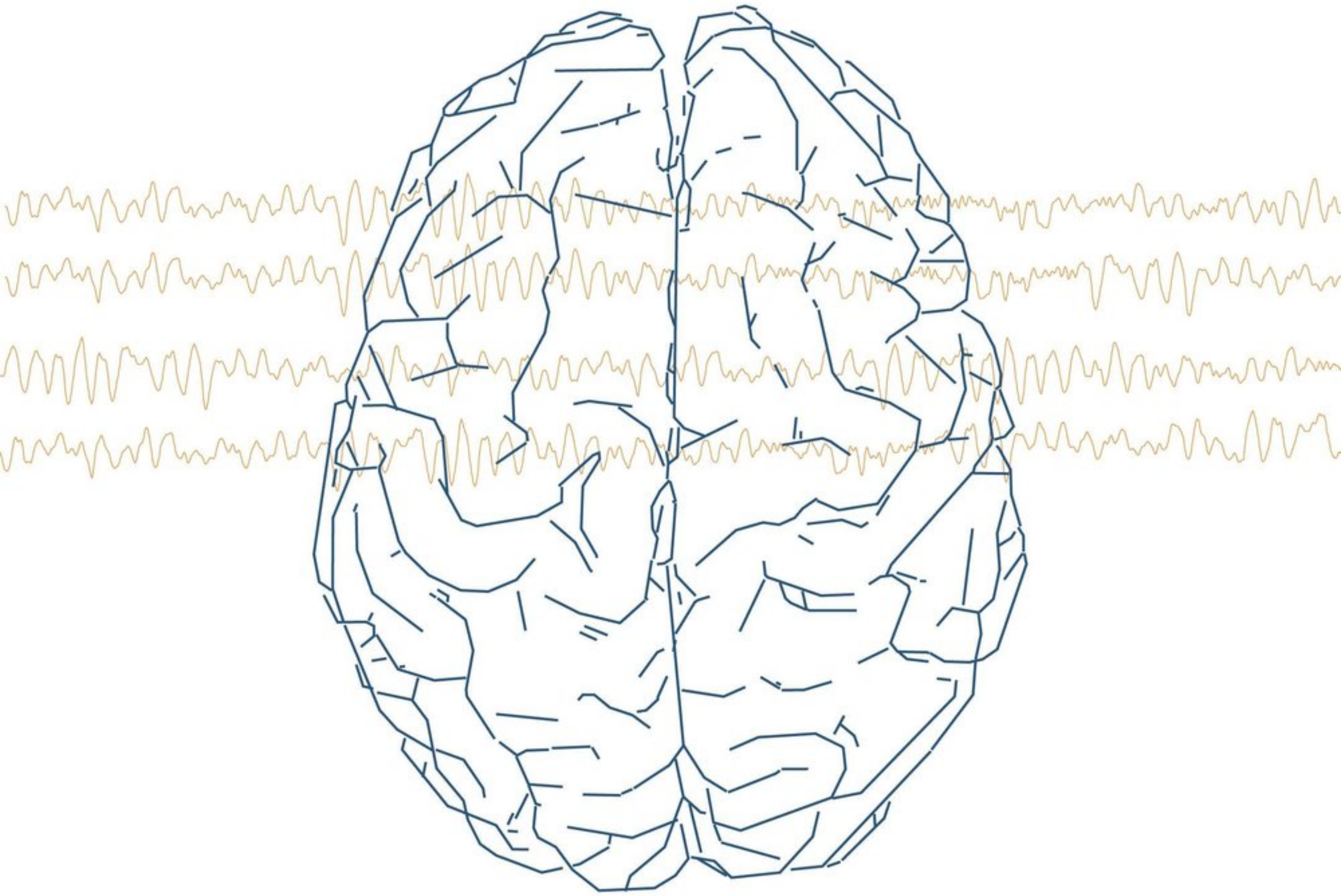
QEEG PROFILE REPORT



Name:	Enter Patient Name
Date of Recording:	2023-02-23
Age:	24.1
Gender:	female
Handedness:	right

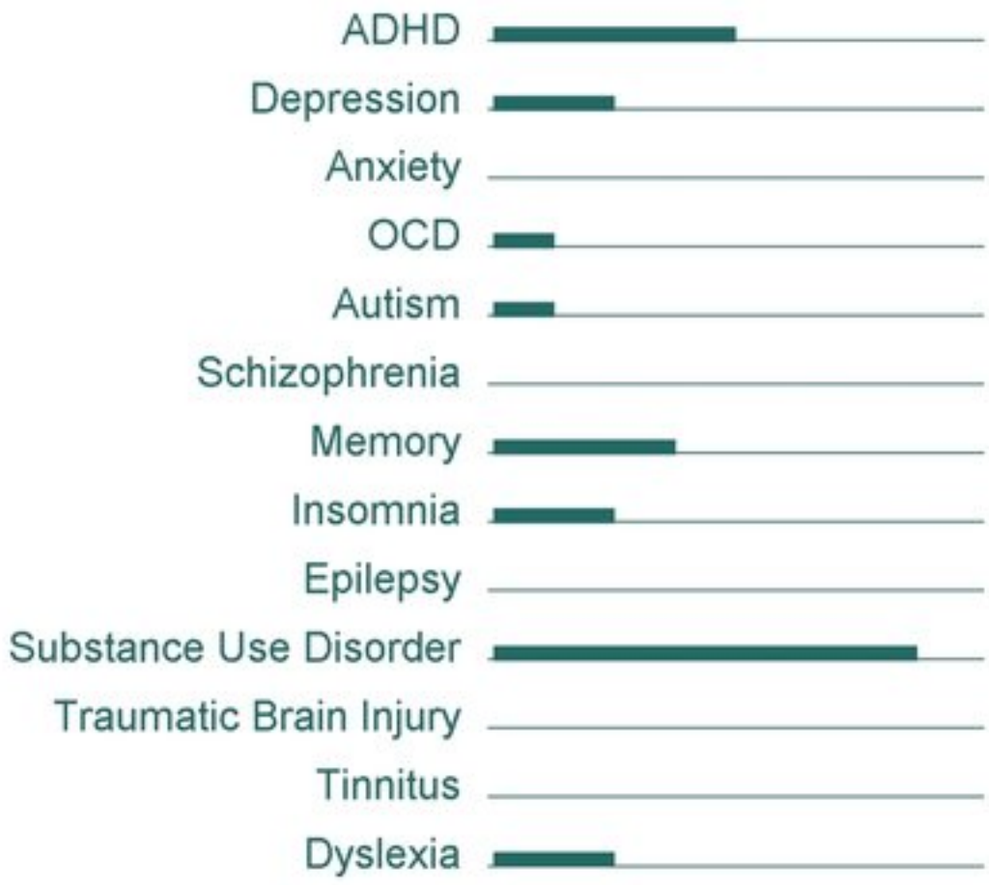
INTRODUCTION

The 'qEEG Profile Report' provides a comprehensive report on the relation between the patient's individual brain activity profile and the patient's (neuro)psychological symptoms. The current introductory page shows general information about the EEG recording and the patient's symptoms. The remainder of this report consists of two main sections:

Section 1: The 'Brain Waves Profile' addresses the surface amplitude results (page 2), the agreement between the EEG results and the patient's symptoms (page 3) and the EEG biomarkers for psychopathology and arousal (page 4).

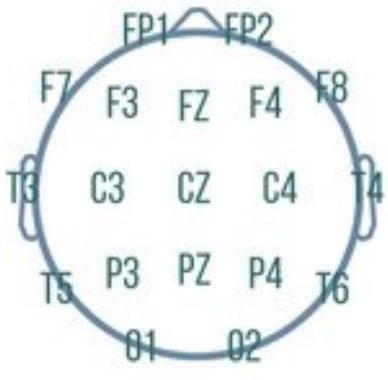
Section 2: Using source localization techniques, the activity and connectivity of well-known 'Resting-State Networks' have been assessed. From the scientific literature it is known that these networks represent functional units: The high level of communication and the high degree of coordination of the activity within these networks during rest suggest that each one of these networks has their own unique role to play. On page 5-10 the results for the 'Default Mode Network', the 'Dorsal Attention Network', the 'Emotion-Regulation Cortex', the 'Sensory-Motor Cortex, the Memory Network' and the 'Visual Cortex' are addressed.

