<b>Precision in results</b>	Appears imprecise.
<b>Directness of results</b>	Direct

*Ragland JD, Laird AR, Ranganath C, Blumenfeld RS, Gonzales SM, Glahn DC*

**Prefrontal activation deficits during episodic memory in schizophrenia**

**American Journal of Psychiatry 2009; 166(8): 863-874**



**Temporal lobe**

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activation during episodic memory tasks in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, direct, unable to assess precision or consistency) suggests increased activity in the left middle temporal gyrus during episodic encoding in people with schizophrenia.</b>
<b>Functional activity during episodic encoding</b>	
<i>Significantly increased activity in people with schizophrenia in;</i> Left middle temporal gyrus; cluster volume 352mm <sup>3</sup> , Talairach centre of mass (-44, -42, -8)	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Scognamiglio C, Houenou J*

**A meta-analysis of fMRI studies in healthy relatives of patients with schizophrenia**

**Australian and New Zealand Journal of Psychiatry 2014; 48(10): 907-16**

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activation in relatives of people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, direct, unable to assess consistency or precision) found over-activation in right middle and superior temporal gyri in relatives during cognitive tasks. There was over-activated in the right middle temporal gyrus during emotion tasks.</b>
<b>Functional activation</b>	



**Temporal lobe**

Cognitive tasks

17 studies

*The following areas showed increased activation in relatives compared to controls;*

Right middle temporal gyrus (BA37): Talairach coordinates (46, -60, 2),  $p < 0.001$

Right superior temporal gyrus (BA39): Talairach coordinates (56, -58, 18),  $p < 0.01$

Emotion tasks

4 studies

*The following areas showed increased activation in relatives compared to controls;*

Right middle temporal gyrus (BA39): Talairach coordinates (50, -66, 10),  $p < 0.01$

<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	No confidence intervals are provided.
<b>Directness of results</b>	Direct

*Shah C, Zhang W, Xiao Y, Yao L, Zhao Y, Gao X, Liu L, Liu J, Li S, Tao B, Yan Z, Fu Y, Gong Q, Lui S*

**Common pattern of gray-matter abnormalities in drug-naive and medicated first-episode schizophrenia: a multimodal meta-analysis**

**Psychological Medicine 2017; 47: 401-13**

[View review abstract online](#)

<b>Comparison</b>	<b>Grey matter volume in first-episode schizophrenia (treated and medication naïve) vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests common decreases in grey matter volume in the left superior temporal gyrus. Grey matter in the left middle temporal gyrus was increased in antipsychotic-naïve patients but decreased in treated patients.</b>
<b>Temporal grey matter volume</b>	



**Temporal lobe**

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<p>24 studies, N = 1,358</p> <p><i>Grey matter decreased in both medicated and medication naïve first-episode patients;</i></p> <p>Left superior temporal gyrus: MNI coordinates (-44, -8, -8)</p> <p><i>Grey matter decreased in medicated but increased in medication naïve first-episode patients;</i></p> <p>Left middle temporal gyrus: MNI coordinates (-52, -46, 6)</p>	
<b>Consistency in results</b>	No measure of consistency is reported.
<b>Precision in results</b>	No measure of precision is reported.
<b>Directness of results</b>	Direct

<p><i>Sommer I, Aleman A, Ramsey N, Bouma A</i></p> <p><b>Handedness, language lateralisation and anatomical asymmetry in schizophrenia: meta-analysis</b></p> <p><b>British Journal of Psychiatry 2001; 178: 344-351</b></p> <p><a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Anatomical asymmetry in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (medium to large samples, inconsistent, imprecise, direct) suggest people with schizophrenia show an absence of normal leftward asymmetry in the planum temporal, and excess rightward asymmetry in the superior temporal gyrus (particularly posterior).</b>
<b>Anatomical asymmetry</b>	
<p><u>Planum temporale</u></p> <p><i>Significant, left asymmetry in controls but not in people with schizophrenia;</i></p> <p>Controls: 11 studies, N = 187, <math>d = 0.7</math>, 95%CI 0.49 to 0.91, <math>p &lt; 0.01</math></p> <p><math>Q = 4.3</math>, <math>p = 0.89</math></p> <p>Schizophrenia: 11 studies, N = 191, <math>d = 0.18</math>, 95%CI -0.33 to 0.69, <math>p = 0.24</math></p>	



