BIOMARKER EVALUATION REPORT

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Executive Summary of Results and Recommendations

Name:		Date of birth: Sex:	09.28.2005 m
Recording Date:	11.11.2020	Referred by:	Dr Rand Coleman
Medication(s)	Trileptal300mg am and 600mg pm; Prozac 60mg pm		
Evaluator	Andrea Meckley Kutyana, PhD, BCN, BCB, QEEG-T		
Reason for evaluation	Make better decisions. Understand why does he seem to not remember things		

SUMMARY OF FINDINGS

Questionnaire	Significant Self-Reported Responses
Amen	The answers indicate a slight level of strain in basal ganglia, temporal lobes and deep limbic system, also a high level of strain in cingulate cortex and prefrontal cortex.
van Deusen	Functions that have been allocated to the left hemisphere are significantly more affected. Functions of the left frontal, left medial temporal lobe, left parietal cortex, left superior temporal lobe and the prefrontal cortex are strongly affected.
ADHD	Criteria met for inattention. Criteria for both over-focusing and emotional dysregulation are increased.

Screening	Within Normal Limits	Areas of Deficit
Psychophysiological Profile	No	Increased skin conductance and muscle tension, low temperature, upper body dominated breathing style, poor heart rate variability coherence.

VISUAL CONTINIOUS PERFORMANCE TASK

Data	Within Normal Limits	Statistically Significant
Omission	Yes	These results suggest adequate attention and inhibitory control to perform a simple, routine task for around twenty minutes.
Commission	Yes	
Reaction Time	Yes	
Reaction Time Variability	Yes	

NEUROLOGIST EEG FINDINGS: Within Normal Limits: No

Description: There is a posterior dominant rhythm at 7.5-9.0 Hz, with a strong central peak at 8.0-8.5 Hz. Bilateral central-midline 6-7 Hz theta frequencies are noted. This EEG is mildly abnormal for age due to mild slowing of the waking background rhythm for age in the awake state.

qEEG FINDINGS

Results	Description
Slower alpha rhythm	Peak alpha frequency is at 8.06 Hz, maximal in the frontal regions (Brodmann area 10)
Fronto-central theta	Increased 4-7 Hz in the fronto-central regions (Brodmann area 6)
Increased theta/beta ratios	Theta/beta ratios are increased along the midline in all conditions.
Arousal index	Increased arousal is noted during the task.

EVOKED RESONSE POTENTIALS

Components	Early potentials		Mid potentials		Late potentials	Specific pattern
	Amplitude	Latency	Amplitude	Latency		
Visual Input			-	-	-	N1 Stress Marker No
Auditory Novelty			low	-	-	
Left Association Areas	-	-	-	-	-	
Right Association Areas	-	-	-	-	-	
Left Memory	low	-	low	-	Long-lasting high	
Right Memory	-	-	-	-	-	
Engagement	-	-	low	-	Long-lasting negativity	N2 Attention Marker No
Inhibition/Suppression	-	-	-	-	Reactivation	
Monitoring	-	-	high	-	-	
Working Memory						
Slow Wave Activity						

DISCUSSION:

There are several findings of interest in his evaluation. First, his EEG is considered to be mildly abnormal for his age by Dr. Turner due to mild slowing of the background rhythm. His peak alpha rhythm is found to be at 8.06 Hz. Thus, when compared to the normative database this results in increased 7-8 Hz which is noted diffusely but maximal in the frontal regions. Alpha is considered the brain's "idling rhythm" and typically found between 9-11 Hz. This suggests a maturational lag and is consistent with reports of early developmental delays. As a result, some aspects of his processing, mental abilities, and behaviors may resemble a younger child. It is noted that available research suggests that Trileptal does affect peak alpha frequency, although the effect is variable across studies (i.e. some studies show an increase, some show a decrease). Additionally , this activity is maximal in the frontal regions with LORETA estimating a frontal source in Brodmann area 10. This area is involved in executive functions by participating in task management , planning and monitoring actions, adjusting the initial plan according to outcomes , considering several things at a time, and integrating external stimuli with internal thought processes.

Second, increased theta activity is also noted in the fronto-central regions along with increased theta/beta ratios. This may be secondary in part to drowsiness that was evident in these recordings. LORETA estimates the source of this activity to be Brodmann area 6 which will further compromise executive functions. This region plays a role in the planning, initiation, and execution of movement as well as the planning, control and regulation of somatosensory, emotional, and cognitive impulses. Finally, increased arousal is noted during the task. Increased arousal is associated with fear and stress and is consistent with the patterns noted during the physiological profile. This can lead to avoidance behavior.

The evoked potentials suggest an inability to activate two sensory channels/modalities (auditory-visual) simultaneously or a reduced sensitivity to perceived auditory input which is consistent with reports of an auditory processing disorder; decreased detail-oriented information processing and memory retrieval; high activation of left hemisphere monitoring usually associated with a high degree of control and meticulous behavior in everyday life leading to exhaustion over time; low energy expenditure to achieve goals due to a general state of under activation or a decreased goal-oriented behavior in everyday life; decreased level of inner involvement; difficulties in decision making; high activation of limbic energy during decision making and monitoring is affected by inner stress.

SUMMARY OF RECOMMENDATIONS

MEDICATION

Possibly recommended	It is difficult to make medication recommendations as he is currently taking medications that may be impacting the EEG. With that in mind, theta activity typically responds to psychostimulants and slower frequency frontal alpha has been reported to respond better to amphetamine -based stimulants such as Adderall or Vyvanse. A norepinephrine reuptake inhibitor such as Strattera may also be helpful.

RECOMMENDATIONS FOR THERAPEUTIC INTERVENTIONS

Lifestyle	Recommended	Modifications Recommended
Daily Life	Yes	Structure and routine
Sleep	Yes	Review sleep hygiene and biofeedback
Diet	Yes	Review guidelines
Exercise	Yes	Consider incorporating activities like yoga
Drugs/Alcohol	No	
Electronics	Yes	Limit to 2 hours per day.

Biofeedback	Recommended	
EEG	Yes	Detailed information can be found in the recommendations section in the report
Heart Rate Variability	Yes	
Pir-HEG	Yes	
EMG	Yes	

Home Training	Recommended	
UNYTE/Mightier	Yes	Detailed information can be found in the recommendations section in the report
BAUD Bio-Acoustical Utilization Device	No	
Alpha-Stim CES	No	
David Audio-Visual Entrainment	No	
Lumosity	No	
Fast ForWord	Yes	

Additional	Recommended	Comments
Psychotherapy	Yes	Consider ADHD coaching

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I. Introduction

Important notice: qEEG and evoked potential assessment do not replace a medical-clinical checkup. They solely serve to generate comparable physiological data in different cognitive states. No neurologic diagnostic statement will be made. A neurologic assessment must be done by a licensed Neurologist.

Procedure: EEG recording was computed according to the 10-20 placement using 19 scalp electrode caps. Brain electrical activity was digitally recorded on a NeuroAmp x23 System, using a linked ears reference montage. Impedances of less than 5k Ohms were achieved at all sites before recordings were initiated and kept >5k Ohms at all times during recording. The signal was digitally processed by a quantitative topographic analysis system (ERPrec software), band passed from 1-50Hz, and saved on a local disc.

The client was seated 1.5m in front of a display monitor. The EEG was recorded in relaxed condition with eyes closed (EC) and eyes opened (EO) for 10 Minutes each and saved. After a short break, a visual or auditory continuous performance task (ACPT/VCPT) was presented on the monitor and performed during recording (task condition). The data was saved separately.

The digitized data is run through an artifact program where eye blinks, movement and other artifacts are identified and removed. The data is then additionally manually processed for artifacts and important transients are marked.

Corrected digital recording of the client is run through a mathematical program called Fourier-Transformation. This procedure analyzes the recorded brain waves and expresses the recordings as a mathematical function - time as a function of frequency - known as its frequency spectrum. To evaluate the data there are diverse descriptive and statistical repetitions which are performed to provide a spectral analysis, topometric analysis, covariance analysis, and comparisons between the states of data acquisition. The data collected is compared and evaluated against a known FDA approved data base.

This report aims to present the results and conclusion of this analysis. Also, therapeutic recommendations are given, according to dysfunction and cortical organization of the client's brain. Presented results are to be handled with caution, as they represent a momentary picture of a whole complex system.

The graphs represent an approximation of the source generator in the cortex calculated through mathematical procedures. Hence the calculated localization can differ from the real source. Therefore, expert knowledge based on functional neuronal models should ultimately determine the clinical relevance of these findings.

II. Questionnaires

1. Questionnaire: Personal and clinical data

General information

- Name (family name, given name) or code:
- Date of birth (Day. Month. Year): **28.09.2005**
- Gender (M-male, F-female): **M**
- Handed (L- left, R – right, ambidextrous): **R**
- Reason of having QEEG/ERP assessment: **Make better decisions. Understand why does seem to not remember things**
- Medication taken now: **Trileptal300mg am and 600mg pm; Prozac 60mg pm**
- Referral source: **Dr Rand Coleman**

Pre- and post-natal history

- Early development, such as started to talk/walk too late: **Crawled, walked late. Difficulty expressing himself**
- Head trauma (with loss of consciousness): **none**
- Poor grades in school, poor performance at work: **Requires support.**

General Brain Regulation

- Often having headaches and/or migraines: **No**
- Feels weak and passive during daytime: **Varies- at times, feels weak. Doesn't ask for help readily.**
- Sleep-related difficulties: **To bed at 9:30p. Takes 30-45 minutes to fall asleep**
- Abuses alcohol or drugs: **Used to do excessive gaming**
- Has history of seizures: **Cousin had seizures**

Sensory system

- Perceptual difficulties in vision, hearing, touch…such as dyslexia, paresis, neglect…: **Various deficits.**
- Difficulties in social interaction and communication, autistic spectrum: **Normal**

Motor system

- Motor-related difficulties, such as fine motor, tremor, rigidity, apraxia…: **Fine motor weakness**

Executive system

- Attention difficulties: **Looses track probably due to processing deficits**
- Impulsiveness: **Makes impulsive decisions**
- Difficulties in correcting behavior: **Needs frequent corrections**
- Psychosis (hallucinations, delusions…): **No**