PATIENT SYMPTOMS

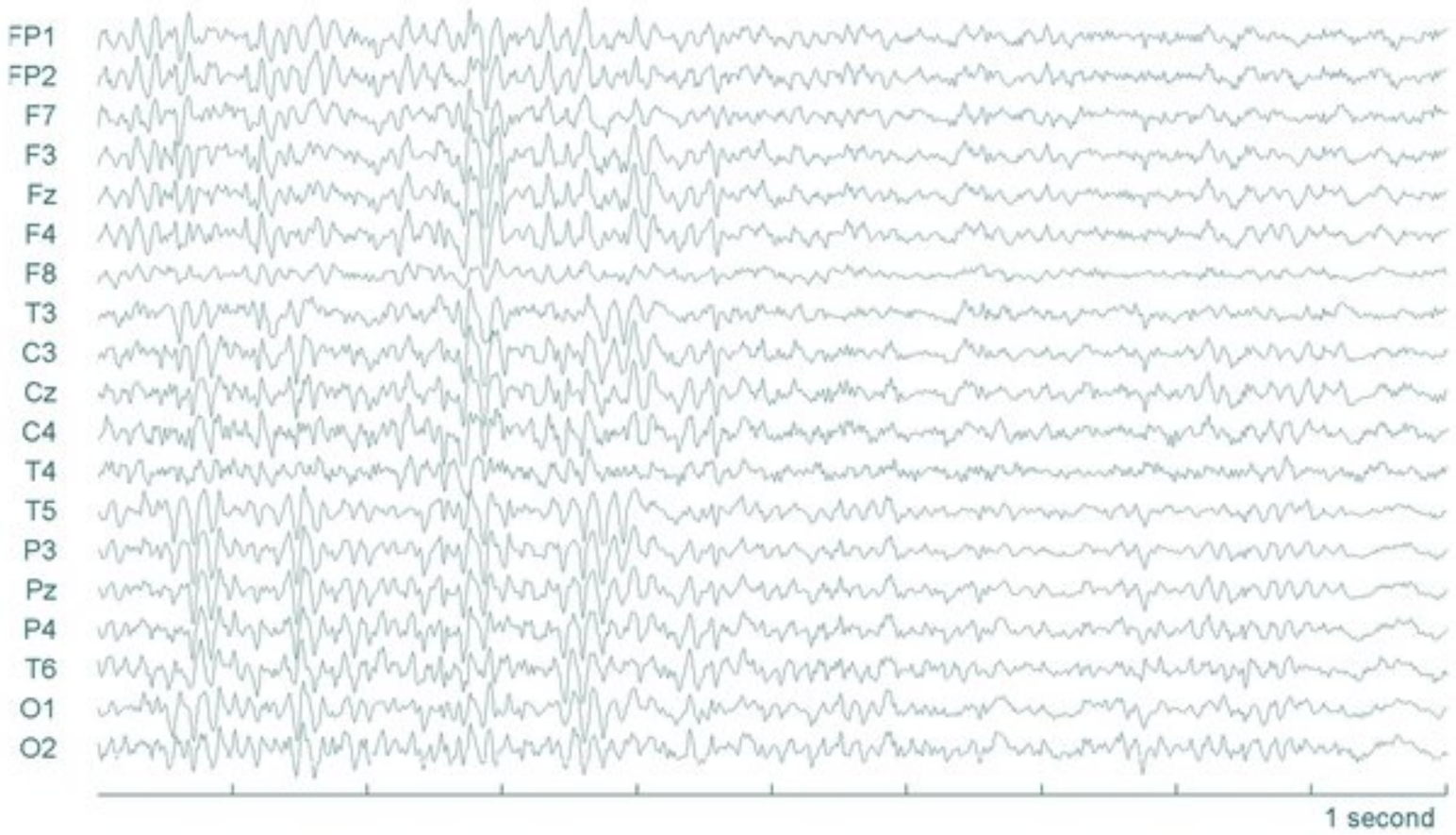


EEG RECORDING

A 19-channel resting-state EEG was recorded using the BrainMaster Discovery amplifier. The 19 channels EEG recording was referenced to the electrodes placed on the earlobes. A sampling frequency of 256 Hz was used. The EEG recording had a duration of 7:03 min for the Eyes Open condition and a duration of 5:01 min for the Eyes Closed condition. The Standardized Artifact Rejection Algorithm (S.A.R.A) was applied to the EEG data. Artifacts were automatically removed, resulting in a de-artifacted EEG recording of 2:46 min for the Eyes Open condition and 4:54 min for the Eyes Closed condition.



Electrode labels and locations, based on the International 10-20 system



A segment of raw EEG signal from the 19 electrode locations in the Eyes Closed condition.

70 uV
-70 uV

BRAIN WAVES PROFILE:

SURFACE AMPLITUDE RESULTS

INTRODUCTION

Specific deviances in neural oscillations as measured with resting-state EEG have been associated with specific disorders in the scientific literature and these deviances can therefore be characterized as 'EEG biomarkers'. On page 2 and 3 of this report, the presence or absence of these biomarkers and their relation with the patient's psychological symptoms will be addressed. However, the cause of deviant brain activity can be multiform and often cut across different psychological disorder categories. A general profile of deviances can be associated with a more general description of CNS functioning and its resulting psychological functioning. The majority of scientific studies on resting-state EEG have been focusing on EEG amplitudes and a general model for understanding deviances in EEG amplitudes is to define these deviances in terms of the level of arousal. Low frequencies (<12Hz) are related with low arousal and high frequencies (>15Hz) are related with high arousal. Here we discuss the qEEG of the patient in relation with what is known about the association between deviant EEG amplitudes in different frequency bands and psychopathology. Finally, it must be stated that EEG should not be used in isolation to diagnose a disorder: The presence of certain EEG biomarkers may represent the vulnerability for developing a psychological disorder, but there are many other factors that determine whether a disorder is expressed in an individual or not.

DELTA (1-3 HZ)

The amplitude of Delta activity was high at temporal electrode sites.
High Delta power is associated with impaired memory and traumatic brain injuries. Delta is dominant during deep sleep and is associated with low arousal during wakefullness. However, localized excessive Delta activity can also be a sign of neural tissue damage. Delta is also extremely sensitive to artifacts caused by eye blinks and eye movements, which results in high frontal Delta amplitudes.

THETA (4-8 HZ)

The amplitude of Theta activity was normal.
The most reliable EEG biomarker for attentional disorders is the presence of excessive fronto-central Theta power, reflecting a hypo-arousal in those areas resulting in sub-optimal functioning of brain areas that are important for the regulation of attention and emotions, impulse control and planning.

ALPHA (8-12 HZ)

The 'Alpha Arrest Reaction (ARR)' was not clearly present at frontal electrode sites. This is caused by the presence of dominant Alpha activity during the Eyes Open condition.

Dominant Alpha activity during the Eyes Closed condition in occipital regions can be seen as a reflection of the idling state of the visual cortex in the absence of afferent stimulation. The absence of a clear ARR can be related to impaired vigilance regulation: The patient is either hypo-aroused, resulting in abnormally high Alpha power during the Eyes Open condition, or the patient is hyper-aroused, resulting in low Alpha power in the Eyes Closed condition.

There was an excess of Alpha amplitudes on frontal electrode sites.
In general, excessive Alpha reflects hypo-arousal and deficient Alpha reflects hyper-arousal. Moreover: as vigilance decreases, Alpha activity shifts from posterior areas to anterior areas.

The Alpha Peak Frequency (APF) was normal. A high APF has been associated with general intelligence or cognitive performance: Individuals with relatively high APFs tend to score higher on IQ tests. Also, high APFs have been related to high arousal.