**Temporal lobe**

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Q = 48.7, p < 0.01

*Significantly less asymmetry of the planum temporale in people with schizophrenia compared to controls;*

11 studies, N = 368, d = -0.51, 95%CI -1.04 to 0.02, p = 0.03, Q = 54.5, p = 0.0005

Superior temporal gyrus

*Significant right asymmetry reported in schizophrenia only (trend level in controls);*

Controls: 17 studies, N = 399, d = -0.47, 95%CI -1.1 to 0.14, p = 0.07, Q = 140.23, p < 0.01

Schizophrenia: 17 studies, N = 469, d = -0.73, 95%CI -1.2 to -0.25, p < 0.01, Q = 151.7, p < 0.01

*No significant difference in degree of asymmetry of STG between people with schizophrenia and controls;*

17 studies, N = 1,020, d = 0.21, 95%CI -0.08 to 0.51, p = 0.08, Q = 93.3, p < 0.01

Posterior segment of the superior temporal gyrus

*Significant right asymmetry reported in schizophrenia only (trend level in controls);*

Controls: 5 studies, N = 130, d = -0.2, 95%CI -0.44 to 0.05, p = 0.06, Q = 1.5, p = 0.9

Schizophrenia: 5 studies, N = 108, d = -0.9, 95%CI -0.17 to -0.62, p < 0.01, Q = 4.85, p = 0.43

*Significantly greater right asymmetry of posterior superior temporal gyrus in people with schizophrenia compared to controls;*

5 studies, N = 238, d = 0.7, 95%CI 0.4 to 1, p < 0.01, Q = 5.42, p = 0.37

<b>Consistency in results</b>	Inconsistent for all measures except posterior STG.
<b>Precision in results</b>	Imprecise
<b>Directness of results</b>	Direct

Steen RG, Hamer RM, Lieberman JA

**Measurement of brain metabolites by <sup>1</sup>H magnetic resonance spectroscopy in patients with schizophrenia: a systematic review and meta-analysis**

Neuropsychopharmacology 2005; 30(11): 1949-1962

[View review abstract online](#)

<b>Comparison</b>	<b>NAA activity in grey and white matter regions in people with schizophrenia vs. controls.</b>
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**Temporal lobe**

<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, direct, inconsistent, unable to assess precision) suggests NAA may be decreased in the temporal cortex (grey and white matter).</b>
<b>NAA levels</b>	
<p><u>Grey matter</u></p> <p>5 studies consider NAA, N unclear Patient average 94.0% of control levels</p> <p><u>White matter</u></p> <p>8 studies consider NAA, N unclear Patient average 87.3% of control levels</p>	
<b>Consistency in results</b>	Significant heterogeneity was reported.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

*Stone JM, Davis JM, Leucht S, Pilowsky LS*

**Cortical dopamine D2/D3 receptors are a common site of action for antipsychotic drugs--an original patient data meta-analysis of the SPECT and PET in vivo receptor imaging literature**

Schizophrenia Bulletin 2009; 35(4): 789-797

[View review abstract online](#)

<b>Comparison</b>	<b>Dopamine D2/D3 receptor occupancy in the temporal cortex of people with schizophrenia vs. controls following first and second-generation antipsychotic administration.</b>
<b>Summary of evidence</b>	<p><b>Moderate to low quality evidence (unclear sample size, unable to assess precision and consistency, direct) suggests dopamine receptor occupancy may be different depending on first or second generation antipsychotic treatment.</b></p> <p><b>Low quality evidence (indirect, unable to assess sample size, precision and consistency) is unclear about the relationship between receptor occupancy and drug effectiveness, side</b></p>