Affective system

- Occupied by mostly negative emotions, depressed: **No**
- Anxious: **Gets angry about his deficits**

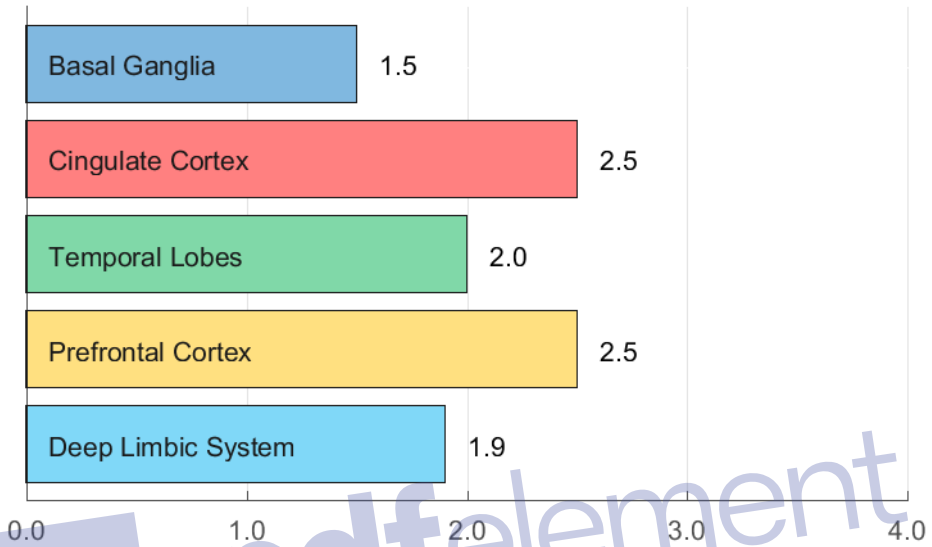
Memory system

- Poor memory for recent events: **May be related to processing.**

2. Questionnaire: Symptoms and Cortical Networks (Amen)

The relations between answers to the questions of the everyday functioning questionnaire and different brain structures have been researched. The figure below shows the weight of stressors on each structure. As answering styles are highly variable between individuals, it cannot be stated if the stressor is significantly impairing everyday functioning or not. Nonetheless it is interesting to observe the differences between various structures.

Graphic summary:



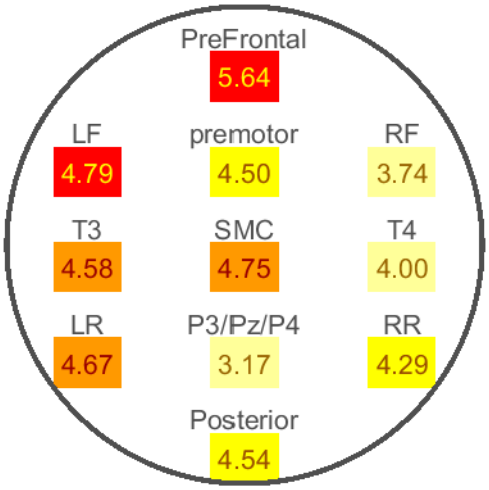
The answers indicate a slight level of strain in basal ganglia, temporal lobes and deep limbic system, also a high level of strain in cingulate cortex and prefrontal cortex.

- The cingulate system goes from the frontal cortex (anterior part) over the medial cingulate cortex and to the posterior cingulate cortex (precuneus). Functions are affected by cognitive and emotional contents. In this context monitoring functions are required, like internal flexibility (vs rigidity). Dysfunctions of the cingulate system influence all other cortical areas. The serotonin system is widespread along the cingulate cortex. The cingulate system receives information from the thalamic anterior nuclei.

- The temporal lobe is involved in different processes of information processing. The posterior superior temporal cortex processes and stores information, the medial temporal cortex is involved in higher level sensory integration. The medial temporal lobe receives (emotional) information from the orbitofrontal and dorsolateral prefrontal cortex, also from specific nuclei of the insula. Once all dimensions of information have been processed, it is sent to the hippocampus via the entorhinal cortex.

- The attentional, emotional and executive system's networks achieve a special significance in the prefrontal cortex. The prefrontal cortex is the conductor of the brain, determining functions like planning, direction and control of actions. The prefrontal cortex receives information from all sensory modalities and deep limbic structures.

3. Questionnaire van Deusen



Summary of results:

- Functions that have been allocated to the left hemisphere are strongly affected.
- Left frontal functions (increased self-blame or feeling of unhappiness) are strongly affected.
- Functions of the left medial temporal lobe (difficulties with information processing e.g. reading or orthography) are strongly affected.
- Both functions of the left parietal cortex and left superior temporal lobe (reading, orthography, logic-constructive processing) are strongly affected.
- Functions of the prefrontal cortex (attention, emotional regulation, executive functions) are strongly affected.

4. ADHD-Questionnaire

Type	Question	Score
Type 1	**Combined ADHD-Type** → *Questions on Attention & Hyperactivity* Meets criteria for *Inattentiveness* questions as well as *Hyperactivity/ Impulsivity* questions.	11
	Inattentiveness Questions → *Questions on Attention* 6 (5) or more ratings of 3 or 4 are required to diagnose this type; with more than 4 such ratings suggesting this type of ADD.	**8**
	Hyperactivity-/Impulsivity Questions → *Questions on Hyperactivity* 6 (5) or more ratings of 3 or 4 are required to diagnose this type; with more than 4 such ratings suggesting this type of ADD.	3
Type 2	**Inattentive ADD** → *Questions on Attention* 6 (5) or more values of 3 or 4 are required to diagnose this type; with more than 4 such ratings suggesting this subtype of ADD; but not 6 or more such ratings for *Hyperactivity-/Impulsivity* questions.	**8**
Type 3	**Over focused ADD** → *Questions on Over Focusing* Meets criteria for *Inattentiveness*, as well as 6 or more such ratings in *Over Focusing* questions.	**6**
Type 4	**Emotion regulation Comorbidity** → *Questions on Emotion regulation* Meets criteria for *Inattentiveness*, as well as 12 or more such ratings in *Emotion regulation* questions.	**20**

Meets the cut-off (6) for inattention, therefore according to DSM V the diagnosis of ADHD (314.0) can be made. However, the impairment caused by the symptoms must be present in at least two settings (school and at home) and there must be clear evidence of clinically significant impairment in social life and school performance . Additionally , the symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder.
Furthermore, the criteria for both over-focusing and emotional dysregulation are increased.

III. Neuropsychological Measures:

1. Performance

Performance was recorded during the visual continuous performance task (VCPT). The measures can be interpreted regarding impulsivity (commission errors), attention (omission errors, missed trials), reaction times (msec) and variability of reaction times.

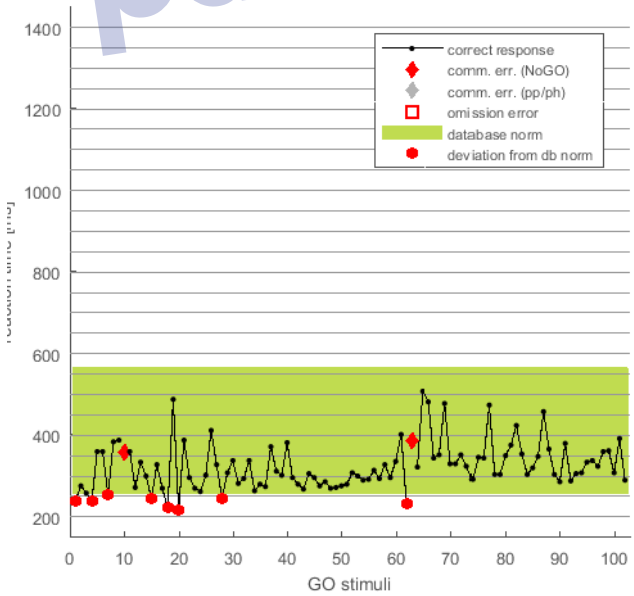
VCPT:

Group name	Correct	Omission	Commission	RT	VR(RT)
a-a GO	100.0 %	0 (0.435)	0	323 (0.352)	5.9 (0.129)
a-p NoGO	98.0 %	0	2 (0.595)	-	-

Number of processed trials: **400** (a-a GO: **100**, a-p NoGO: **100**, p-p: **100**, p-h: **100**)

Overview: The scores of Keegan Hull are within the normal range in reference to Attention, Impulsivity, Reaction time and Response consistency.

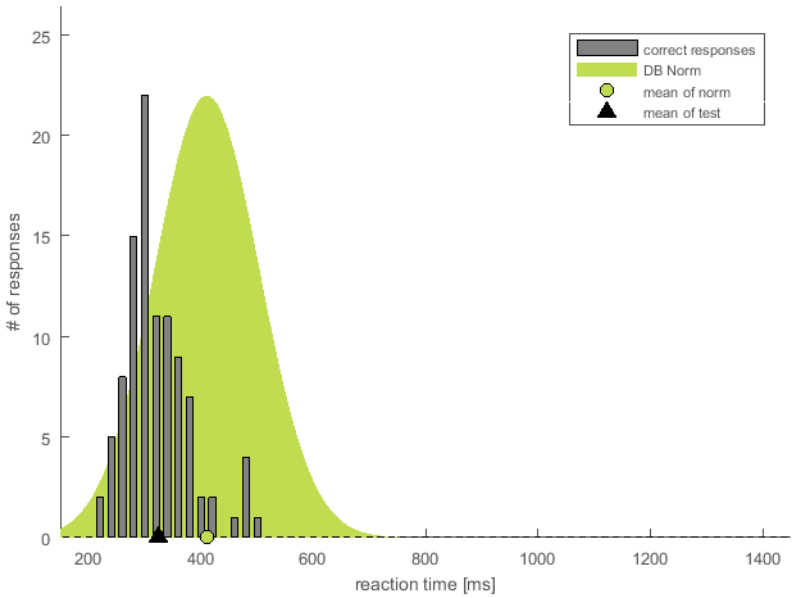
Figure 1: below, reaction times are presented over time. Red dots represent reaction times below or above database (DB) norm levels. Black dots represent correct responses, red squares omission errors (inattentiveness) and red crosses commission errors (impulsivity).