SMR (12-15 HZ)

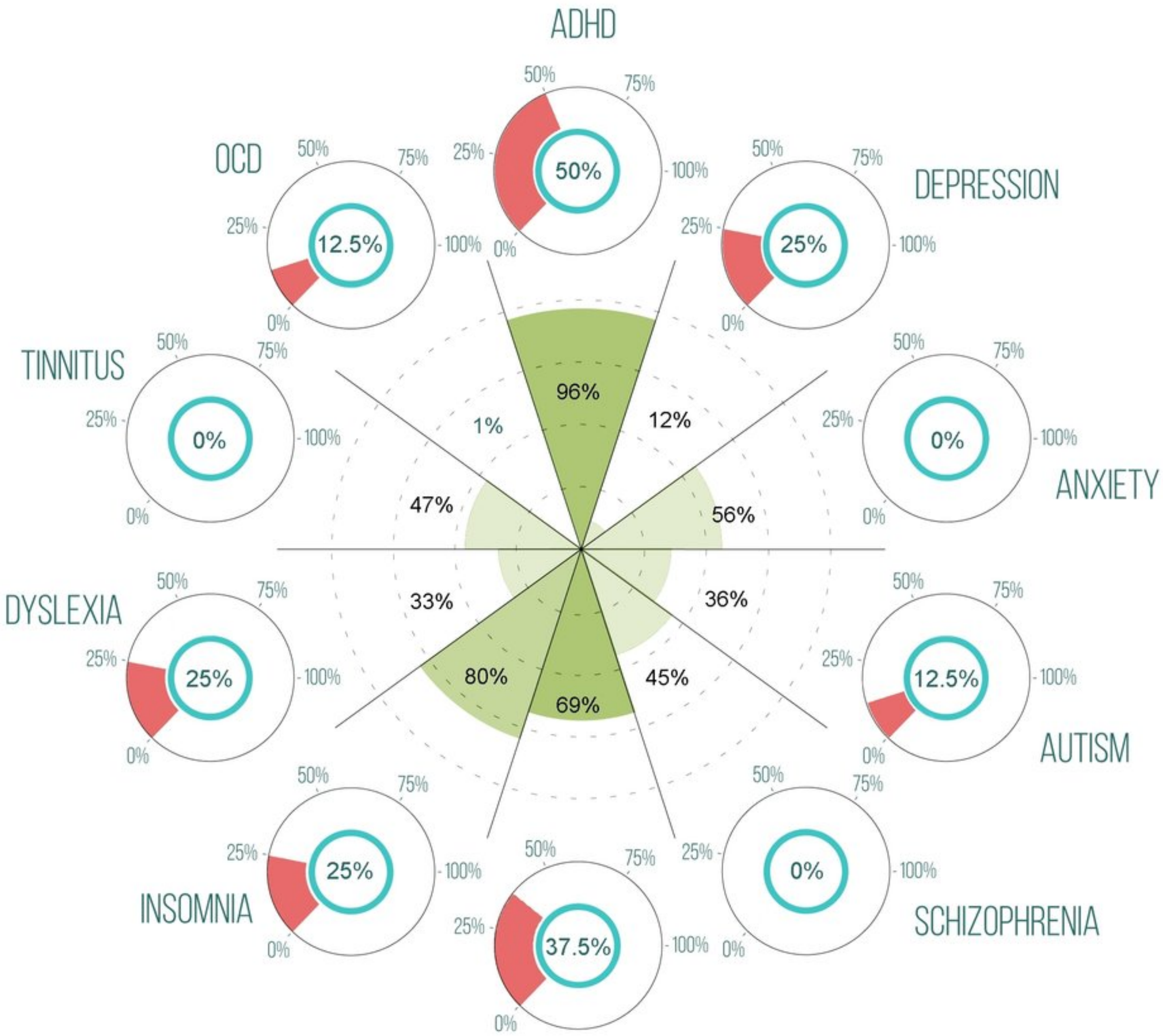
Slow Beta activity (12-15 Hz) on central brain areas is called 'Sensory-Motor Rhythm' (SMR). The amplitude of SMR was high. Spindling SMR activity during sleep is important for deep sleep: It's role is to inhibit motor output. Excessive SMR during wakefullness can be a sign of hypo-arousal and impaired vigilance regulation and has been associated with attentional disorders.

BETA (15-30 HZ)

The patient showed normal Beta activity.
A deficit in Beta activity has been linked with attentional disorders and often coincides with high Theta power. However, about 15% of the patients with attentional disorders will show excessive Beta. Excessive Beta amplitudes are associated with hyper-arousal and can be also associated with anxiety disorder and insomnia. Beta amplitudes are very susceptible to muscle artifacts: Excessive Beta in frontal, temporal and occipital Beta can be caused by tension in the forehead (e.g. frowning or raised eye brows), jaw muscles and neck muscIles, respectively.

BRAIN WAVES PROFILE:

EEG BIOMARKER MATCH



The red bars reflect the patient's symptom severity. Epilepsy, Substance Use Disorder and Traumatic Brain Injury are not depicted, since these disorders have not shown to be reliably associated with EEG biomakers.

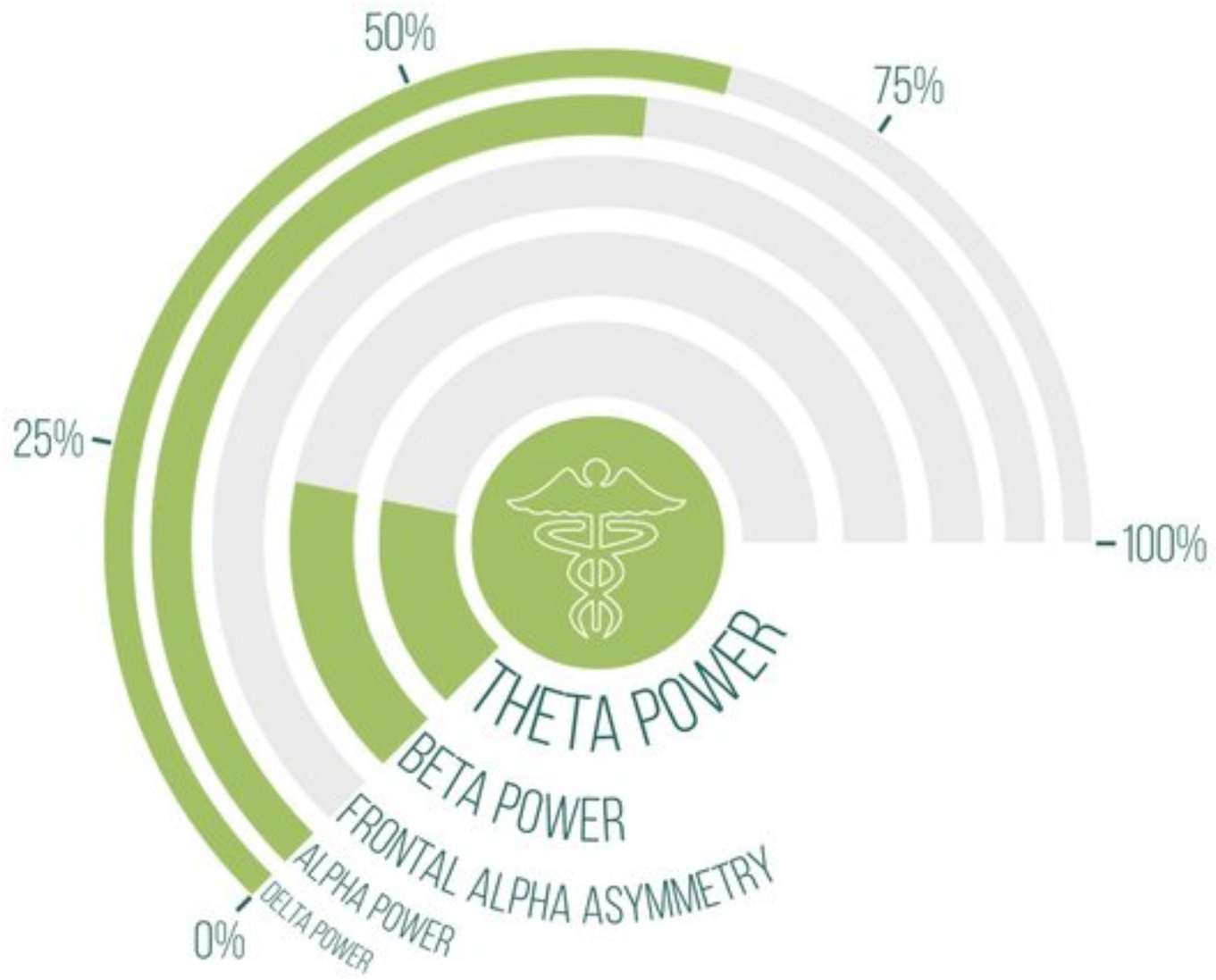
The relationships between the patient's brain activity deviations and the patient's symptoms are depicted in the green pie chart. The stronger the presence of certain biomarkers for a particular disorder, the larger the segment. The color intensity depicts the scientific support for the association between these markers and the disorder.