**Temporal lobe**

	<b>effects or measurement type.</b>
<b>Dopamine D2/D3 receptor occupancy</b>	
<p><i>Fifteen studies were pooled to estimate the dopamine receptor occupancy;</i></p> <p>Temporal cortex occupancy following first-generation antipsychotic administration: N not reported, 77% ± 12%</p> <p>Temporal cortex occupancy following second-generation antipsychotic administration: N not reported, 67% ± 19%</p> <p style="text-align: center;">t = 3.5, p = 0.001</p> <p>Ratio of striatal/temporal occupancy for first generation antipsychotics: 96 ± 24%</p> <p>Ratio of striatal/temporal occupancy for second generation antipsychotics: 74 ± 35%</p> <p style="text-align: center;">t = 3.7, p &lt; 0.001</p> <p>Subgroup analysis 1: correlation to clinical efficacy.</p> <p>Indirect comparison using dose-response curve calculated from separate efficacy studies into first- and second-generation antipsychotics.</p> <p>Occupancy correlated strongly with drug effectiveness for temporal D2/D3: r = 0.95, p &lt; 0.001.</p> <p>Subgroup analysis 2: controlling for assessment method; Simplified Reference Tissue Modelling vs. Ratio modelling.</p> <p>Significant difference in the two methods was seen in the temporal cortex, ratio modelling estimated 61% occupancy, SRTM estimated 78%. F = 21.3, p = 0.04.</p> <p>The association of measurement method and drug type (typical vs. atypical) was zero.</p> <p style="text-align: center;">Subgroup analysis 3: single vs. dual ligands.</p> <p>In the temporal cortex, single ligand binding had a 13% higher (95%CI 6% to 21%) occupancy estimate than dual ligands. F = 13, p = 0.0006.</p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	CI's not reported for all outcomes, precise for subgroup analysis 3.
<b>Directness of results</b>	Direct

*Sugranyes G, Kyriakopoulos M, Corrigall R, Taylor E, Frangou S*

**Autism spectrum disorders and schizophrenia: meta-analysis of the neural correlates of social cognition**



**Temporal lobe**

<p>PLoS ONE 2011; 6(10): e25322  <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Functional activation during face emotion recognition in schizophrenia vs. autism spectrum disorders.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large samples, direct, unable to assess precision or consistency) found decreased activation in schizophrenia compared to autism in bilateral superior temporal gyri.</b>
<b>Face emotion recognition</b>	
<p>17 studies, N = 511  <i>The following clusters showed decreased activation in schizophrenia vs. autism spectrum disorders;</i>                  Left superior temporal: Talairach coordinates (-56, -24, 6), cluster volume 1824mm<sup>3</sup>                  Right superior temporal: Talairach coordinates (40, -48, 14), cluster volume 432mm<sup>3</sup></p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are provided.
<b>Directness of results</b>	Direct

<p><i>Sun J, Maller JJ, Guo L, Fitzgerald PB</i>  <b>Superior temporal gyrus volume change in schizophrenia: A review on Region of Interest volumetric studies</b>                   Brain Research Reviews 2009; 61(1): 14-32  <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Superior temporal gyrus volume in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (large sample, direct, unable to assess consistency or precision) suggests a volume deficit in the superior temporal gyrus of people with schizophrenia. Low quality evidence (small samples) is uncertain of relationships between symptoms and superior temporal gyrus volume.</b>



**Temporal lobe**

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<b>Temporal grey matter volume</b>	
46 studies, N = 2,771	
35/46 studies (N = 1682/2771) reported significant volume differences in the superior temporal gyrus in people with schizophrenia.	
12/35 studies (N = 1117/1682) showed unilateral (left) reduction of superior temporal gyrus volume.	
13/35 studies (N = 565/1682) showed a bilateral reduction of superior temporal gyrus volume.	
<b>Correlations with symptoms</b>	
Increased psychotic syndrome and auditory hallucinations were correlated with reduced left anterior superior temporal gyrus volume (4 studies, N = 171).	
Increased thought disorder severity was correlated with reduced left posterior superior temporal gyrus (3 studies, N = 125); right superior temporal gyrus (1 study, N = 80); anterior superior temporal gyrus (1 study, N = 18).	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

<i>Torres US, Portela-Oliveira E, Borgwardt S, Busatto GF</i>	
<b>Structural brain changes associated with antipsychotic treatment in schizophrenia as revealed by voxel-based morphometric MRI: an activation likelihood estimation meta-analysis</b>	
<b>BMC Psychiatry 2013; 13: 342</b>	
<a href="#">View review abstract online</a>	
<b>Comparison</b>	<b>Brain changes with antipsychotic treatment in people with schizophrenia vs. mixed controls (healthy controls, drug-free patients, or pre-post medication in patients).</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (large sample, indirect, unable to assess consistency or precision) suggests decreases in the left lateral temporal cortex with antipsychotic treatment.</b>
<b>Temporal grey matter volume with medication use</b>	



