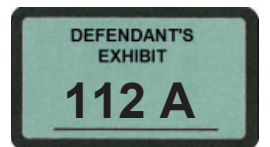


Robert Bowers' PET Brain Scan

Dr. Andrew Newberg



Findings:

The PET scan is of excellent quality. Visual and quantitative analysis reveals abnormal areas of significantly decreased metabolism in parts of the cerebellum, the hypothalamus, brain stem and pons, as well as the right caudate, right parahippocampus and right medial temporal lobe, and the left amygdala. As detailed in the chart below, significant metabolic abnormalities are indicated where metabolism is 1.65 standard deviations above or below the population mean (as per the MIMneuro software program manual). There is also significant abnormally increased metabolism in several frontal regions including the medial frontal gyrus, middle frontal gyrus, and rectal gyrus. There is also abnormally increased metabolism in the left superior temporal gyrus and right subcallosal region. It should be noted that for all homologous regions, 11 have right more than left metabolism while 52 have left more than right metabolism suggesting a marked hemispheric asymmetry.

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Quantitative Results

From MIMneuro Software Analysis

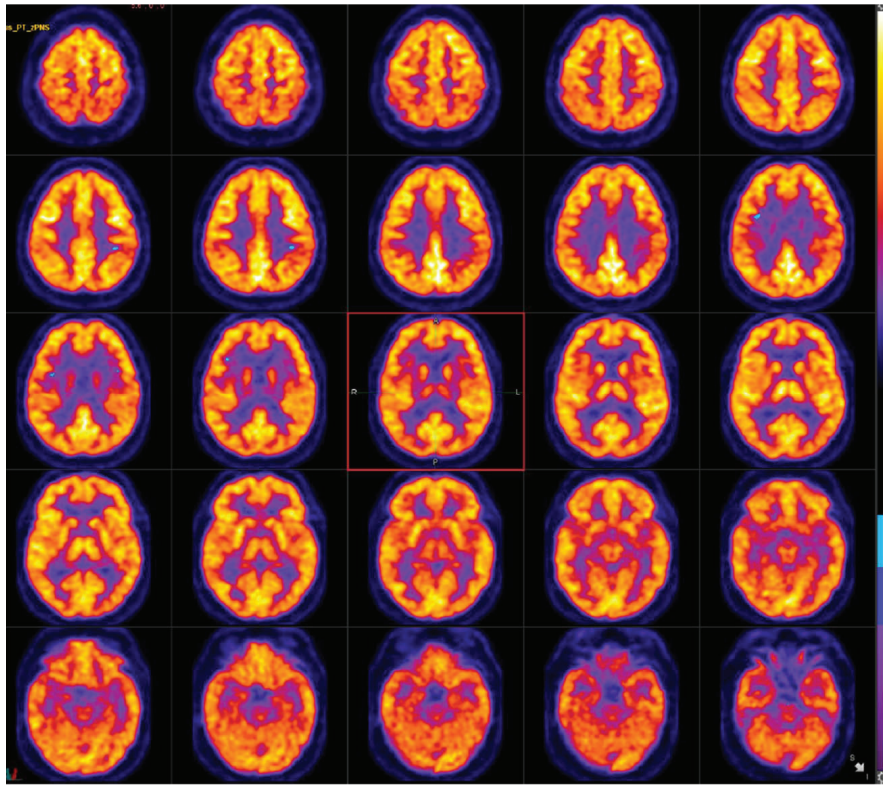
Quantitative Results from MIMneuro Software Analysis: The scores represent the patient's metabolic value compared to a database of normal controls (provided by the software program). The Z-score refers to standard deviations above or below the mean of the normal controls for each region and where appropriate, left and right hemispheres (as well as the difference between the hemispheres). The MIMneuro software uses 1.65 standard deviations above or below the mean as being considered abnormal. The MIMneuro software manual states that brain region abnormalities are statistically significant when they are 1.65 standard deviations or further from the mean of the normals (corresponding to a 95% statistical significance level).

Structure	Z-Score	L Z-Score	R Z-Score
Hypothalamus	-2.67	N/A	N/A
Inferior Occipital Gyrus	-2.22	-1.69	-1.93
Inferior Cerebellar Peduncle	-2.12	-1.65	-2.33
Brain Stem	-1.90	N/A	N/A
Middle Cerebellar Peduncle	-1.85	-1.57	-1.98
Pons	-1.73	N/A	N/A
Amygdala	-1.70	-2.30	-1.07
Medulla	-1.67	N/A	N/A
Caudate	-1.44	-1.18	-1.73
Midbrain	-1.44	N/A	N/A
Temporal Operculum	-1.41	-1.11	-1.37
Superior Cerebellar Peduncle	-1.33	-1.20	-1.35
Parahippocampal Gyrus	-1.21	-0.55	-1.70
Medial Temporal Lobe	-1.17	-0.51	-1.67
Hippocampus	-1.03	-0.39	-1.47
Postcentral Gyrus	-0.99	-1.23	-0.58
Superior Occipital Gyrus	-0.96	-0.80	-0.98
Globus Pallidus	-0.86	-0.65	-1.05
Occipital Lobe	-0.79	-0.54	-1.02
Fusiform Gyrus	-0.77	-0.58	-0.82
Cerebellar Vermis	-0.63	N/A	N/A
Cerebellum	-0.62	N/A	N/A
Cerebellar Hemisphere	-0.60	-0.46	-0.73
Putamen	-0.57	-0.27	-0.82
Cuneus	-0.53	-0.31	-0.72
Pontine Tegmentum	-0.51	N/A	N/A
Supramarginal Gyrus	-0.44	0.12	-1.04
Middle Occipital Gyrus	-0.38	-0.20	-0.48
Paracentral Lobule	-0.37	-0.59	-0.08
Primary Visual Cortex	-0.35	-0.14	-0.57