The analysis of reaction times compared to peers (green area) show a good consistency in reaction time.

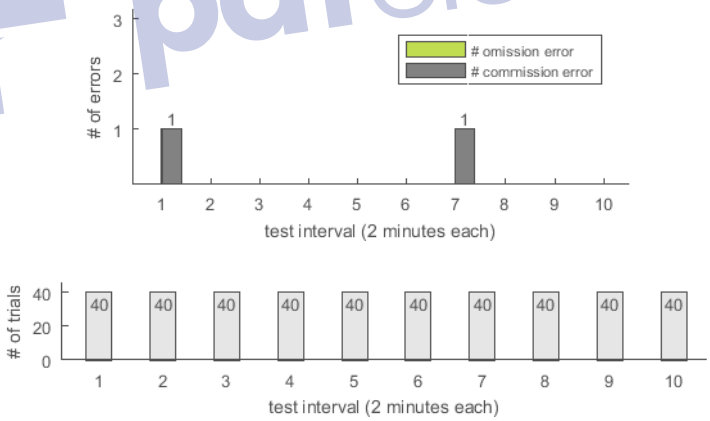
Figure 2: below, reaction times are represented as a function of occurrence. The distribution of grey bars indicates how stable the reaction times were (variability of reaction times). Wide distributions show

unstable performance, while narrow distributions can be interpreted as stable performance. The green area indicates the database norm.



The average reaction time of (black triangle) is similar to his peers (green dot).

Figure 3: below, the distribution of errors over time (intervals of 2 min) is illustrated. More errors towards the end of the task indicate growing fatigue in the course of performance.



There are 2 errors throughout the entire test.

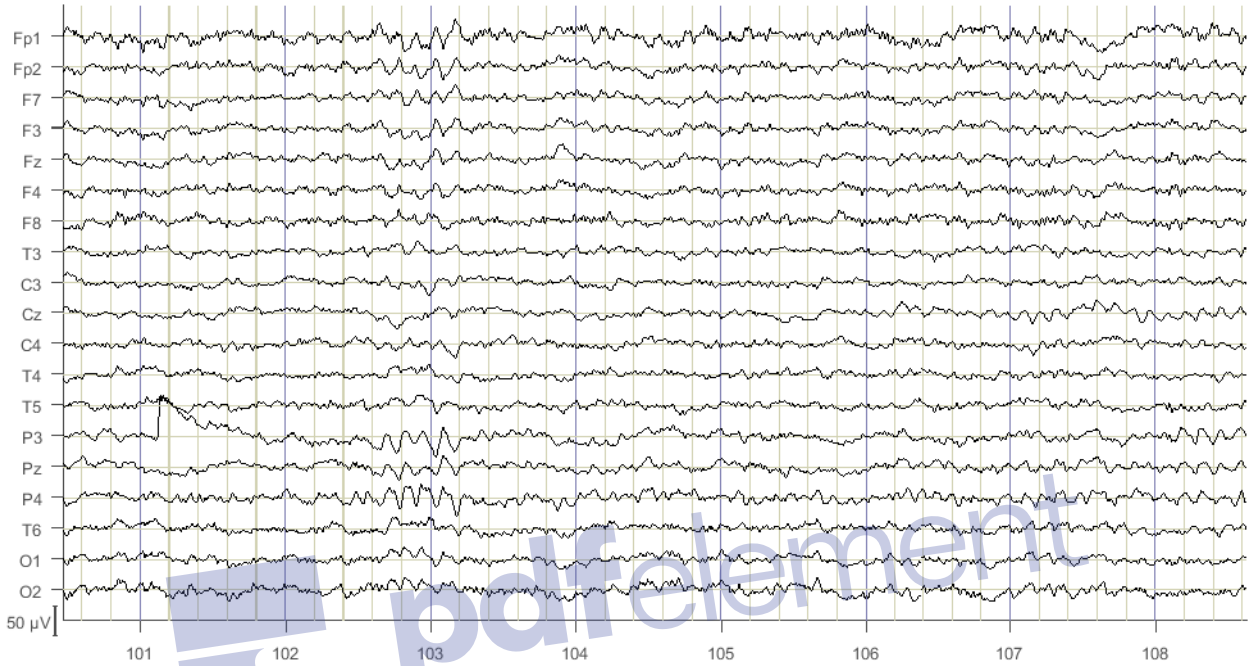
IV. Evidence-based investigation by measuring neurophysiological brain functions (functional neurophysiology, biomarkers):

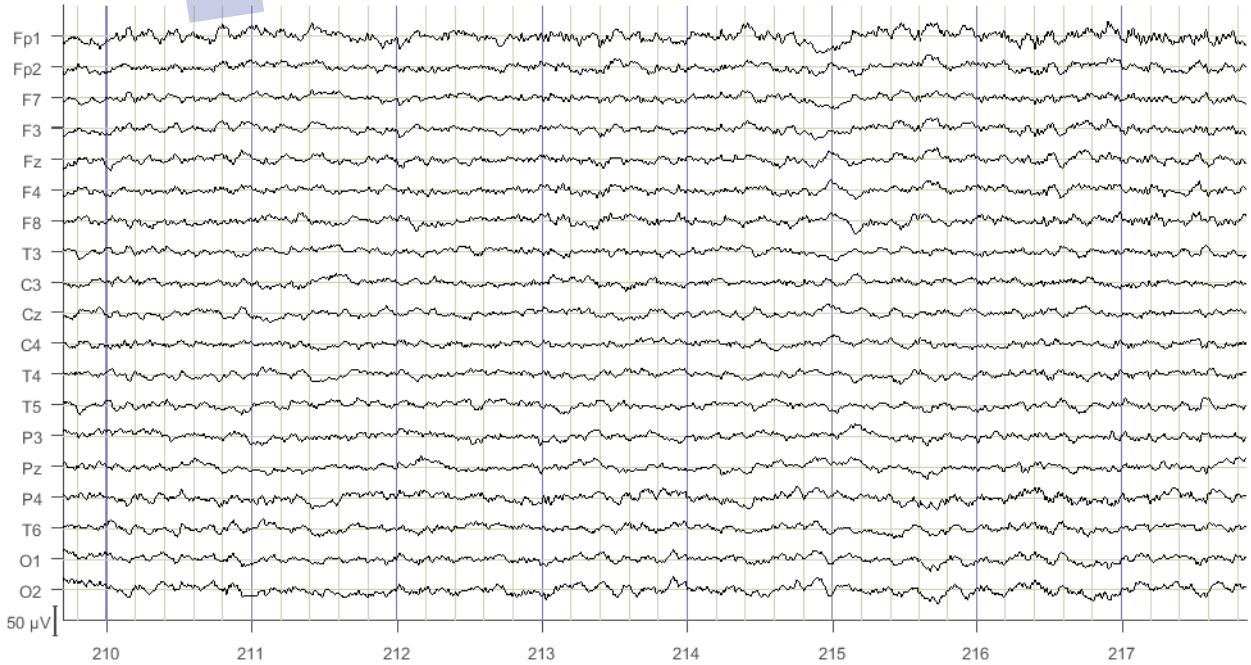
1. Spontaneous EEG

EEG was recorded during relaxation with closed eyes (10 minutes) and opened eyes (8 minutes). From this recording, spectral data was calculated and compared with database population. Database comparison was calculated with weighted montage.

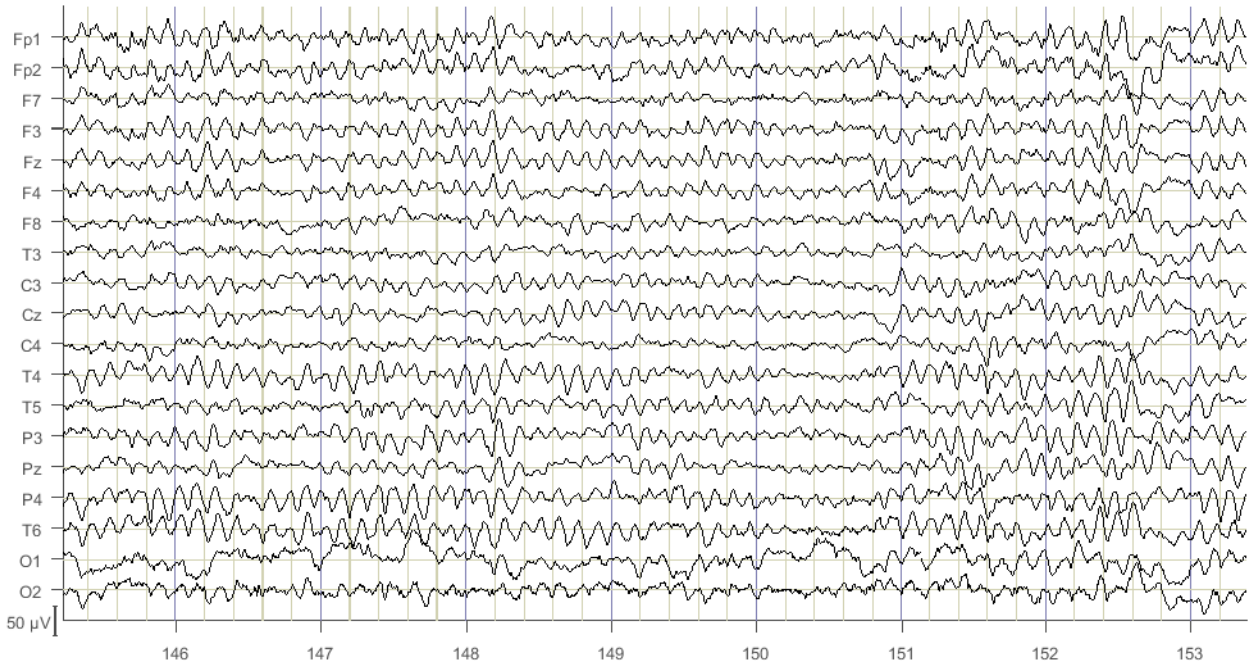
Fragment:

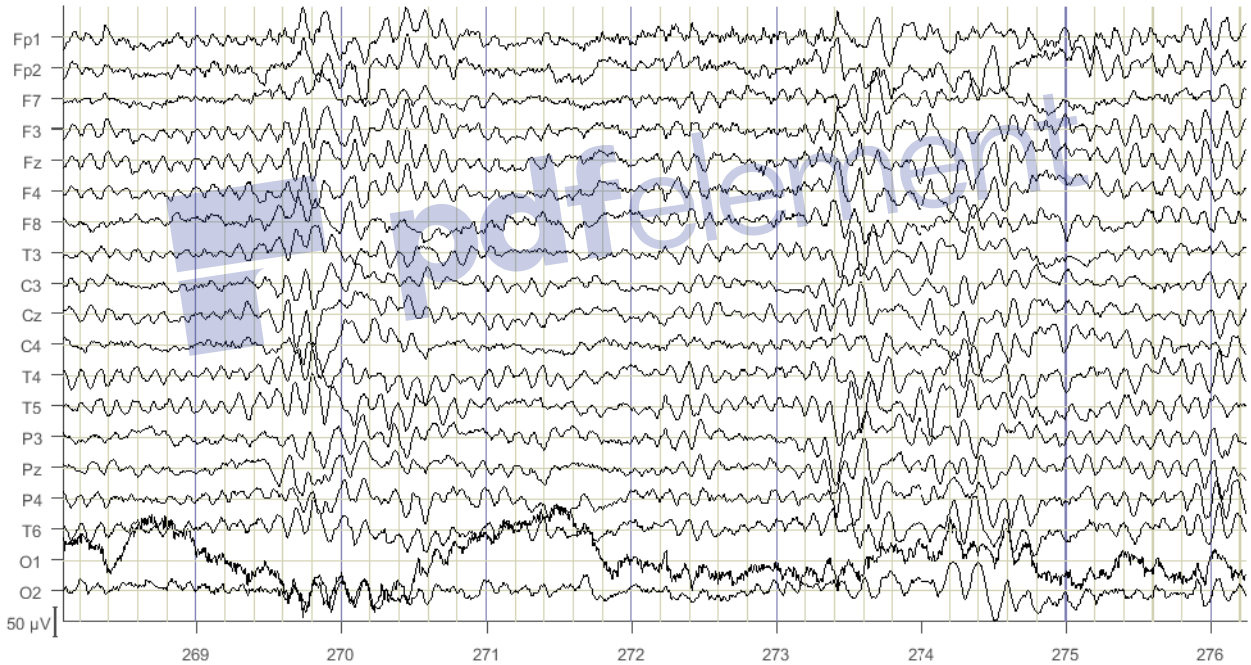
Eyes opened





Eyes closed



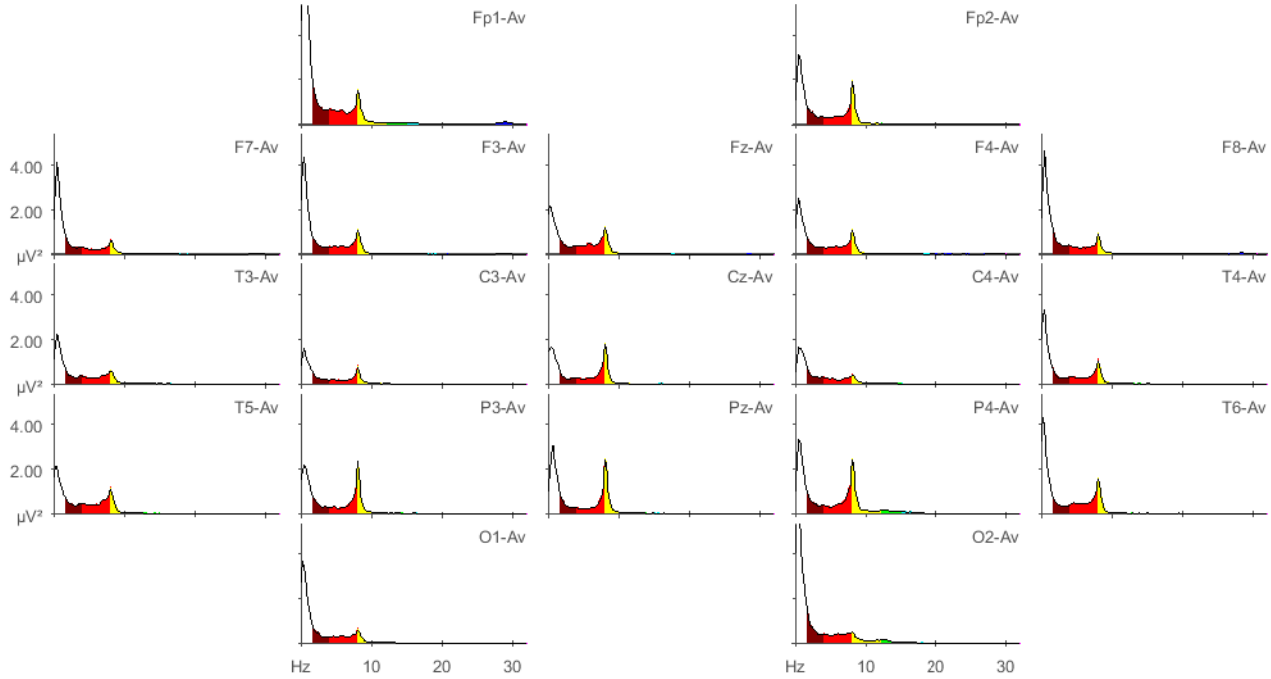


2. Spike Detection

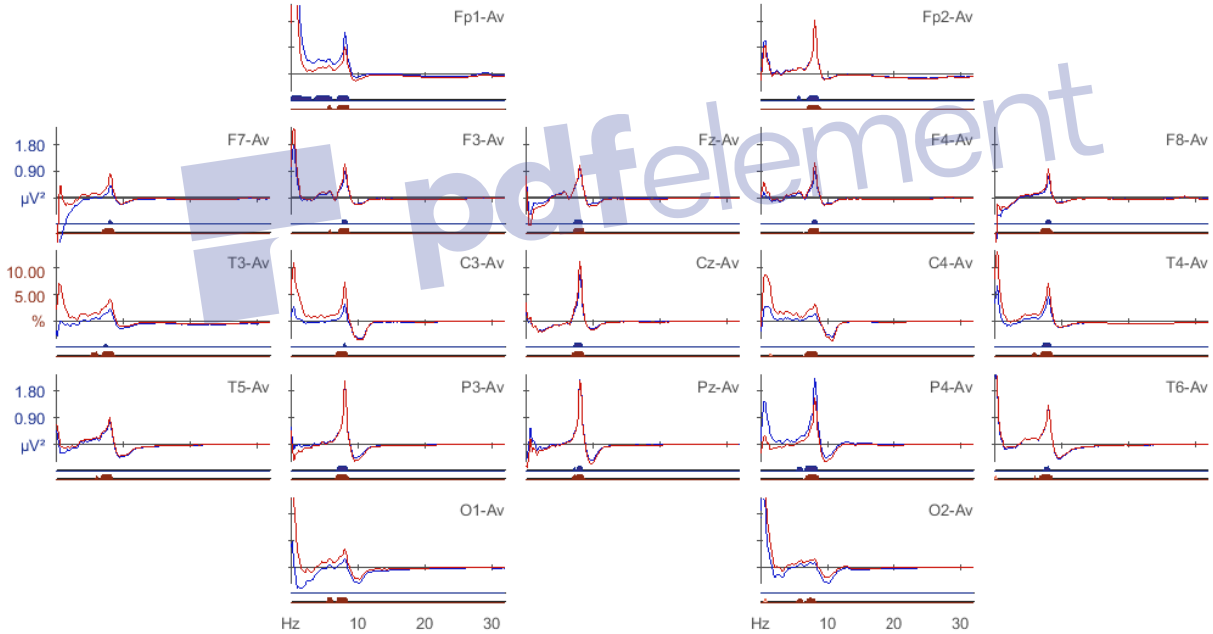
Spikes are sharp transient waves representing interictal epileptiform activity in the brain. The spike detection procedure uses morphological filtering of EEG signals in order to detect such transient activity and separate it from normal background waves.

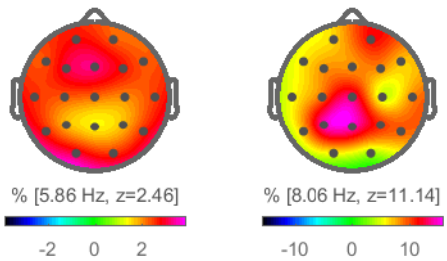
These recordings were read by a neurologist so this procedure was not applied in this analysis.

Spectral data: eyes opened (7:55)

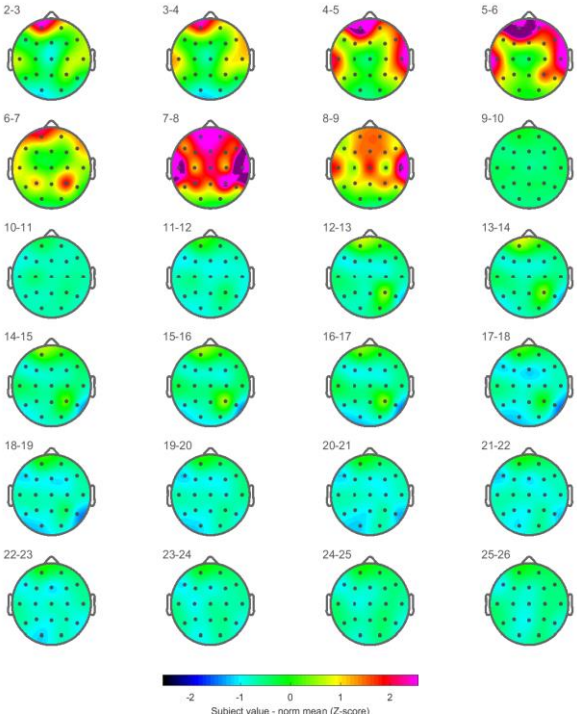


comparison with reference data: Difference (blue: absolute, red: relative). Bars on the bottom line indicate significant deviations from norm.