BRAIN WAVES PROFILE:

EEG BIOMARKER SCALES

PATHOLOGY

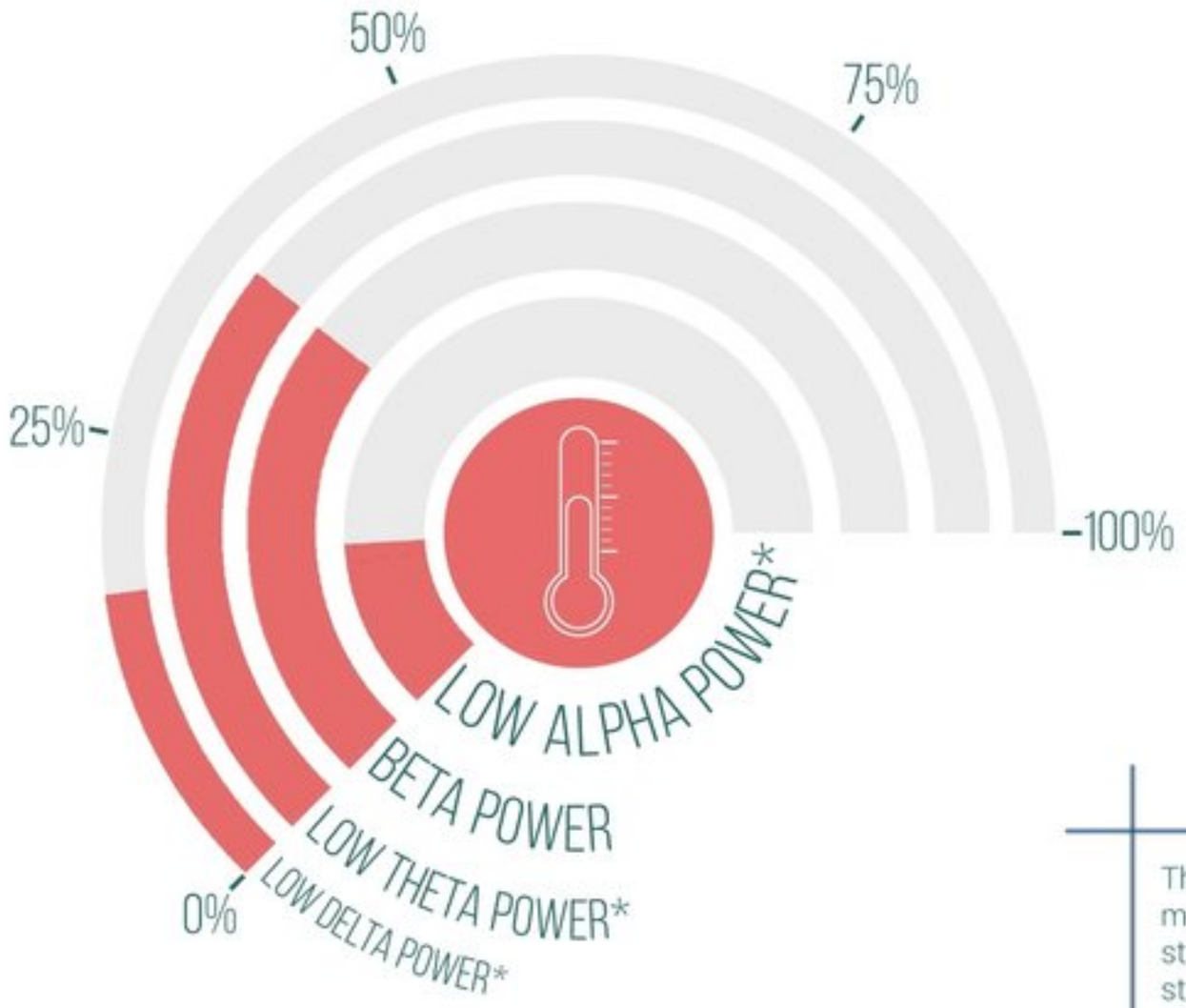
Deviations in neural oscillations have been related to different psychopathologies. Excess Theta and Alpha power as well as deviant Beta power have been associated with ADHD and frontal Alpha asymmetry is a marker for depression. Excess Delta power has been associated with TBI and memory disorders, Generally speaking, most deviations in neural oscillations are reflective of sub-optimal functioning of the brain area(s) they are manifested in. These deviations may be related to arousal level, which may explain symptomatology related to sleep, anxiety and attention. However, they can also be caused by genetic factors, brain maturation abnormalities, drug use/abuse, diet, lifestyle and life experiences.



↑ Higher percentages indicate higher risk for pathology

AROUSAL

Arousal can generally be described as the activation of the autonomous nervous system (ANS) and the central nervous system (CNS). It is related to mental alertness, and is reflected by heart rate, heart rate variability, pupil dilation and muscle tone. Arousal is reflected by the ratio between the amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). High fast/slow ratios are associated with a relative high arousal level and vice versa. Arousal level is very important for mental performance. Abnormally high or low levels of arousal are often associated with psychopathology.



*Alpha, Theta and Delta power are inversely related with arousal. Higher percentages reflect lower Alpha, Theta and Delta power. Values around 50% represent normal arousal levels.

The EEG Biomarker Scales are graphical representations of the relationship between measures of neural activity pathology or arousal. The circular diagrams represent the strength of the association between a neural marker and pathology or arousal: The stronger the association, the thicker the bar and the closer it is to the center of the diagram. The percentage indicates the contribution of a neural marker to the level of pathology or arousal.

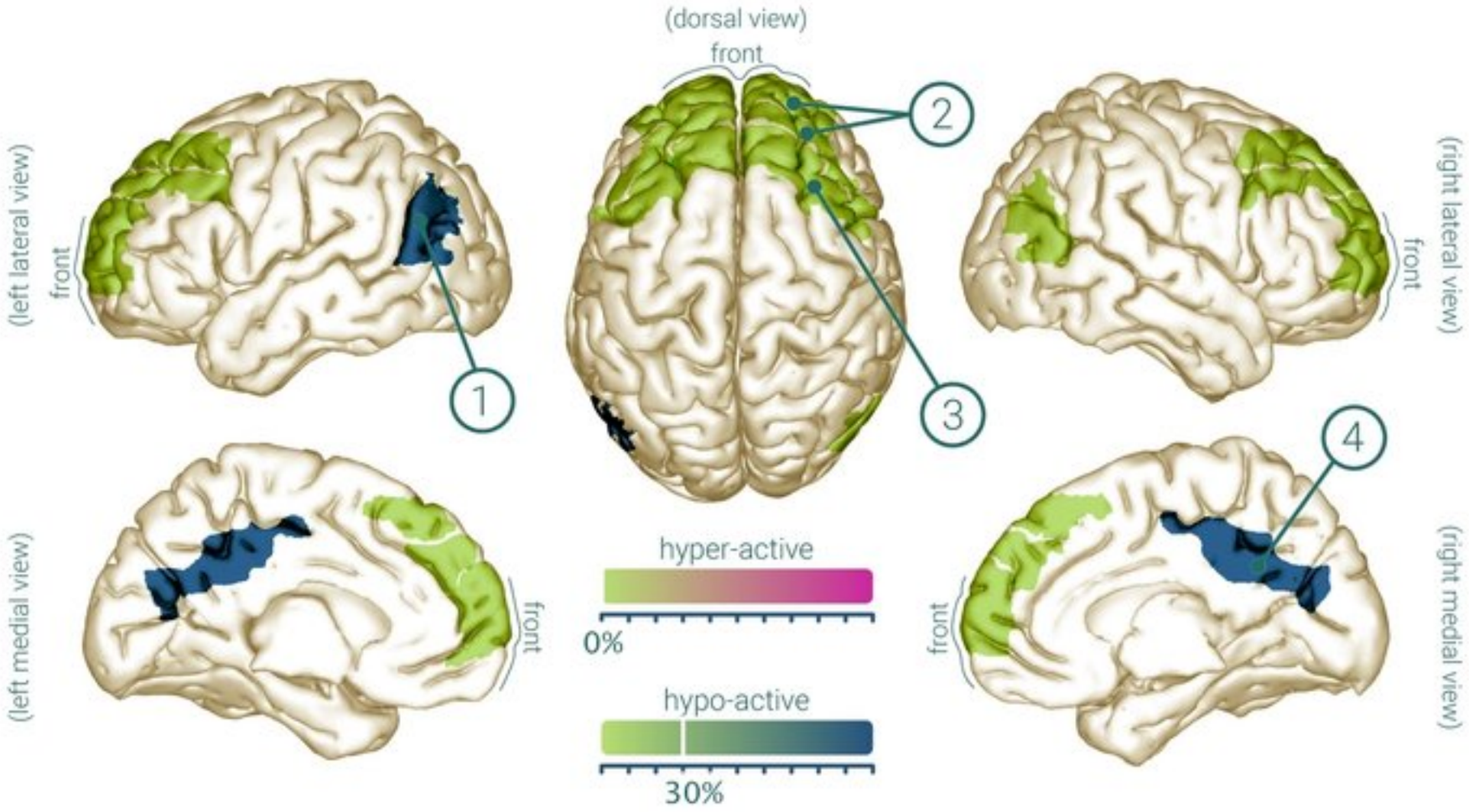
RESTING-STATE NETWORKS:

THE DEFAULT MODE NETWORK

The Default Mode Network (DMN) is active during rest and is associated with self-reflective processes or mental simulation. Low DMN activity may reflect an inability to switch from a task-oriented state to a rest-oriented state. Abnormal DMN activity has been associated with a number of psychological disorders.