**Temporal lobe**

<p>10 studies, N = 548</p> <p><i>The following clusters showed decreases in patients on antipsychotics;</i></p> <p>Left lateral temporal cortex (BA20): Talairach coordinate -48 -16 -20, cluster volume 408mm<sup>3</sup></p>	
<b>Consistency in results</b>	No measure of consistency is reported.
<b>Precision in results</b>	No measure of precision is reported.
<b>Directness of results</b>	Indirect; mixed control group.

<p><i>Vucurovic K, Caillies S, Kaladjian A</i></p> <p><b>Neural correlates of theory of mind and empathy in schizophrenia: An activation likelihood estimation meta-analysis</b></p> <p>Journal of Psychiatric Research 2020; 120: 163-74</p> <p><a href="#">View review abstract online</a></p>	
<b>Comparison</b>	Functional activation during theory of mind tasks in schizophrenia vs. controls.
<b>Summary of evidence</b>	Moderate quality evidence (large samples, direct, unable to assess precision or consistency) suggests decreased activation in schizophrenia the left middle temporal gyrus during theory of mind tasks.
<b>Theory of mind</b>	
<p>17 studies, N = 560</p> <p><i>The following clusters showed decreased activation in schizophrenia in;</i></p> <p>A 1408mm<sup>3</sup> volume cluster of the left middle temporal gyrus (Talairach: x=-47.4, y=-69.7, z=13.2; ALE=0.02; BA39).</p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are provided.
<b>Directness of results</b>	Direct



**Temporal lobe**

*Wensing T, Cieslik EC, Muller VI, Hoffstaedter F, Eickhoff SB, Nickl-Jockschat T*

**Neural correlates of formal thought disorder: An activation likelihood estimation meta-analysis**

**Human Brain Mapping 2017; 38: 4946-65**

[View review abstract online](#)

<b>Comparison</b>	<b>Functional activation in people with schizophrenia and formal thought disorder vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate quality evidence (medium-sized sample, direct, unable to assess precision or consistency) suggests hyperactivation and hypoactivation in the left superior and middle temporal gyrus of people with formal thought disorder.</b>
<b>Functional activation</b>	
<p>17 studies, N = 282</p> <p><i>The following regions showed hyperactivation or hypoactivation;</i></p> <p>Left superior temporal gyrus: 114 voxels, MNI coordinates -54, -32, 9</p> <p>Left middle temporal gyrus: 72 voxels, MNI coordinates -46, -54, 3</p>	
<b>Consistency in results</b>	No measure of heterogeneity is reported.
<b>Precision in results</b>	Precise for all outcomes except right hemisphere DLPFC activation in the restricted analysis.
<b>Directness of results</b>	Direct

*Wright IC, Rabe-Hesketh S, Woodruff PW, David AS, Murray RM, Bullmore ET*

**Meta-analysis of regional brain volumes in schizophrenia**

**American Journal of Psychiatry 2000; 157(1): 16-25**

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<b>Comparison</b>	<b>Brain volume in people with schizophrenia vs. controls.</b>
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**Temporal lobe**