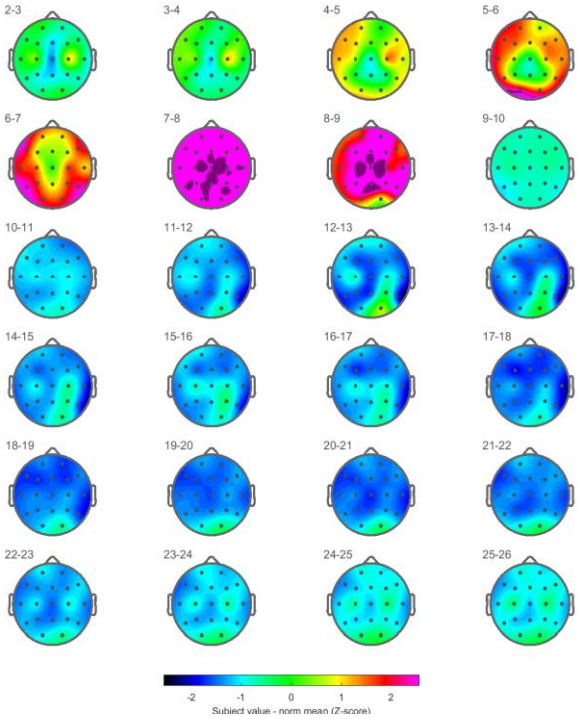




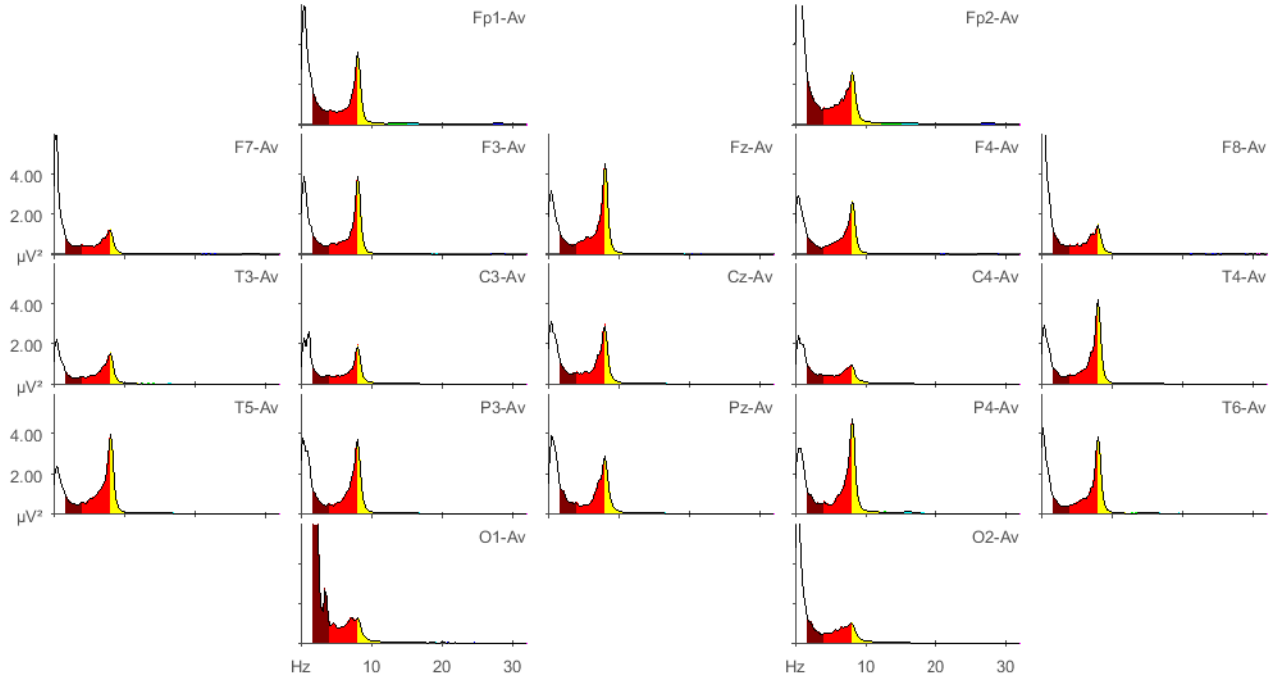
Database - Subject (absolute):



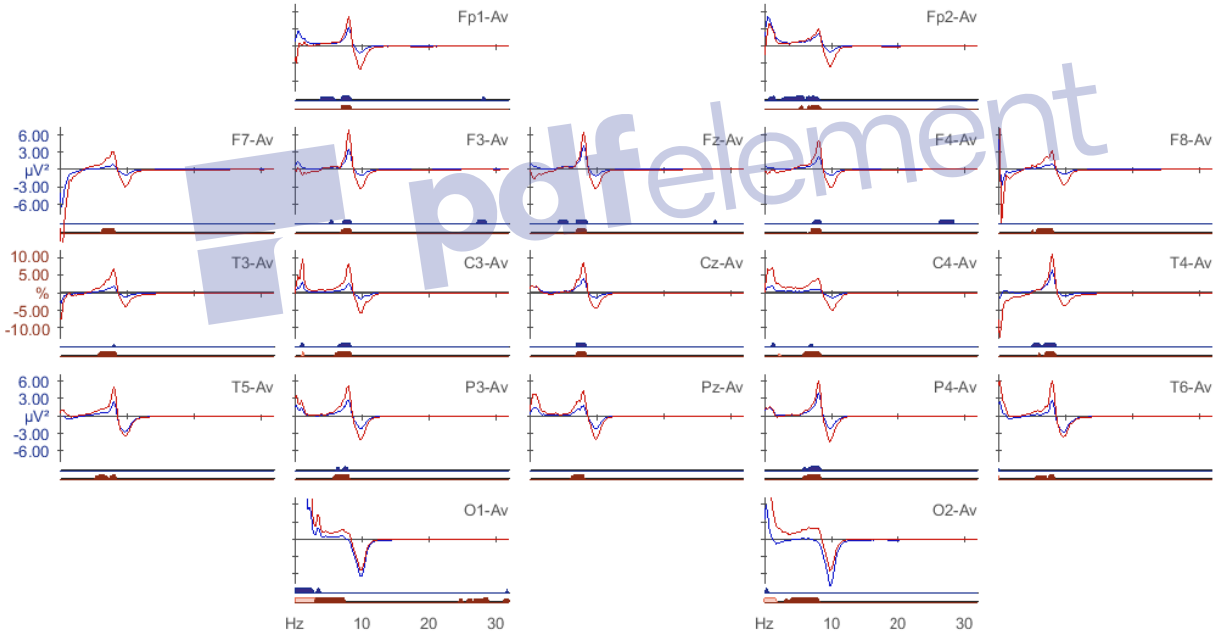
Database - Subject (relative):

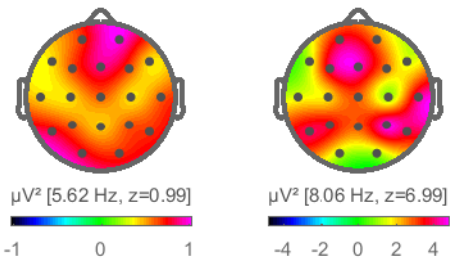


Spectral data: eyes closed (9:46)



comparison with reference data: Difference (blue: absolute, red:relative). Bars on the bottom line indicate significant deviations from norm.





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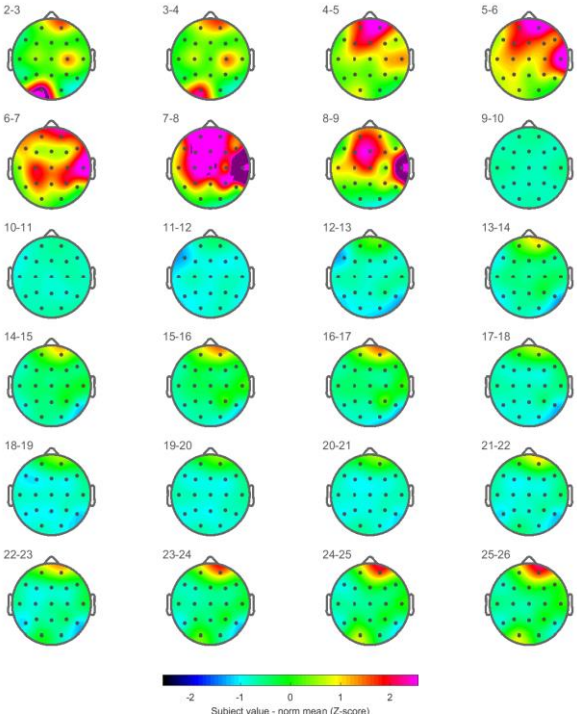