NETWORK ACTIVITY

The DMN consists of frontal brain areas that are known to be involved in higher executive functions such as working memory, planning and cognitive control. The Angular Gyrus is known to be involved in allocation of attention and the Posterior Cingulate Gyrus is associated with self-referential processes.

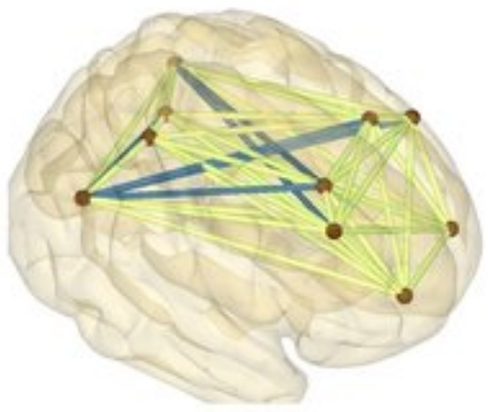


Brain Areas Involved:

1. Angular Gyrus (BA39)
2. Middle Frontal Gyrus (BA9 & 10)
3. Supplementary Motor Area (BA8)
4. Posterior Cingulate Gyrus (BA31)

(BA=Brodman Area)

NETWORK CONNECTIVITY



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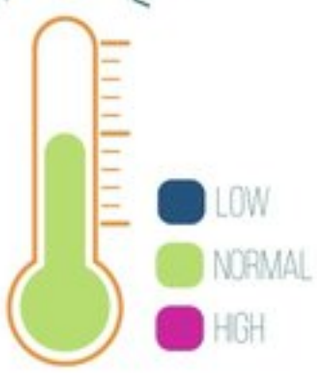
Reduced DMN connectivity has been associated with the cognitive decline and the detoriation of memory functions which are associated with the aging brain.

AROUSAL



Low DMN activity can reflect high arousal, but high DMN activity can also be related with excessive rumination, which is associated with high arousal.

PATHOLOGY

Attentional 'lapses' may be caused by an over-active DMN. High DMN activity may also reflect excessive introspective thought, which is related with anxiety and mood disorders, while decreased introspective thought often occurs in autism.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.

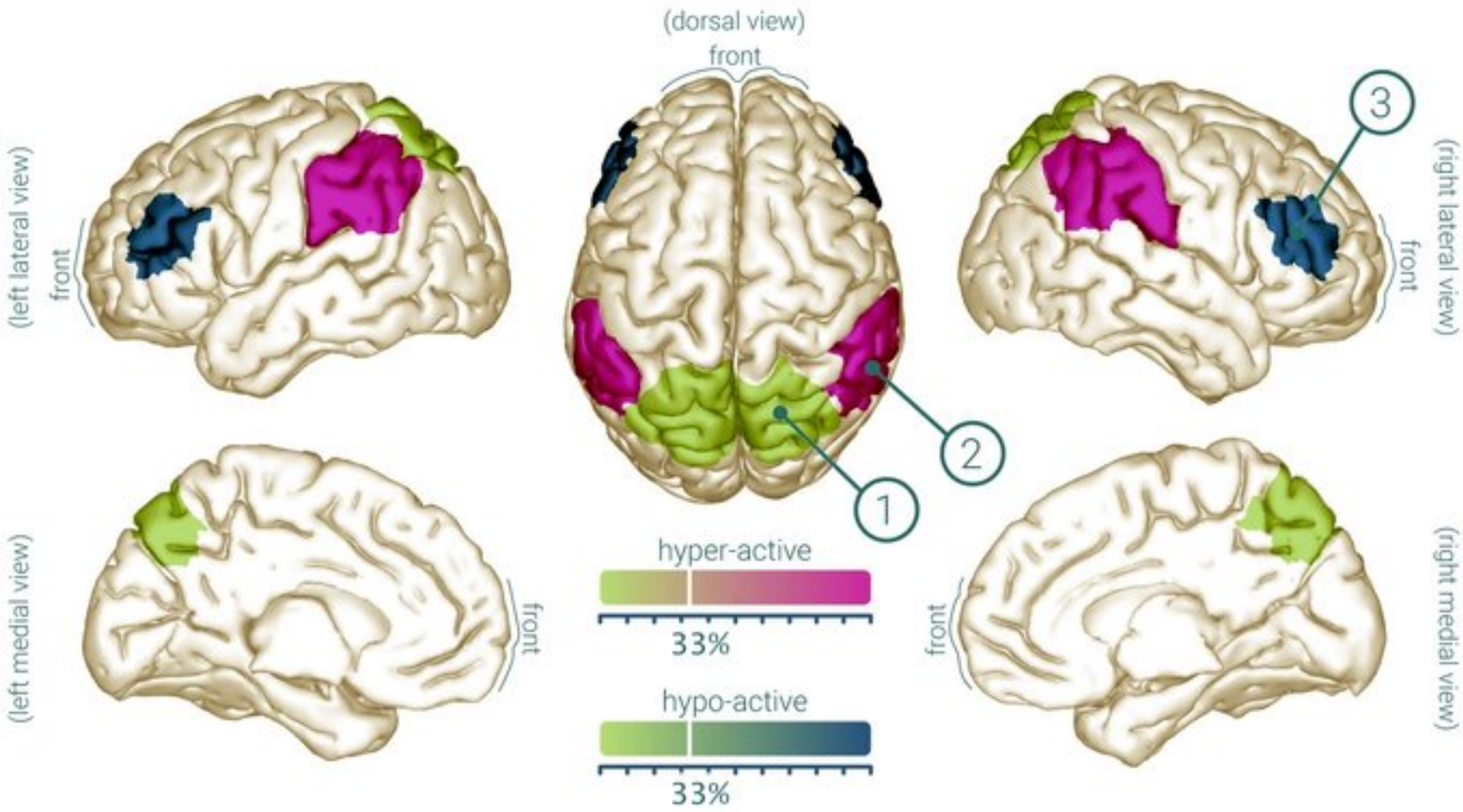
RESTING-STATE NETWORKS:

THE DORSAL ATTENTION NETWORK

The Dorsal Attention Network (DAN) consist of frontal and parietal areas which are important for higher executive functions, such as working memory, goal-directed actions and attention.

NETWORK ACTIVITY

The DAN consists of the Dorsolateral Prefrontal Cortex (DLPFC), which is associated with cognitive control, working memory and awareness. the Inferior Parietal Lobule, which is important for goal-directed action, creativity and reasoning and the Superior Parietal Lobule, which is known to be involved in imagination, (learning) advanced motor skills and visual attention.

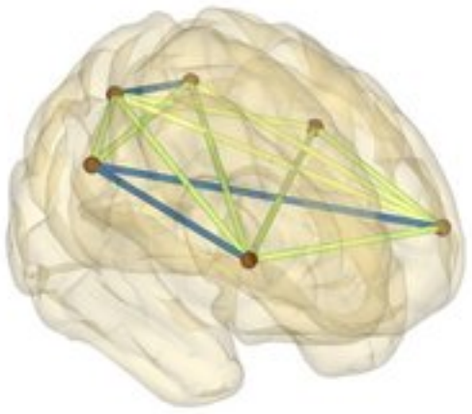


Brain Areas Involved:

1. Superior Parietal Lobule (BA7)
2. Inferior Parietal Lobule (BA40)
3. Dorsolateral Prefrontal Cortex (BA46)

(BA=Brodman Area)

NETWORK CONNECTIVITY



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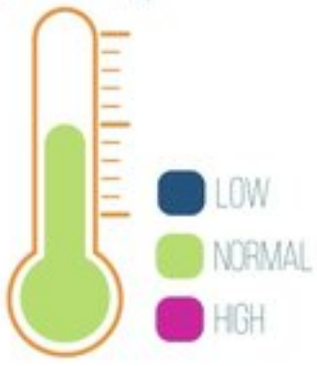
Deviations in phase coherence between the different areas of the DAN reflect sub-optimal functioning of the DAN, which may result in impaired cognitive control and memory.