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Medial Temporal Lobe	-1.17	-0.51	-1.67

Thalamus	-0.30	-0.45	-0.11
Nucleus Accumbens	-0.23	0.03	-0.56
Lingual Gyrus	-0.20	0.05	-0.36
Superior Parietal Lobule	-0.20	-0.27	-0.10
Inferior Temporal Gyrus	-0.18	0.28	-0.61
Anterior Orbital Gyrus	-0.16	0.18	-0.51
Insula	-0.14	-0.30	0.09
Parietal Lobe	-0.01	0.00	-0.03
Angular Gyrus	0.00	-0.16	0.19
Middle Temporal Gyrus	0.09	0.49	-0.22
Precentral Gyrus	0.29	0.88	-0.31
Temporal Lobe	0.35	0.86	-0.28
Inferior Frontal Gyrus, Pars Triangularis	0.44	0.67	0.24
Inferior Frontal Gyrus, Pars Opercularis	0.45	0.52	0.31
Anterior Cingulate Gyrus	0.51	0.50	0.51
Heschl Gyrus	0.59	0.28	0.81
Posterior Cingulate Gyrus	0.62	0.95	0.30
Retrosplenial Area	0.63	0.97	0.22
Inferior Frontal Gyrus	0.63	0.83	0.43
Lateral Temporal Lobe	0.64	1.06	0.05
Cingulate Gyrus	0.67	0.81	0.47
Middle Orbital Gyrus	0.70	1.08	0.21
Precuneus	0.85	1.19	0.26
Medial Orbital Gyrus	0.87	0.89	0.78
Lateral Orbital Gyrus	0.90	1.27	0.17
Orbitofrontal Region	1.00	1.34	0.54
Superior Temporal Gyrus	1.29	1.58	0.63
Inferior Frontal Gyrus, Pars Orbitalis	1.33	1.69	0.91
Temporal Pole	1.33	1.22	1.16
Rolandic Operculum	1.39	1.00	1.29
Posterior Orbital Gyrus	1.45	1.93	0.83
Subcallosal Area	1.57	1.40	1.67
Gyrus Rectus	1.87	2.14	1.62
Superior Frontal Gyrus	1.88	2.04	1.46
Middle Frontal Gyrus	1.90	2.20	1.36
Supplementary Motor Area	2.22	2.46	1.69
Inferior Medial Frontal Gyrus	2.32	2.86	1.63
Frontal Lobe	2.33	2.70	1.79
Olfactory Cortex	2.76	3.50	1.68
Superior Medial Frontal Gyrus	3.21	3.09	3.05

Inferior Frontal Gyrus, Pars Orbitalis	1.33	1.69	0.91
Temporal Pole	1.33	1.22	1.16
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Olfactory Cortex	2.76	3.50	1.68
Superior Medial Frontal Gyrus	3.21	3.09	3.05



Impression:

Overall, the findings show brain areas of both abnormally increased and decreased metabolism. Typically, areas of abnormally increased metabolism reflect inflammation or a persistent excitatory state in the brain. Areas of abnormally decreased metabolism reflect neuronal injury and dysfunction.

There is abnormally decreased metabolism in the right caudate nucleus which is involved in several brain processes, including regulation of motor/movement function and various cognitive processes, including memory, learning, and emotional response regulation. Since the caudate is part of the dopamine system, it is part of the reward system of the brain that helps a person to feel motivation, desire, and craving. Given the abnormal metabolism in the right caudate, there would be expected dysfunction in these processes.

Abnormally decreased metabolism in the hypothalamus, brain stem, and pons are associated with poor regulation of the autonomic nervous system and the natural fight or flight response. Abnormalities in these structures can be associated with inappropriate stress response, excessive reactions and misperceived threats.

Abnormally decreased metabolism in the amygdala and parahippocampus are associated with unusual emotional responses and emotional dysregulation. Impaired assessment of the environment and misperception of threats, and initiating responses to perceived threats are also associated with dysfunction in these regions

Abnormally decreased metabolism in the cerebellum is linked to impaired motor coordination, but also error processing and learning. In addition, cerebellar abnormalities are increasingly linked to traumatic memories and dysregulated emotions.

Abnormally increased metabolism in the frontal regions is associated with problems with concentration or attention, information processing speed, organizing and planning, impaired abstraction, impaired initiation or generation of thoughts and concepts, impaired theory of mind, social cognition dysregulation, and are also associated with emotional dysregulation. Given the increased metabolism in the frontal lobes, frontotemporal dementia is not likely.

Abnormally increased metabolism in the left medial temporal lobe can be associated with impaired memory, abstract reasoning, and a variety of delusions including religious delusions.

Overall Impression

There are a number of metabolic abnormalities on this PET scan. When there are a large number of brain areas that have abnormal metabolism and asymmetries, the findings are consistent with extensive clinical abnormalities including emotional regulation impairment, cognitive and motor processing problems, and psychotic symptoms. This patient carries the clinical diagnosis of schizophrenia, a complex disease that has both positive and negative symptoms that are associated with multiple brain abnormalities. For example, schizophrenia has been associated with significantly abnormal asymmetries in the brain, often with the right sided structures less active than the left, as is observed with this patient. In addition, there is recognition of dysfunction in the limbic system, frontal lobes, and striatum in patients with schizophrenia, all of which are abnormal in this patient.