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<p><b>Summary of evidence</b></p>	<p><b>High quality evidence (medium to large samples, consistent, precise, direct) suggests small reductions in the superior temporal gyrus in people with schizophrenia.</b></p>
<p><b>Temporal lobe volume</b></p>	
<p style="text-align: center;"><u>Left temporal volume</u> 25 studies, N = 1,362</p> <p><i>Small effect size – average volume of schizophrenia temporal lobe 98% of control volume, 95%CI 96% to 99%;</i></p> <p style="text-align: center;"><math>d = -0.18</math>, no CIs reported, <math>p = 0.25</math></p> <p style="text-align: center;"><u>Right temporal volume</u> 25 studies, N = 1,362</p> <p><i>Small effect size – average volume of schizophrenia temporal lobe 97% of control volume, 95%CI 96% to 98%;</i></p> <p style="text-align: center;"><math>d = -0.24</math>, no CIs reported, <math>p = 0.33</math></p> <p style="text-align: center;"><u>Left superior temporal gyrus</u> 10 studies, N = 585</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 97% of control volume, 95%CI 95% to 100%;</i></p> <p style="text-align: center;"><math>d = -0.17</math>, no CIs reported, <math>p = 0.29</math></p> <p style="text-align: center;"><u>Right superior temporal gyrus</u> 10 studies, N = 585</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 97% of control volume, 95%CI 95% to 100%;</i></p> <p style="text-align: center;"><math>d = -0.17</math>, no CIs reported, <math>p = 0.76</math></p> <p style="text-align: center;"><u>Left anterior superior temporal gyrus</u> 8 studies, N = 377</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 93% of control volume, 95%CI 88% to 99%;</i></p> <p style="text-align: center;"><math>d = -0.41</math>, no CIs reported, <math>p = 0.02</math></p> <p style="text-align: center;"><u>Right anterior superior temporal gyrus</u> 7 studies, N = 347</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 95% of control volume, 95%CI 91% to 98%;</i></p> <p style="text-align: center;"><math>d = -0.28</math>, no CIs reported, <math>p = 0.50</math></p>	



**Temporal lobe**

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<p><u>Left posterior superior temporal gyrus</u></p> <p>5 studies, N = 222</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 93% of control volume, 95%CI 87% to 99%;</i></p> <p><i>d = -0.40, no CIs reported, p = 0.06</i></p> <p><u>Right posterior superior temporal gyrus</u></p> <p>4 studies, N = 192</p> <p><i>Small effect size – average volume of schizophrenia temporal gyrus 103% of control volume, 95%CI 98% to 108%;</i></p> <p><i>d = 0.19, no CIs reported, p = 0.40</i></p>	
<b>Consistency in results</b>	Consistent
<b>Precision in results</b>	Precise – CI range does not exceed 10% in either direction.
<b>Directness of results</b>	Direct

<p><i>Zakzanis KK, Poulin P, Hansen KT, Jolic D</i></p> <p><b>Searching the schizophrenic brain for temporal lobe deficits: a systematic review and meta-analysis</b></p> <p><b>Psychological Medicine 2000; 30(3): 491-504</b></p> <p><a href="#">View review abstract online</a></p>	
<b>Comparison 1</b>	<b>Temporal lobe volume in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (small to medium-sized samples, direct, unable to assess consistency or precision) suggests decreased temporal lobe volume in schizophrenia.</b>
<b>Temporal lobe volume</b>	
<p><u>Bilateral temporal lobe</u></p> <p><i>MRI: small effect suggests decreased bilateral temporal lobe volume in schizophrenia patients;</i></p> <p>9 studies, N unclear, <i>d = 0.39, SD = 0.45</i></p> <p><i>CT: medium effect suggests decreased temporal lobe volume in schizophrenia;</i></p> <p>2 studies, N unclear, <i>d = 0.49, SD = 0.55</i></p>	



**Temporal lobe**

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Left temporal lobe

*MRI: large effect suggests decreased left temporal lobe volume in schizophrenia;*

15 studies, N = 317,  $d = 0.88$ , SD = 1.4

*CT: small effect suggests decreased left temporal lobe volume in schizophrenia;*

3 studies, N = 80,  $d = 0.30$ , SD = 0.21

Right temporal lobe

*MRI: medium effect suggests decreased right temporal lobe volume in schizophrenia;*

15 studies, N = 317,  $d = 0.51$ , SD = 0.37

*CT: small effect suggests decreased right temporal lobe volume in schizophrenia;*

3 studies, N = 80,  $d = 0.26$ , SD = 0.14

*MRI: the left temporal lobe showed significantly lower volume than the right temporal lobe;*

$F = 3.11$ ,  $p < 0.05$

<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct
<b>Comparison 2</b>	<b>Temporal lobe functional activity in people with schizophrenia patients vs. controls</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (small or unclear sample sizes, direct, unable to assess precision and consistency) suggests reduction in functional activation in the temporal lobe if people with schizophrenia.</b>

**Temporal lobe activity**

Bilateral temporal lobe

*PET: large effect suggests decreased activity in schizophrenia;*

5 studies, N unclear,  $d = 0.87$ , SD = 1.1

*SPECT: large effect suggests decreased activity in schizophrenia,*

1 study, N = 22,  $d = 1.3$

*SPECT: large effect suggests decreased medial temporal lobe activity in schizophrenia;*