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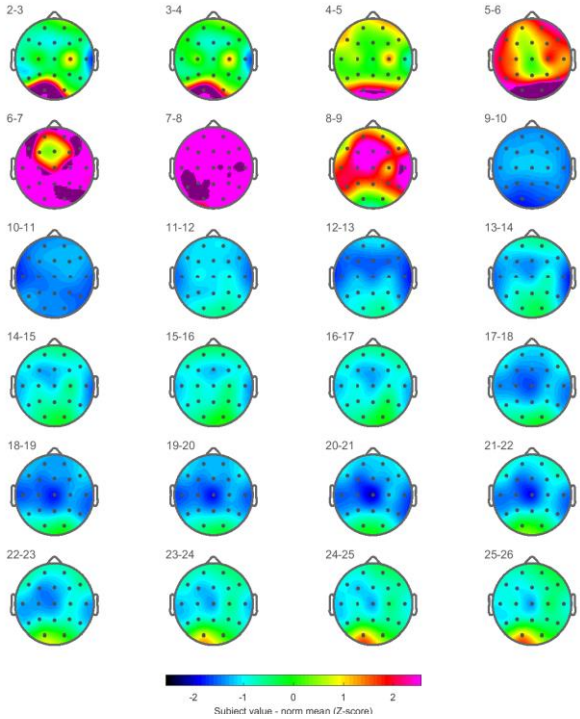
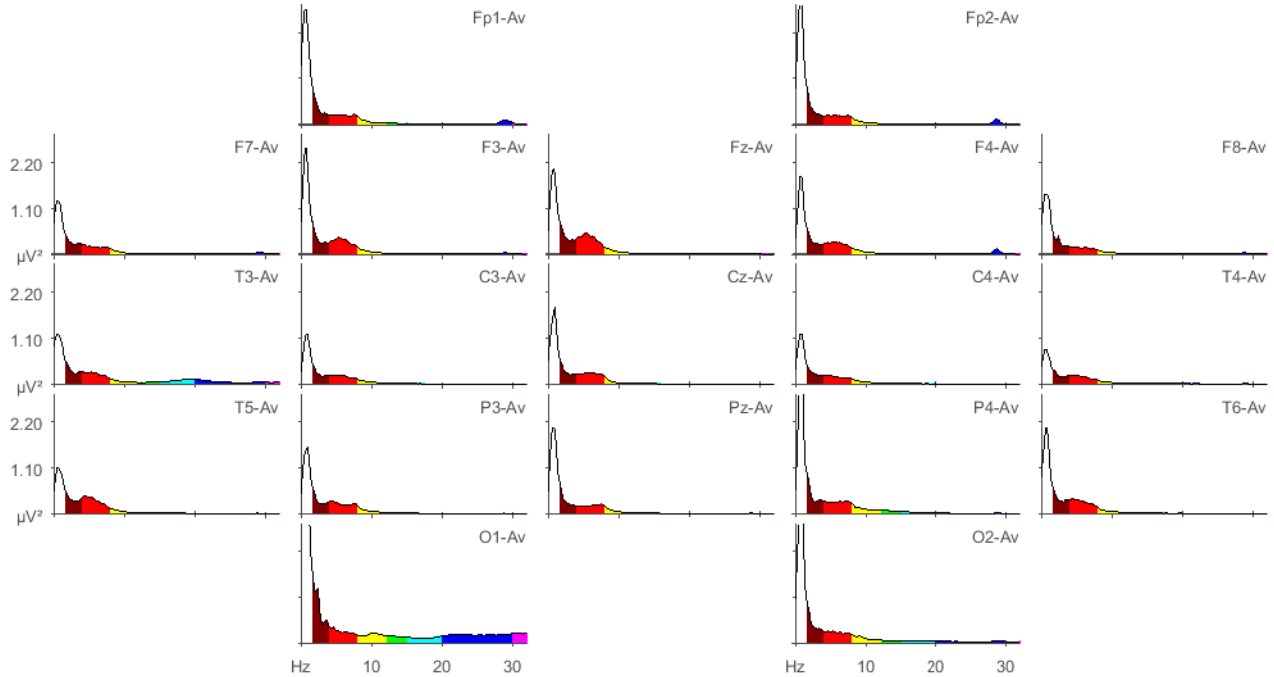
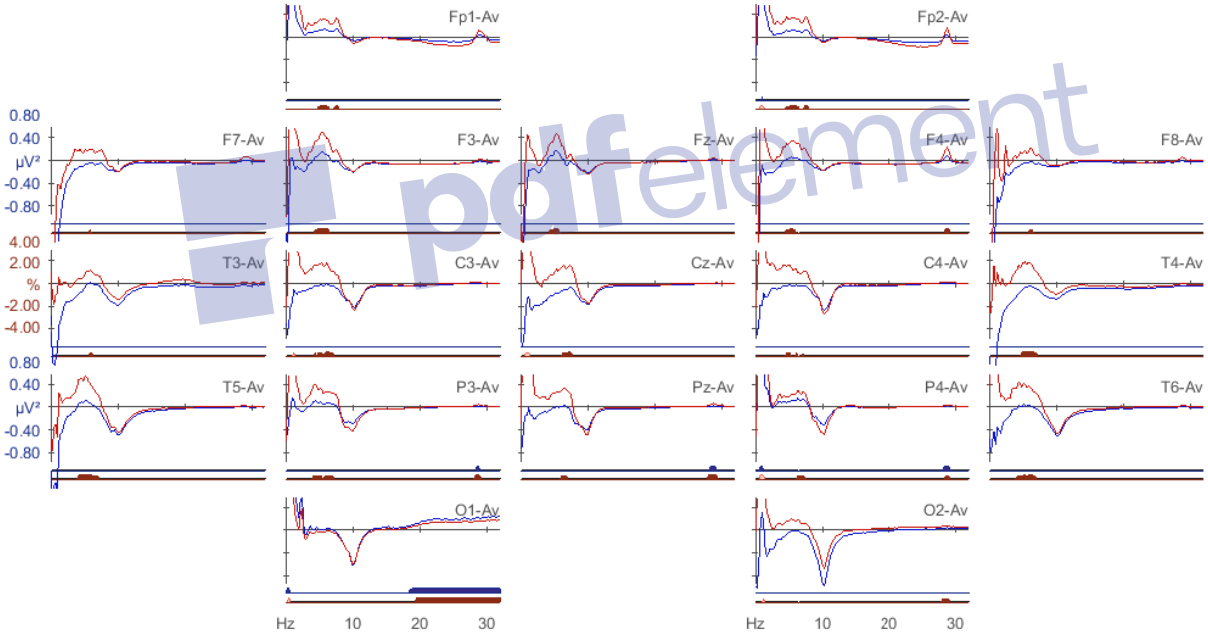
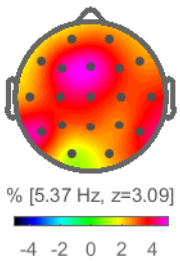


Spectral data: VCPT (18:30)



comparison with reference data: Difference (blue: absolute, red: relative). Bars on the bottom line indicate significant deviations from norm.





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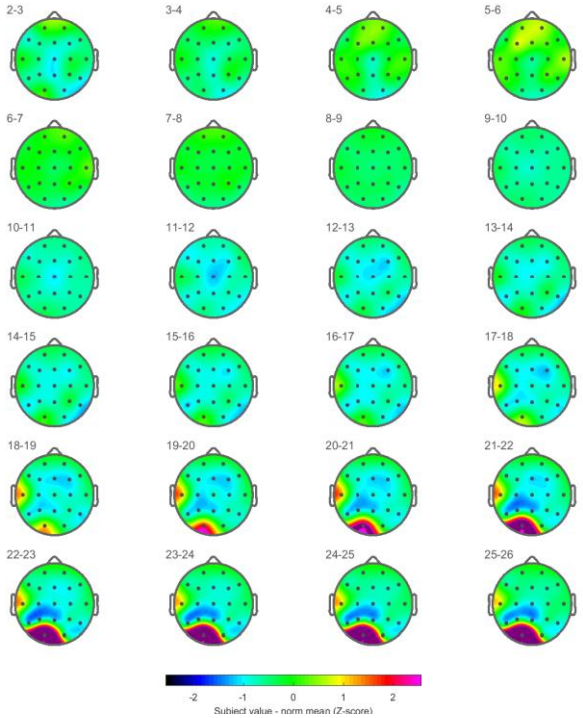
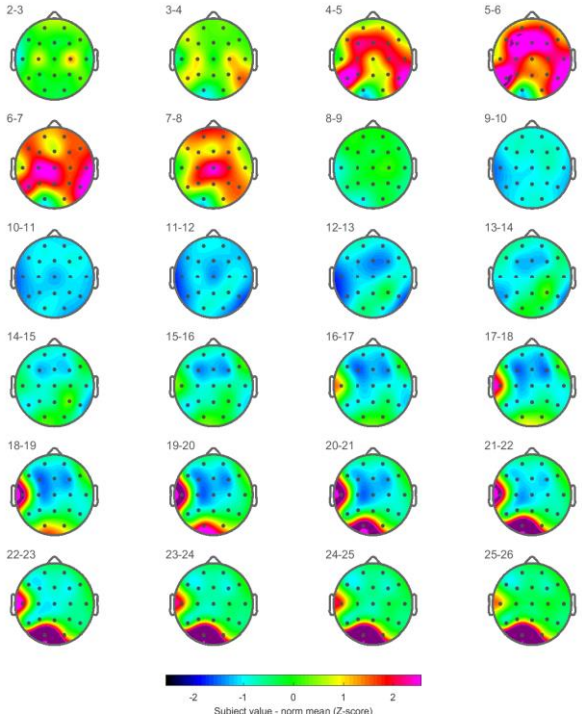
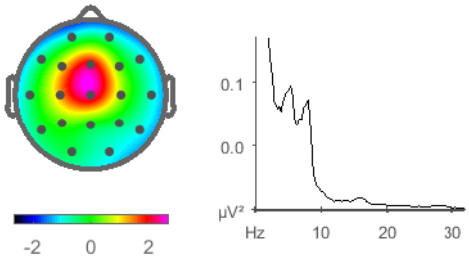


Database - Subject (relative):

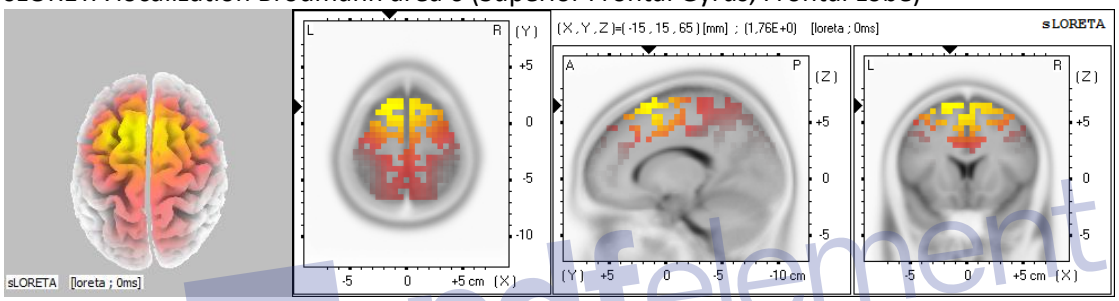


The graphs represent an approximation of the source generator in the cortex calculated through mathematical procedures. Hence the calculated localization can differ from the real source. Therefore, expert knowledge based on functional neuronal models should ultimately determine the clinical relevance of these findings.