AROUSAL



High DAN activity during rest reflects high arousal and vice versa.

PATHOLOGY

High DAN activity during rest can reflect an inability to switch to a rest-oriented mental state and may be related to anxiety and mood disorders. Deviant activity in the DAN may also underlie attentional and memory disorders.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.

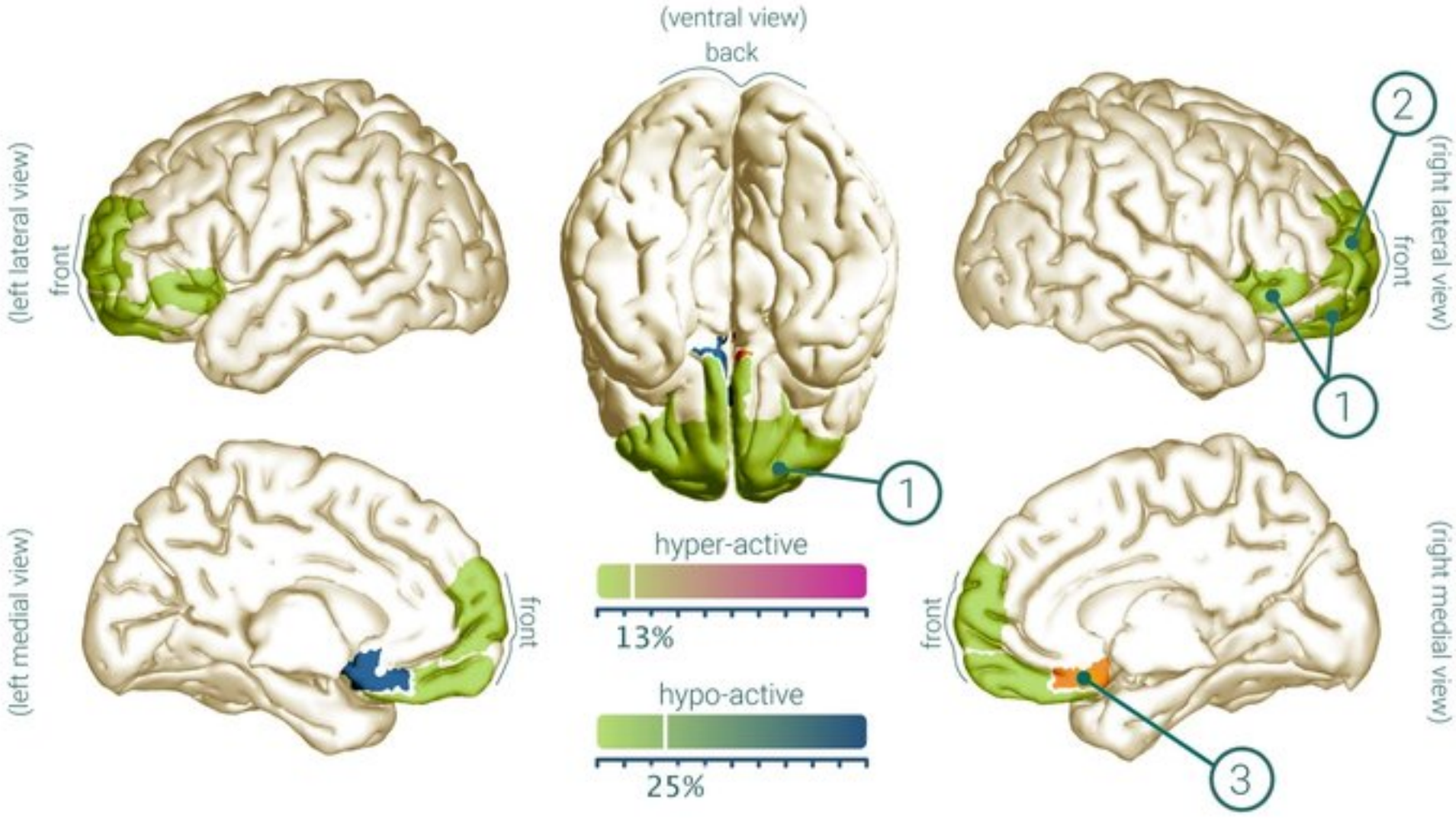
RESTING-STATE NETWORKS:

THE EMOTION-REGULATION CORTEX

The Emotion-Regulation Cortex (ERC) plays a role in emotion regulation, empathy, risk assessment, decision making and fear processing.

NETWORK ACTIVITY

The ERC consists of the Middle Frontal Gyrus, which is involved in emotional decision making and the Orbitofrontal Gyrus, which is known for it's role in the evaluation of emotional stimuli and the representation of the somewhat intangenable concepts of personality or 'cognitive style'.

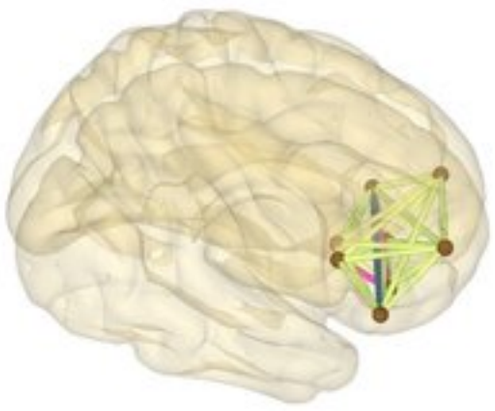


Brain Areas Involved:

1. Orbitofrontal Cortex (BA11 & 47)
2. Middle Frontal Gyrus (BA10)
3. Subgenual Gyrus (BA25)

(BA=Brodman Area)

NETWORK CONNECTIVITY



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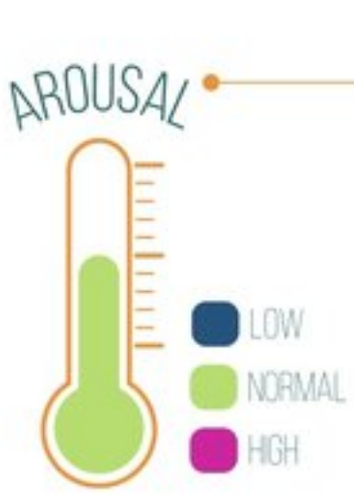
Deviations in phase coherence between the different areas of the ERC reflect sub-optimal functioning of the ERC which may result in impaired emotion-related processes.



Affective processes are known to influence arousal. Phasic increases of arousal have been shown to correlate with ERC activity.

Low activity in the ERC has been linked with mood and anxiety disorders, while high activity in the ERC has been associated with OCD. Substance Use Disorder results in low ERC activity during abstinance but high ERC activity during exposure to drug-related cues. Grey matter in the ERC has also been shown to decrease in response to psychological trauma.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.

