

What is claimed is:

1. A method for determining dopamine function in a subject, the method comprising analyzing one or more Neuromelanin (NM)-Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:

receiving imaging information of the brain region of interest;
determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information; and
determining the dopamine function based on the NM concentration;
wherein the determining of the dopamine function comprises: (1) if the one or more NM-MRI scans has increased NM signal compared to a one or more control scans then dopamine function is increased; or (2) if the one or more NM-MRI scans has decreased NM signal compared to a one or more control scans then dopamine function is decreased.

2. The method of claim 1, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.

3. The method of claim 2, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.

4. The method of claim 1, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.

5. The method of claim 4, wherein the cognitive task assesses catecholamine-related processes.

6. The method of claim 5, wherein the catecholamine-related processes comprise dopamine- related processes.

7. The method of claim 5, wherein the catecholamine-related processes comprise reward processing.

8. The method of claim 1, wherein the brain region is at least one of the substantia nigra₁.

- ~~9. The method of claim 1, wherein the brain region is the~~ ventral substantia nigra~~;~~₁
- ~~10. The method of claim 1, wherein the brain region is the~~ lateral substantia nigra~~;~~₁
- ~~11. The method of claim 1, wherein the brain region is the~~ ventrolateral substantia nigra~~;~~₁
- ~~12. The method of claim 1, wherein the brain region is the~~ substantia nigra pars compacta (SNpc)~~;~~₁
- ~~13. The method of claim 1, wherein the brain region is the~~ substantia nigra pars reticulata (SNpr)~~;~~₂
- ~~14. The method of claim 1, wherein the brain region is the~~ and ventral tegmental area (VTA).

~~159.~~ The method of claim 1, wherein the subject has or is suspected of having one or more dopamine function-related disorder.

~~1610.~~ The method of claim 1, wherein the subject has or is suspected of having schizophrenia spectrum disorders.

~~1711.~~ The method of claim 1, wherein the subject has or is suspected of having psychotic illness.

~~1812.~~ The method of claim 1, wherein the subject has or is suspected of having addiction disorder.

~~1913.~~ The method of claim 1, wherein the subject has or is suspected of having at least one of depression~~;~~₁

~~20. The method of claim 1, wherein the subject has or is suspected of having~~ or late-life depression.

~~2114.~~ The method of claim 1, wherein the subject has or is suspected of having bipolar disorder.

~~2215.~~ The method of claim 1, wherein the subject has or is suspected of having Huntington's disease.

~~2316.~~ The method of claim 1, wherein the subject has or is suspected of having Parkinson's disease.

~~2417.~~ The method of claim 1, wherein the subject has or is suspected of having one or more movement disorders.

~~2518.~~ The method of claim 1, wherein the subject has or is suspected of having psychomotor slowing.

~~2619.~~ The method of claim 1, wherein the subject has or is suspected of having one or more neuropsychiatric disorders.

~~2720.~~ The method of claim 1, wherein the subject has or is suspected of having a cocaine use disorder.

~~28.—A method for determining if a subject has or is at risk of developing a neuropsychiatric disorder, the method comprising analyzing one or more Neuromelanin (NM)-Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:~~

~~receiving imaging information of the brain region of interest; and
determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information;
wherein the determining if a subject has or is at risk of developing a neuropsychiatric disorder comprises: (1) if the one or more NM-MRI scans has an altered NM signal compared to a one or more control scans without a neuropsychiatric disorder then the subject has or is at risk of developing a neuropsychiatric disorder; or (2) if the one or more NM-MRI scans has a NM signal comparable to the signal of a one or more control scans without a neuropsychiatric disorder then the subject does not have or is not at risk of developing a neuropsychiatric disorder.~~

~~29.—The method of claim 28, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.~~

~~30.—The method of claim 29, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.~~