Following deviations were calculated (EC):
1. frequency: 5.62 Hz
Graph of the independent component of this activity:

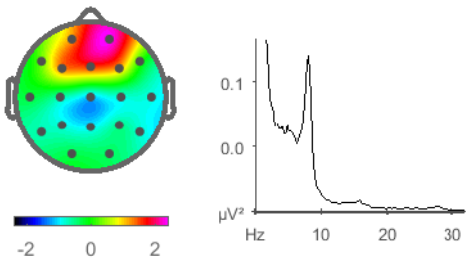


sLORETA localization Brodmann area 6 (Superior Frontal Gyrus, Frontal Lobe)

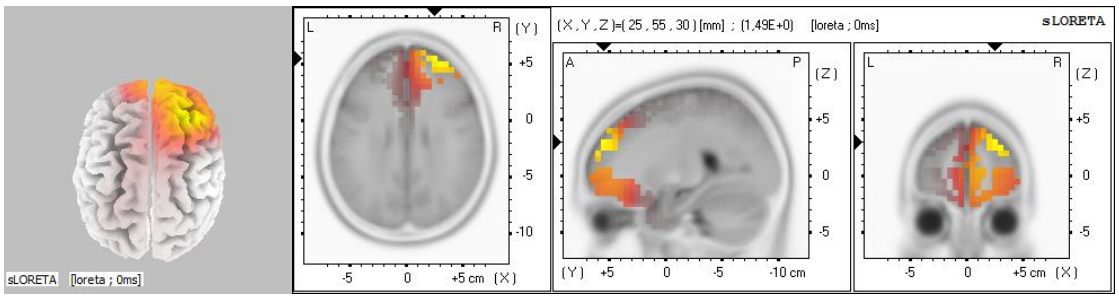


Brodmann area 6: Is located in the frontal cortex and includes the premotor area PMA (lateral of BA 6) and supplementary motor area SMA (medial BA 6). BA 6, BA 4 and BA 24-the cingulate motor cortex, become active together with the basal ganglia and cerebellum when movement is planned, initiated and executed. BA 6 stores action plans and strategies, recalls motor memories and movement sequences, enabling optimization of movement processes. The supplementary motor area SMA is involved in planning and initiation of complex movements, also bimanual coordination. Several studies have found that the lateral BA 6 is also active during mental arithmetic; other studies indicate that BA 6 is the beginning and end of the frontostriatal loop, which is part of the executive system. Additional to motor execution, the frontostriatal loop is also involved in planning, control and regulation of somatosensory, emotional and cognitive impulses.

2. frequency: 8.06 Hz
Graph of the independent component of this activity:



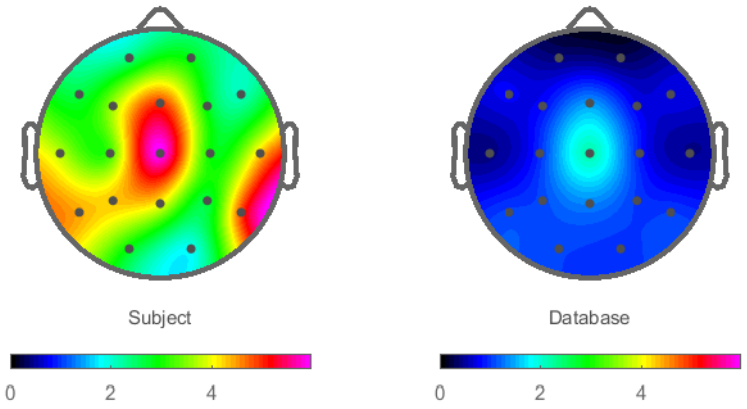
sLORETA localization Brodmann area 10 (Superior Frontal Gyrus, Frontal Lobe)



Brodmann area 10: Is part of the anterior (rostral) prefrontal cortex (PfC) and represents the frontal association area. This area is involved in executive functions by participating in task management, planning and monitoring of actions. In this sense, BA 10 is responsible for adjusting the initial plan according to outcomes, considering several things at a time and integrating external stimuli with internal thought processes.

Theta/Beta-Ratio

The Theta/Beta ratio gives an index as to the quality of an individual's ability to pay attention. This ratio is negatively correlated with age, as it is expected to be larger in younger children, smaller in adulthood and rises again in later adulthood. This is measured in a GO/NOGO Test where it is expected that a higher ratio will produce more errors. This ratio has been demonstrated in the research of Monastra (Monastra et. al., 1999).



Version	v01	v01	v01
Eyes open	**Fz**	**Cz**	**Pz**
Subject (Stanine)	**2.23** (99.3% | 9)	**2.35** (99.2% | 9)	**1.9** (97.9% | 9)
Eyes closed	**Fz**	**Cz**	**Pz**
subject (Stanine)	**2.72** (99.9% | 9)	**2.8** (99.9% | 9)	**2.5** (99.2% | 9)
VCPT	**Fz**	**Cz**	**Pz**
Subject (Stanine)	**2.17** (97.7% | 9)	**2.15** (96.2% | 9)	**1.61** (85.2% | 7)

Theta/beta ratios are significant increased in all conditions.

Arousal

This index represents the arousal caused by the vegetative nervous system. It is specifically the parietal and occipital branch projected from the insula to the respective regions. The index is calculated separately for each hemisphere. The patient's index is set in bold; the arousal index of the age group is shown in parentheses. Scientific papers on this index are being prepared. Preliminary results show that this index hints at patient's level of apathy, lethargy, unrest, and stress. The higher the value, the higher the inner unrest.

Version	v10	v10
Eyes open	**O1 relative Left hemisphere**	**O2 relative Right hemisphere**
Subject (stanine)	**4.47** (29.4% | 4)	**4.82** (35.8% | 4)
Eyes closed	**O1 relative Left hemisphere**	**O2 relative Right hemisphere**
Subject (stanine)	**4.32** (76.6% | 6)	**3.12** (60.5% | 6)
VCPT	**O1 relative Left hemisphere**	**O2 relative Right hemisphere**
Subject (stanine)	**7.86** (90.0% | 8)	**6.97** (80.1% | 7)

Arousal in relationship to focusing

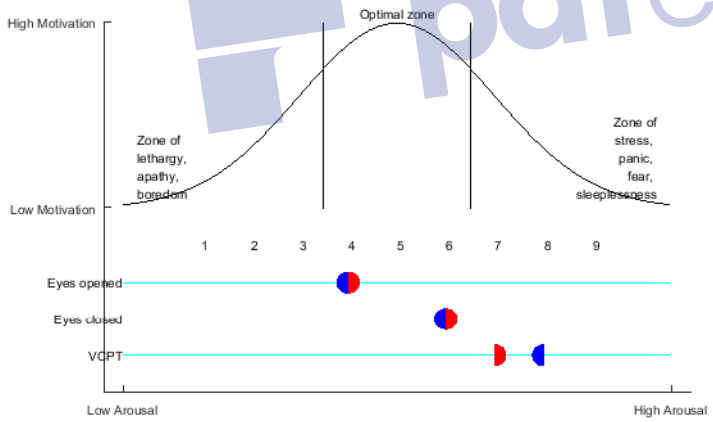
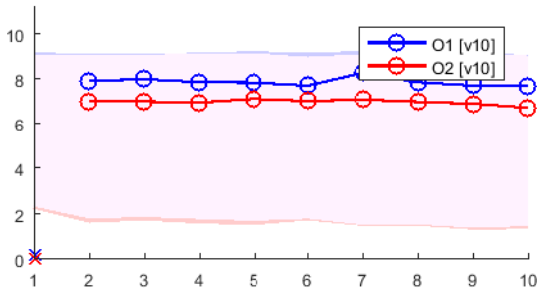


Figure 1: Arousal-Index of the left hemisphere (blue) and the right hemisphere (red) in eyes opened, eyes closed and VCPT.

During eyes opened as well as during eyes closed, the index shows balanced values for Keegan Hull. During VCPT, the index is increased. Increased arousal is associated with fear and stress. Typically, this leads to avoidance behavior.

Arousal modulation during VCPT

A VCPT recording lasts around 21 minutes. This data was split into 10 equally long epochs, with each epoch lasting for around 125 seconds. Arousal was measured for each epoch. Left hemisphere (O1) and right hemisphere (O2) were recorded separately.

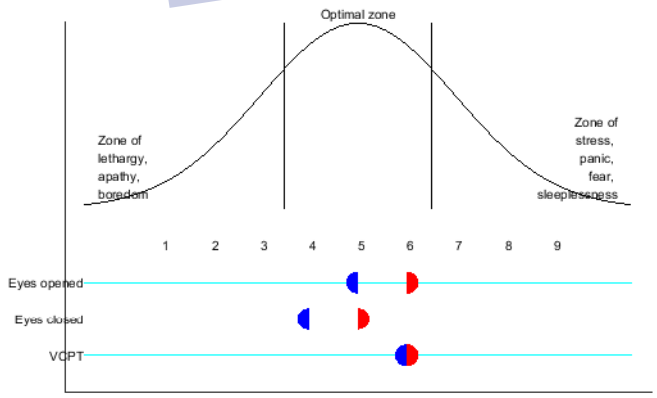


For Keegan Hull, both hemispheres are synchronized.

Central-sensory Index (relative power, beta-gamma squared); CSI

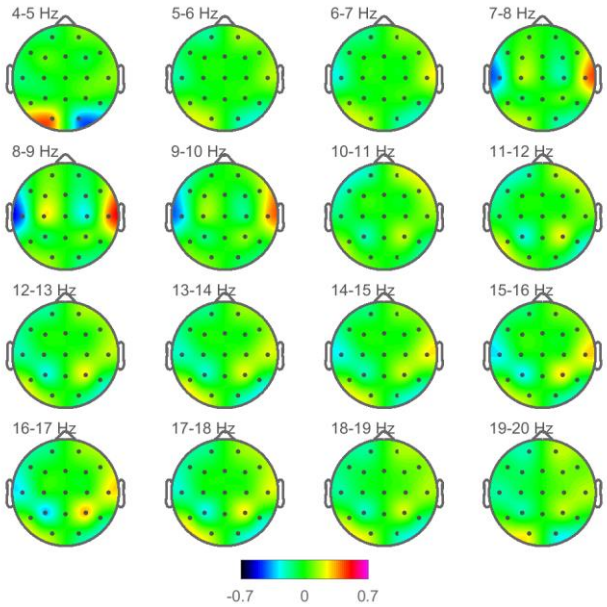
The central sensory index reflects the organization and functioning of the somatosensory areas. They receive information from many different systems: thalamic nuclei, basal ganglia, limbic system and cingulate system. Functionally, the CSI gives clues to the way of processing: low values are associated with increased introspection/introversion, high values with increased external orientation or extraversion. In children, the CSI provides important information regarding processing in a stimulus-intensive context. In adults, essential indications on the dimension anxiety/internal excitement can be obtained. The scientific publication is still pending.