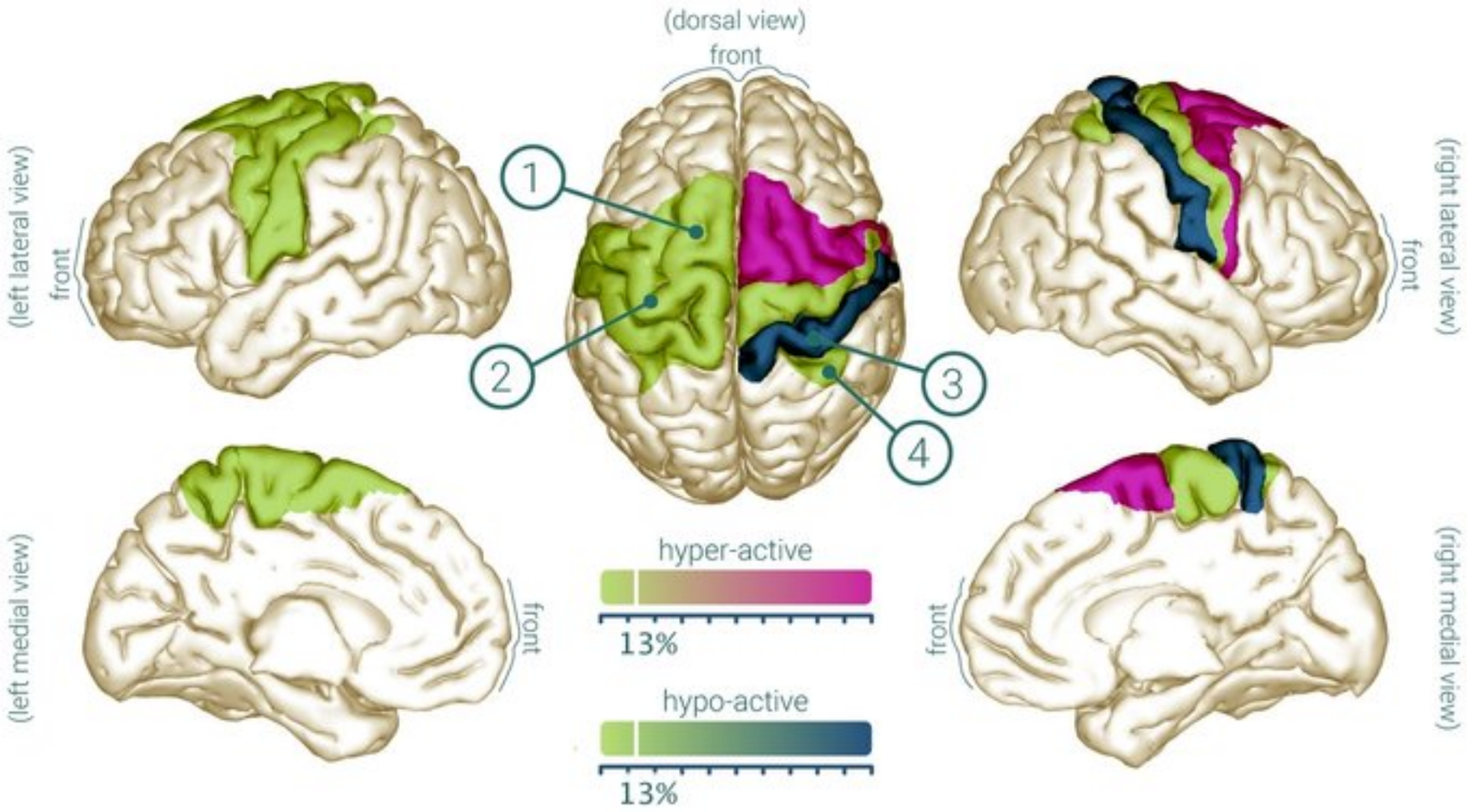
RESTING-STATE NETWORKS:

THE SENSORY-MOTOR CORTEX

The Sensory-Motor Cortex (SMC) is responsible for somatosensory processing (the sense of touch) and preparing and executing motor actions.

NETWORK ACTIVITY

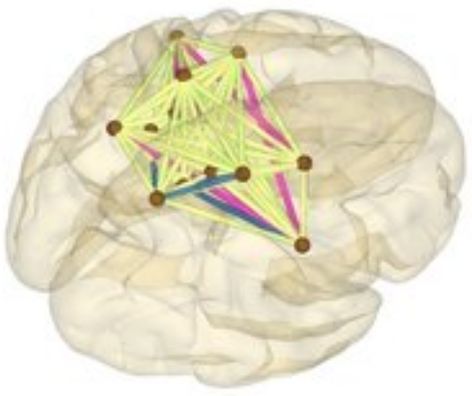
The Primary Somatosensory and Motor Cortices are involved in the sense of touch and executing actions, respectively. The Secondary Somatosensory Cortex is involved with higher level somatosensory processing, such as the integration of proprioceptive information with visual information to create a sense of the body in space. The Premotor cortex is responsble for preparing actions and also contains visuomotor neurons that respond to viewing the actions of others. This system is called the 'mirror neuron system'.



Brain Areas Involved:

1. Premotor Cortex (BA6)
2. Primary Motor Cortex (BA4)
3. Primary Somatosensory Cortex (BA1-3)
4. Secondary Somatosensory Cortex (BA5) (BA=Brodman Area)

NETWORK CONNECTIVITY



Deviations in phase coherence between the different areas of the SMC reflect sub-optimal functioning of the SMC which may result in impaired sensorimotor processing.

PATHOLOGY

Patients suffering from autism disorder are known to have an impaired mirror neuron system, making it difficult for them to understand the actions of others. It has been shown that 'Mu suppression'; the suppression of alpha-like activity in the SMC as a response to viewing other people's actions is impaired in autistic individuals.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.

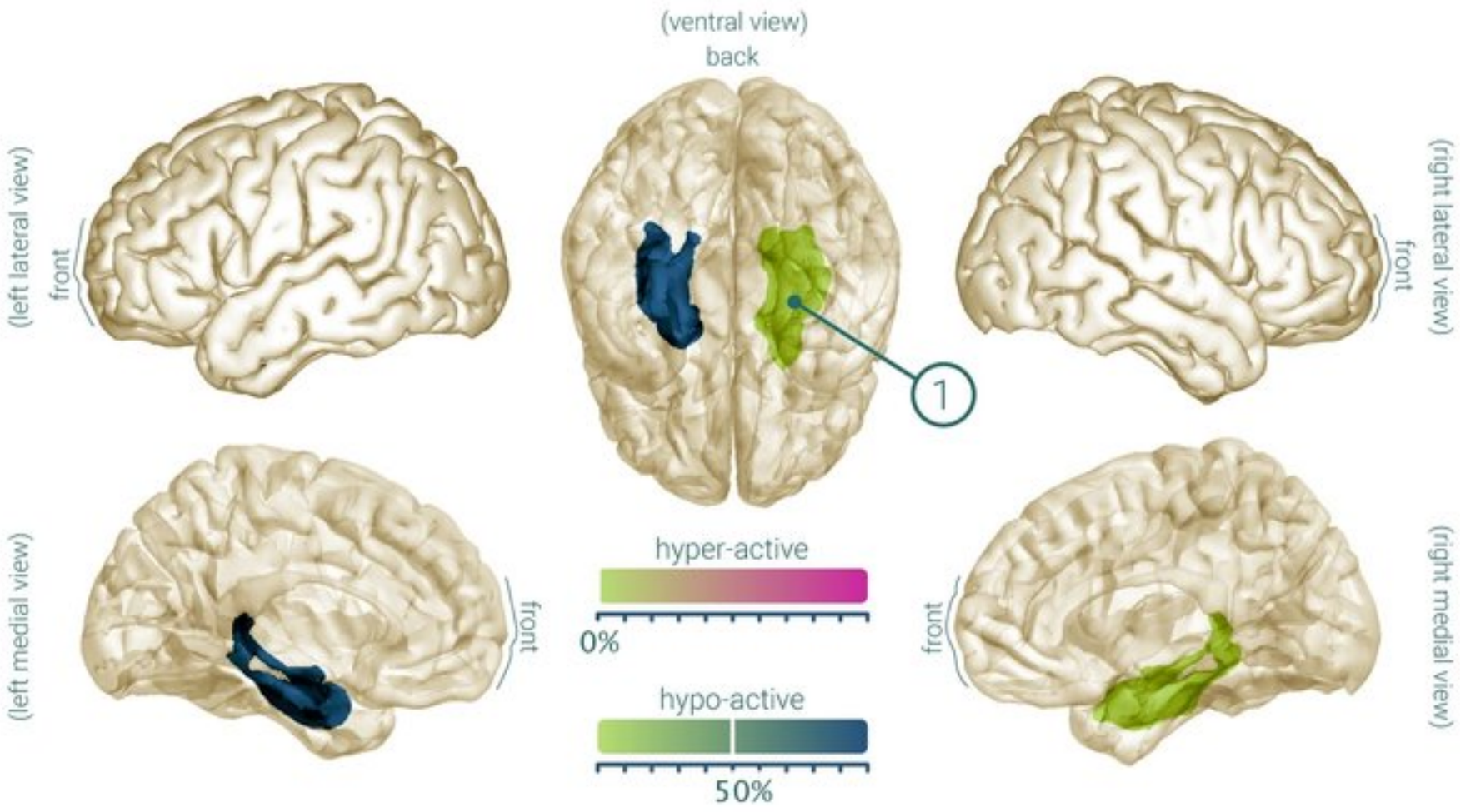
RESTING-STATE NETWORKS:

THE MEMORY NETWORK

The Memory Network (MN), consisting of Hippocampal areas located in the Medial Temporal Lobe, is involved in encoding, storage and retrieval of long-term episodic and semantic memory.

NETWORK ACTIVITY

The Hippocampal areas are known to be pivitol for encoding and retrieval of information about autobiographical events which not only include information about the 'who, what, where, when and how', but also about the emotions that accompanied the event. It is also responsible for encoding and retrieval of semantic information, which refers to 'factual knowledge'.