- 31.—~~The method of claim 28, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.~~
- 32.—~~The method of claim 31, wherein the cognitive task assesses catecholamine-related processes.~~
- 33.—~~The method of claim 32, wherein the catecholamine-related processes comprise dopamine-related processes.~~
- 34.—~~The method of claim 32, wherein the catecholamine-related processes comprise reward processing.~~
- 35.—~~The method of claim 28, wherein the one or more NM-MRI scans has increased signal compared to a one or more control scans without a neuropsychiatric disorder.~~
- 36.—~~The method of claim 28, wherein the one or more NM-MRI scans has decreased signal compared to a one or more control scans without a neuropsychiatric disorder.~~
- 37.—~~The method of claim 28, wherein the brain region is the substantia nigra.~~
- 38.—~~The method of claim 28, wherein the brain region is the ventral substantia nigra.~~
- 39.—~~The method of claim 28, wherein the brain region is the lateral substantia nigra.~~
- 40.—~~The method of claim 28, wherein the brain region is the ventrolateral substantia nigra.~~
- 41.—~~The method of claim 28, wherein the brain region is the substantia nigra pars compacta (SNpc).~~
- 42.—~~The method of claim 28, wherein the brain region is the substantia nigra pars reticulata (SNpr).~~
- 43.—~~The method of claim 28, wherein the brain region is the ventral tegmental area (VTA).~~
- 44.—~~The method of claim 28, wherein the neuropsychiatric disorder comprises schizophrenia spectrum disorders.~~

- 45.—The method of claim 28, wherein the neuropsychiatric disorder comprises psychotic illness.
- 46.—The method of claim 28, wherein the neuropsychiatric disorder comprises addiction.
- 47.—The method of claim 28, wherein the neuropsychiatric disorder comprises depression.
- 48.—The method of claim 28, wherein the neuropsychiatric disorder comprises late-life depression.
- 49.—The method of claim 28, wherein the neuropsychiatric disorder comprises bipolar disorder.
- 50.—The method of claim 28, wherein the neuropsychiatric disorder comprises Huntington's disease.
- 51.—The method of claim 28, wherein the neuropsychiatric disorder comprises psychomotor slowing.
- 52.—The method of claim 28, wherein the neuropsychiatric disorder comprises Parkinson's disease.
- 53.—The method of claim 28, wherein the neuropsychiatric disorder comprises one or more movement disorders.
- 54.—The method of claim 28, wherein the neuropsychiatric disorder comprises cocaine use disorder.
- 55.—A method for determining if a subject has or is at risk of developing a cognitive disorder, the method comprising analyzing one or more Neuromelanin (NM)-Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:
- receiving imaging information of the brain region of interest; and
 - determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information;
- wherein the determining if a subject has or is at risk of developing a cognitive disorder comprises: (1) if the one or more NM-MRI scans has altered signal compared

~~to a one or more control scans without a cognitive disorder then the subject has or is at risk of developing a cognitive disorder; or (2) if the one or more NM-MRI scans has signal comparable to the signal of a one or more control scans without a cognitive disorder then the subject does not have or is not at risk of developing a cognitive disorder.~~

56.—~~The method of claim 55, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.~~

57.—~~The method of claim 56, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.~~

58.—~~The method of claim 55, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.~~

59.—~~The method of claim 58, wherein the cognitive task assesses catecholamine-related processes.~~

60.—~~The method of claim 59, wherein the catecholamine-related processes comprise dopamine-related processes.~~

61.—~~The method of claim 59, wherein the catecholamine-related processes comprise reward processing.~~

62.—~~The method of claim 55, wherein the one or more NM-MRI scans has increased signal compared to a one or more control scans without a neuropsychiatric disorder.~~

63.—~~The method of claim 55, wherein the one or more NM-MRI scans has decreased signal compared to a one or more control scans without a neuropsychiatric disorder.~~

64.—~~The method of claim 55, wherein the brain region is the substantia nigra.~~

65.—~~The method of claim 55, wherein the brain region is the ventral substantia nigra.~~

66.—~~The method of claim 55, wherein the brain region is the lateral substantia nigra.~~

67.—~~The method of claim 55, wherein the brain region is the ventrolateral substantia nigra.~~

68.—The method of claim 55, wherein the brain region is the substantia nigra pars compacta (SNpc).