8 studies, N unclear,  $d = 0.89$ , SD = 1.2

Left temporal lobe

*PET: large effect size suggests decreased activity in schizophrenia;*



**Temporal lobe**

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<p>1 study, N = 83, <math>d = 0.47</math>  <i>SPECT: medium effect size suggests decreased activity in schizophrenia;</i>                      7 studies, N = 166, <math>d = 0.54</math>, SD = 0.54  <u>Right temporal lobe</u>  <i>PET: No differences between groups;</i>                      1 study, N = 83, <math>d = 0.14</math>  <i>SPECT: small effect size suggests decreased activity in schizophrenia;</i>                      7 studies, N = 166, <math>d = 0.42</math>, SD = 0.42</p>	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are reported.
<b>Directness of results</b>	Direct

<p>Zhao Q, Li Z, Huang J, Yan C, Dazzan P, Pantelis C, Cheung EFC, Lui SSY, Chan RCK</p> <p><b>Neurological soft signs are not “soft” in brain structure and functional networks: evidence from ALE meta-analysis</b></p> <p>Schizophrenia Bulletin 2013; doi:10.1093/schbul/sbt063  <a href="#">View review abstract online</a></p>	
<b>Comparison</b>	<b>Brain regions associated with neurological soft signs in people with schizophrenia vs. controls.</b>
<b>Summary of evidence</b>	<b>Moderate to low quality evidence (unclear sample size, direct, unable to assess precision or consistency) found increased activation in the superior temporal gyrus, and reduced white matter in the right middle temporal gyrus correlated with increased severity of neurological soft signs.</b>
<b>Neurological soft signs</b>	
<p><i>Increased activation in patients vs. controls correlating with NSS severity;</i>                      Left superior temporal gyrus: Talairach coordinates (-46, 0, -10)  <i>White matter reductions correlating with NSS severity in;</i></p>	



**Temporal lobe**

Right middle temporal gyrus: Talairach coordinates (44, -68, 22) There were no associations between NSS severity and temporal grey matter volume.	
<b>Consistency in results</b>	No measure of heterogeneity is provided.
<b>Precision in results</b>	No confidence intervals are provided.
<b>Directness of results</b>	Direct

**Explanation of acronyms**

ALE = activation likelihood estimate, Cho = choline, CI = confidence interval, COS = child onset schizophrenia, CredInt = credible interval, Cr = creatine, CT = computed tomography, *d* = Cohen's *d* and *g* = Hedges' *g* = standardised mean differences, DTI = diffusion tensor imaging, fMRI = functional magnetic resonance imaging, FSN = fail-safe N, FWHM = full-width at half maximum smoothing kernel, *I*<sup>2</sup> = the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance), MNI = Montreal Neurological Institute, MRS = magnetic resonance spectroscopy, N = number of participants, NAA = N-acetyl aspartate, *p* = statistical probability of obtaining that result (*p* < 0.05 generally regarded as significant), PET = positron emission tomography, PDE = phosphodiesterases, PME = phosphomonoesters, SD = standard deviation, SPECT = single-photon emission computed tomography, STG = superior temporal gyrus, Q = Q statistic (chi-square) for the test of heterogeneity, vs. = versus



## Temporal lobe

### Explanation of technical terms

\* Bias has the potential to affect reviews of both RCT and observational studies. Forms of bias include; reporting bias – selective reporting of results, publication bias - trials that are not formally published tend to show less effect than published trials, further if there are statistically significant differences between groups in a trial, these trial results tend to get published before those of trials without significant differences; language bias – only including English language reports; funding bias - source of funding for the primary research with selective reporting of results within primary studies; outcome variable selection bias; database bias - including reports from some databases and not others; citation bias - preferential citation of authors. Trials can also be subject to bias when evaluators are not blind to treatment condition and selection bias of participants if trial samples are small<sup>48</sup>.

† Different effect measures are reported by different reviews.