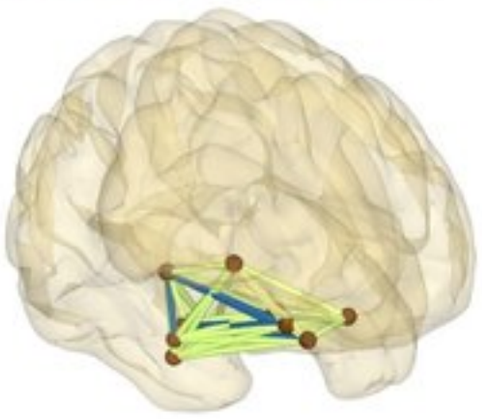


Brain Areas Involved:

1. Medial Temporal Lobe: Hippocampal Areas (BA27, 28, 34-36)

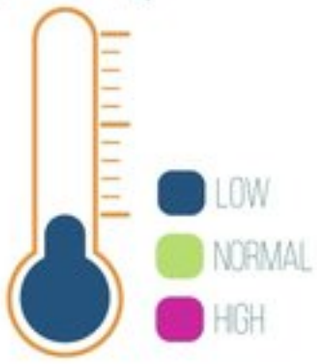
(BA=Brodman Area)

NETWORK CONNECTIVITY



Deviations in phase coherence between the different areas of the MN have shown to be related with memory disorders.

AROUSAL

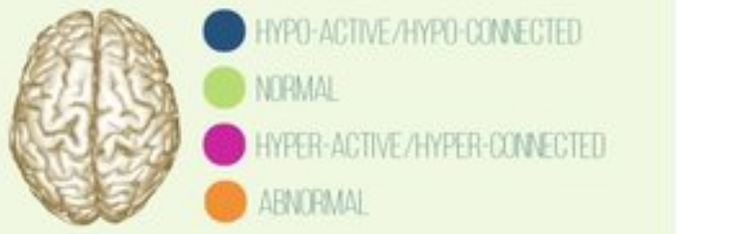


Research has shown that exposure to psychological stress, resulting in elevated arousal, is associated with deactivation of the hippocampus resulting in impaired memory functions.

PATHOLOGY

Memory deficits have shown to be related with abnormal activity in the hippocampal areas. More specifically: Abnormal activity in the hippocampal areas is associated with Mild Cognitive Impairment (MCI), Alzheimer's disease and Schizophrenia.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.



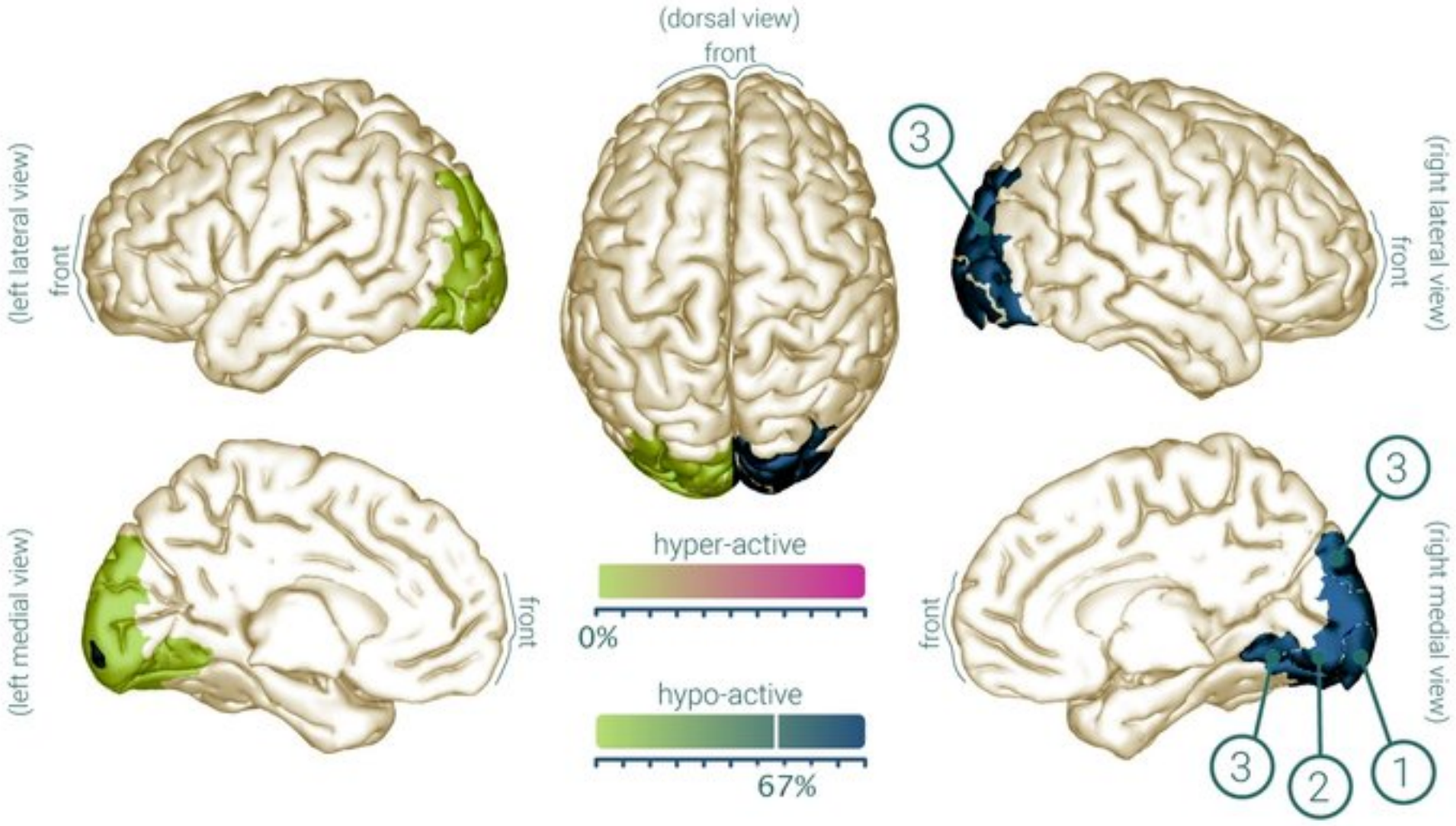
RESTING-STATE NETWORKS:

THE VISUAL CORTEX

The Visual Cortex (VC) is a group of occipital brain areas that is specialized in processing visual information.

NETWORK ACTIVITY

The VC is hiarchically organized with respect to the complexity of visual features that it processes. Low-level visual features, such as color, contrast levels and line orientations are processed in the primary visual cortex (V1, BA17). The secondary visual cortex (V2 and V3, BA18 and BA19) receives input from V1 and is involved in figure-ground segregation, object recognition (V2/BA18) and spatial working memory (V3/BA19).

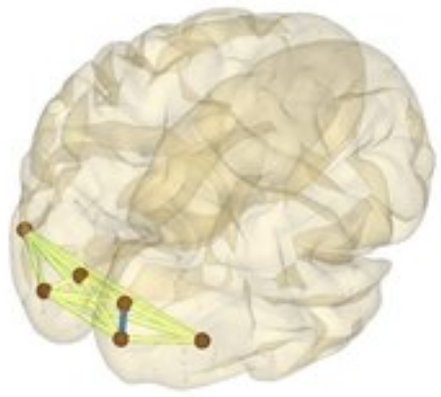


Brain Areas Involved:

1. Striate Cortex (BA17)
2. Middle Occipital Gyrus (BA18)
3. Inferior Occipital Gyrus (BA19)

(BA=Brodman Area)

NETWORK CONNECTIVITY



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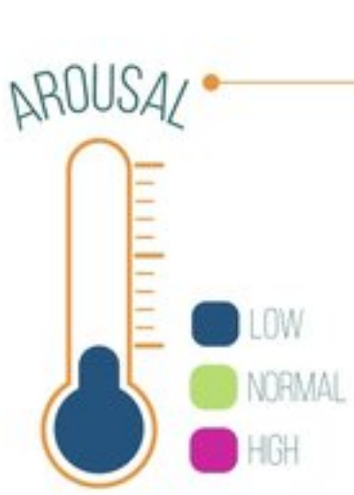
Deviations in phase coherence between the different areas of the VC may result in impaired visual processing.



Low Alpha activity during the Eyes Closed recording reflects high arousal and high Alpha activity during the Eyes Open recording reflects low arousal (see page 2 of this report).

The level of arousal reflected by the Alpha activity in the VC can be related with anxiety disorders (high arousal) and with drowsiness or fatigue (low arousal).

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit in both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but the average hyper- or hypoconnectivity across frequencies.