69.—The method of claim 55, wherein the brain region is the substantia nigra pars reticulata (SNpr).

70.—The method of claim 55, wherein the brain region is the ventral tegmental area (VTA).

71.—The method of claim 55, wherein the cognitive disorder comprises a neurocognitive disorder.

72.—The method of claim 55, wherein the cognitive disorder comprises memory dysfunction.

73.—A method for determining if a subject has or is at risk of developing an addiction disorder, the method comprising analyzing one or more Neuromelanin (NM) Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:

receiving imaging information of the brain region of interest; and
determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information;
wherein the determining if a subject has or is at risk of developing an addiction disorder comprises: (1) if the one or more NM-MRI scans has altered NM signal compared to a one or more control scans without an addiction disorder then the subject has or is at risk of developing an addiction disorder; or (2) if the one or more NM-MRI scans has a NM signal comparable to a one or more control scans without addiction disorder then the subject does not have or is not at risk of developing an addiction disorder.

74.—The method of claim 73, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.

75.—The method of claim 74, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.

~~76.—The method of claim 73, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.~~

~~77.—The method of claim 76, wherein the cognitive task assesses catecholamine-related processes.~~

~~78.—The method of claim 77, wherein the catecholamine-related processes comprise dopamine-related processes.~~

~~79.—The method of claim 77, wherein the catecholamine-related processes comprise reward processing.~~

~~80.—The method of claim 73, wherein the one or more NM-MRI scans has increased signal compared to a one or more control scans without a neuropsychiatric disorder.~~

~~81.—The method of claim 73, wherein the one or more NM-MRI scans has decreased signal compared to a one or more control scans without a neuropsychiatric disorder.~~

~~82.—The method of claim 73, wherein the brain region is the substantia nigra.~~

~~83.—The method of claim 73, wherein the brain region is the ventral substantia nigra.~~

~~84.—The method of claim 73, wherein the brain region is the lateral substantia nigra.~~

~~85.—The method of claim 73, wherein the brain region is the ventrolateral substantia nigra.~~

~~86.—The method of claim 73, wherein the brain region is the substantia nigra pars compacta (SNpc).~~

~~87.—The method of claim 73, wherein the brain region is the substantia nigra pars reticulata (SNpr).~~

~~88.—The method of claim 73, wherein the brain region is the ventral tegmental area (VTA).~~

~~89.—The method of claim 73, wherein the addiction disorder comprises cocaine use disorder.~~

90.—~~The method of claim 73, wherein the addiction disorder comprises nicotine use disorder.~~

91.—~~The method of claim 73, wherein the addiction disorder comprises alcohol use disorder.~~

92.—~~The method of claim 73, wherein the addiction disorder comprises methamphetamine use disorder.~~

93.—~~The method of claim 73, wherein the addiction disorder comprises opiates use disorder.~~

94.—~~The method of claim 73, wherein the addiction disorder comprises behavioral addictions.~~

95.—~~A method of determining if a subject has or is at risk of developing Parkinson's disease, the method comprising analyzing one or more Neuromelanin (NM) Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:~~

~~receiving imaging information of the brain region of interest; and
determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information;
wherein the determining if a subject has or is at risk of developing Parkinson's disease comprises: (1) if the one or more NM-MRI scans has a decreased NM signal compared to a one or more control scans without Parkinson's disease then the subject has or is at risk of developing Parkinson's disease; or (2) if the one or more NM-MRI scans has a NM signal comparable to the signal of a one or more control scans without Parkinson's disease then the subject does not have or is not at risk of developing Parkinson's disease.~~

96.—~~The method of claim 95, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.~~

97.—~~The method of claim 96, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.~~

98.—The method of claim 95, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.