ALE analysis (Anatomical Likelihood Estimate) refers to a voxel-based meta-analytic technique for structural imaging in which each point of statistically significant structural difference is spatially smoothed into Gaussian distribution space, and summed to create a statistical map estimating the likelihood of difference in each voxel, as determined by the entire set of included studies. Incorporated with the Genome Scan Meta-analysis (GSMA), the meta-analysis of coordinates from multiple studies can be weighted for sample size to create a random effect analysis. The ALE statistic (if reported) represents the probability of a group

difference occurring at each voxel included in the analysis.

Fractional similarity network analysis refers to a network analysis technique in which secondary networks are identified within the larger framework of activity, creating a matrix for regional co-activity.

Weighted mean difference scores refer to mean differences between treatment and comparison groups after treatment (or occasionally pre to post treatment) and in a randomised trial there is an assumption that both groups are comparable on this measure prior to treatment. Standardised mean differences are divided by the pooled standard deviation (or the standard deviation of one group when groups are homogenous) which allows results from different scales to be combined and compared. Each study's mean difference is then given a weighting depending on the size of the sample and the variability in the data. Less than 0.4 represents a small effect, around 0.5 a medium effect, and over 0.8 represents a large effect<sup>48</sup>.

Odds ratio (OR) or relative risk (RR) refers to the probability of a reduction ( $< 1$ ) or an increase ( $> 1$ ) in a particular outcome in a treatment group, or a group exposed to a risk factor, relative to the comparison group. For example, a RR of 0.75 translates to a reduction in risk of an outcome of 25% relative to those not receiving the treatment or not exposed to the risk factor. Conversely, a RR of 1.25 translates to an increased risk of 25% relative to those not receiving treatment or not having been exposed to a risk factor. A RR or OR of 1.00 means there is no difference between groups. A medium effect is considered if  $RR > 2$  or  $< 0.5$  and a large effect if  $RR > 5$  or  $< 0.2$ <sup>49</sup>. InOR stands for logarithmic OR where a InOR of 0 shows no difference between groups. Hazard ratios



## Temporal lobe

measure the effect of an explanatory variable on the hazard or risk of an event.

Correlation coefficients (eg,  $r$ ) indicate the strength of association or relationship between variables. They are an indication of prediction, but do not confirm causality due to possible and often unforeseen confounding variables. An  $r$  of 0.10 represents a weak association, 0.25 a medium association and 0.40 and over represents a strong association. Unstandardised ( $b$ ) regression coefficients indicate the average change in the dependent variable associated with a 1 unit change in the independent variable, statistically controlling for the other independent variables. Standardized regression coefficients represent the change being in units of standard deviations to allow comparison across different scales. Reliability and validity refers to how accurate the instrument is. Sensitivity is the proportion of actual positives that are correctly identified (100% sensitivity = correct identification of all actual positives) and specificity is the proportion of negatives that are correctly identified (100% specificity = not identifying anyone as positive if they are truly not).

‡ Inconsistency refers to differing estimates of treatment effect across studies (i.e. heterogeneity or variability in results) that is not explained by subgroup analyses and therefore reduces confidence in the effect estimate.  $I^2$  is the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance) - 0% to 40%: heterogeneity might not be important, 30% to 60%: may represent moderate heterogeneity, 50% to 90%: may represent substantial heterogeneity and 75% to 100%: considerable heterogeneity.  $I^2$  can be

calculated from  $Q$  (chi-square) for the test of heterogeneity with the following formula;

$$I^2 = \left( \frac{Q - df}{Q} \right) \times 100\%$$

§ Imprecision refers to wide confidence intervals indicating a lack of confidence in the effect estimate. Based on GRADE recommendations, a result for continuous data (standardised mean differences, not weighted mean differences) is considered imprecise if the upper or lower confidence limit crosses an effect size of 0.5 in either direction, and for binary and correlation data, an effect size of 0.25. GRADE also recommends downgrading the evidence when sample size is smaller than 300 (for binary data) and 400 (for continuous data), although for some topics, this criteria should be relaxed<sup>50</sup>.

|| Indirectness of comparison occurs when a comparison of intervention A versus B is not available but A was compared with C and B was compared with C, which allows indirect comparisons of the magnitude of effect of A versus B. Indirectness of population, comparator and or outcome can also occur when the available evidence regarding a particular population, intervention, comparator, or outcome is not available so is inferred from available evidence. These inferred treatment effect sizes are of lower quality than those gained from head-to-head comparisons of A and B.



## Temporal lobe

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