99.—The method of claim 98, wherein the cognitive task assesses catecholamine-related processes.

100.—The method of claim 99, wherein the catecholamine-related processes comprise dopamine-related processes.

101.—The method of claim 99, wherein the catecholamine-related processes comprise reward processing.

102.—The method of claim 95, wherein the brain region is the substantia nigra.

103.—The method of claim 95, wherein the brain region is the ventral substantia nigra.

104.—The method of claim 95, wherein the brain region is the lateral substantia nigra.

105.—The method of claim 95, wherein the brain region is the ventrolateral substantia nigra.

106.—The method of claim 95, wherein the brain region is the substantia nigra pars compacta (SNpc).

107.—The method of claim 95, wherein the brain region is the substantia nigra pars reticulata (SNpr).

108.—The method of claim 95, wherein the brain region is the ventral tegmental area (VTA).

109.—A method of determining if a subject has or is at risk of developing psychomotor slowing, the method comprising analyzing one or more Neuromelanin (NM) Magnetic Resonance Imaging (NM-MRI) scans of the subject's dopamine-associated brain region of interest, wherein the analyzing comprises:

receiving imaging information of the brain region of interest; and

determining a NM concentration in the brain region of interest using voxelwise analysis based on the imaging information;

wherein the determining if a subject has or is at risk of developing psychomotor slowing comprises: (1) if the one or more NM-MRI scans has a decreased NM signal

compared to a one or more control scans without psychomotor slowing then the subject has or is at risk of developing psychomotor slowing; or (2) if the one or more NM-MRI scans has a NM-signal comparable to the signal of a one or more control scans without psychomotor slowing then the subject does not have or is not at risk of developing psychomotor slowing.

110.—The method of claim 109, wherein the subject has depression.

111.—The method of claim 109, wherein the subject has late life depression.

112.—The method of claim 109, wherein the voxelwise analysis comprises determining at least one topographical pattern within the brain region of interest.

113.—The method of claim 112, wherein the at least one topographical pattern includes at least one pattern comprising a change in cell number in the brain region of interest.

114.—The method of claim 109, wherein the one or more acquired NM-MRI scans are related to the subject's performance on a cognitive task.

115.—The method of claim 114, wherein the cognitive task assesses catecholamine-related processes.

116.—The method of claim 115, wherein the catecholamine-related processes comprise dopamine-related processes.

117.—The method of claim 115, wherein the catecholamine-related processes comprise reward processing.

118.—The method of claim 109, wherein the one or more acquired NM-MRI scans are related to the subject's performance a gait speed task.

119.—The method of claim 109, wherein the one or more acquired NM-MRI scans are related to the subject's performance a processing speed task.

120.—The method of claim 109, wherein the brain region is the substantia nigra.

121.—The method of claim 109, wherein the brain region is the ventral substantia nigra.

122.—The method of claim 109, wherein the brain region is the lateral substantia nigra.

~~123.—The method of claim 109, wherein the brain region is the ventrolateral substantia nigra.~~

~~124.—The method of claim 109, wherein the brain region is the substantia nigra pars compacta (SNpc).~~

~~125.—The method of claim 109, wherein the brain region is the substantia nigra pars reticulata (SNpr).~~

~~126.—The method of claim 109, wherein the brain region is the ventral tegmental area (VTA).~~

~~127.—The method of any one of claims 1–126, wherein the method is used with a second imaging method.~~

~~128.—The method of claim 127, wherein the second imaging method comprises Positron Emission Tomography (PET).~~

~~129.—The method of claim 127, wherein the second imaging method comprises structural MRI.~~

~~130.—The method of claim 127, wherein the second imaging method comprises functional MRI (fMRI).~~

~~131.—The method of claim 127, wherein the second imaging method comprises blood oxygen level dependent (BOLD) fMRI.~~