Version	v02	v02
Eyes open	**Left hemisphere**	**Right hemisphere**
Subject (Stanine)	**-9.47** (49.1% | 5)	**-8.76** (61.1% | 6)
Eyes closed	**Left hemisphere**	**Right hemisphere**
Subject (Stanine)	**-13.3** (23.5% | 4)	**-11.57** (50% | 5)
During VCPT	**Left hemisphere**	**Right hemisphere**
Subject (Stanine)	**-8.09** (65.9% | 6)	**-7.74** (71.7% | 6)

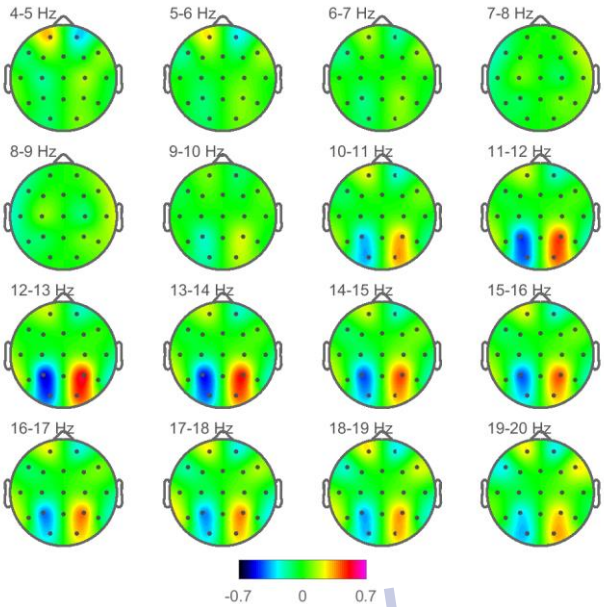


Asymmetry

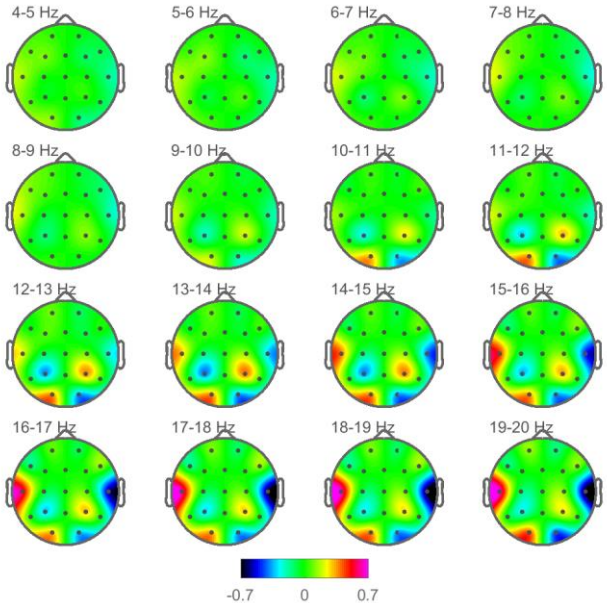
Asymmetry eyes closed:



Asymmetry eyes open:



Asymmetry VCPT:

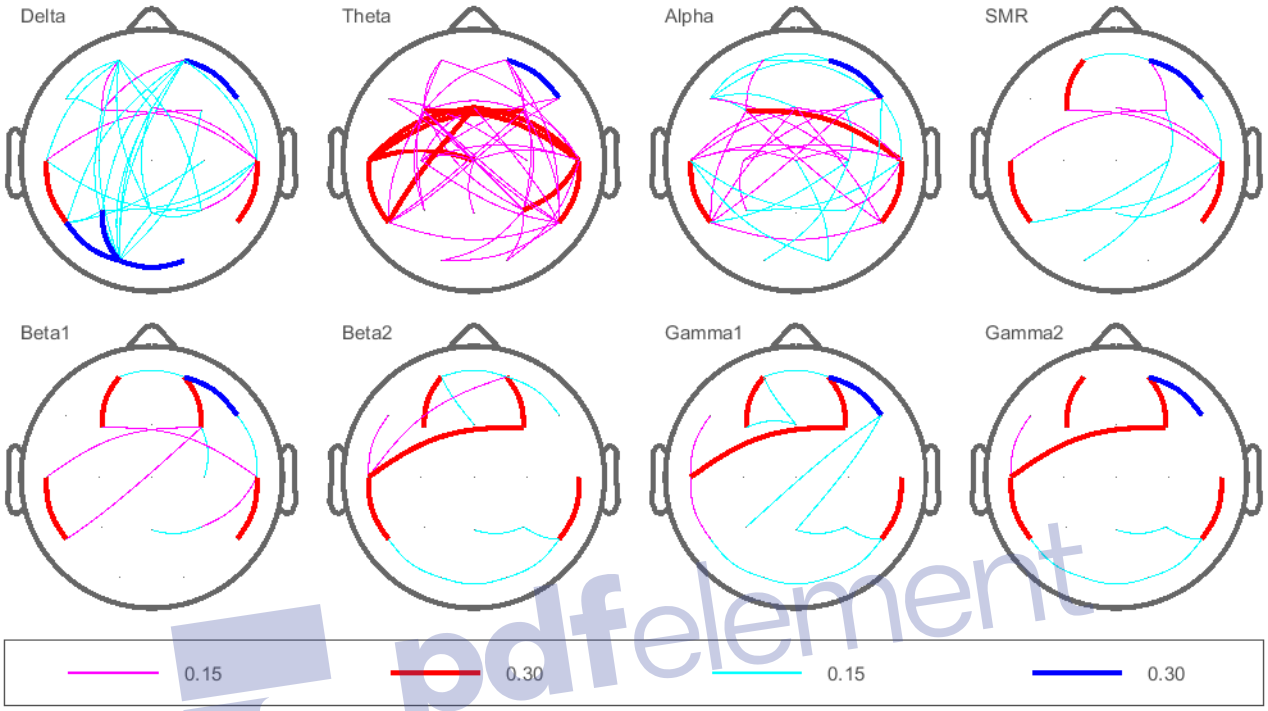


Without significant findings

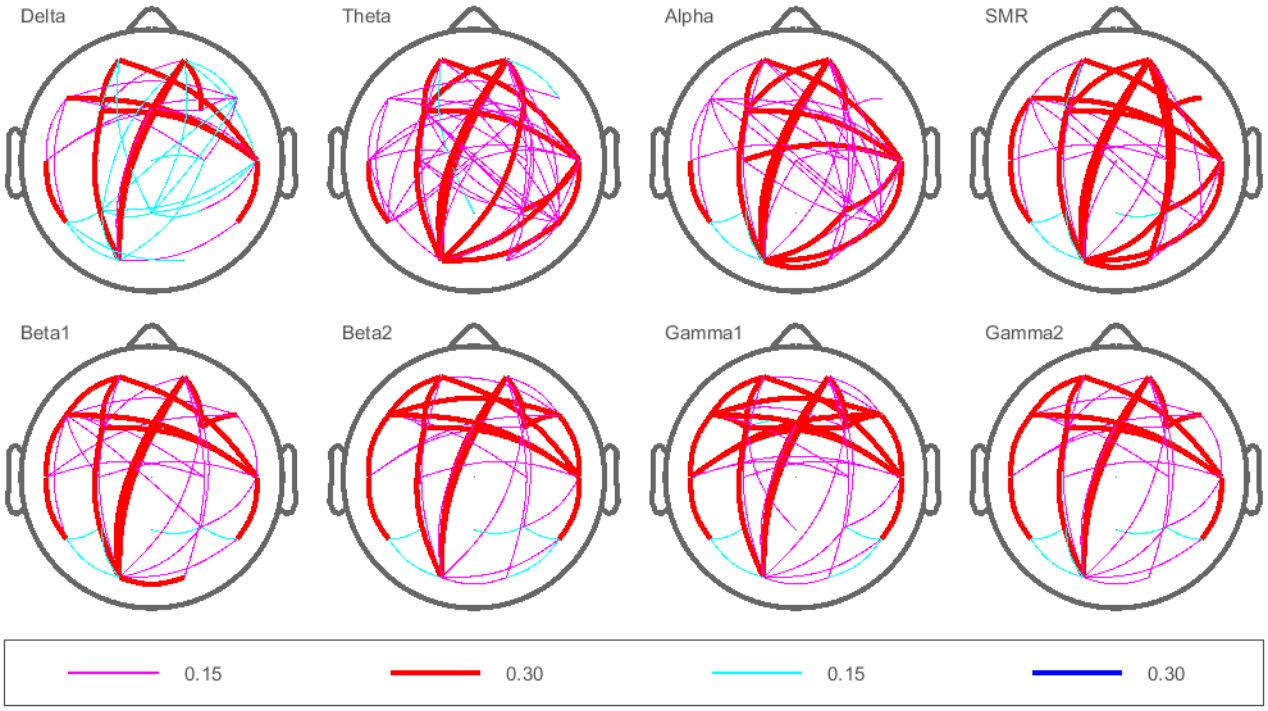
Coherence

The coherence analysis is a measure of the relationship of various structures in the cortex. The coherence analysis provides a ratio of the correlation of a specific frequency range. Violet and red lines represent excessive positive correlations, light blue and dark blue lines represent excessive negative correlations. Excessive positive correlations suggest that there is over-communication between the sites. Excessive negative correlations suggest that there is a lack of communication between the sites.

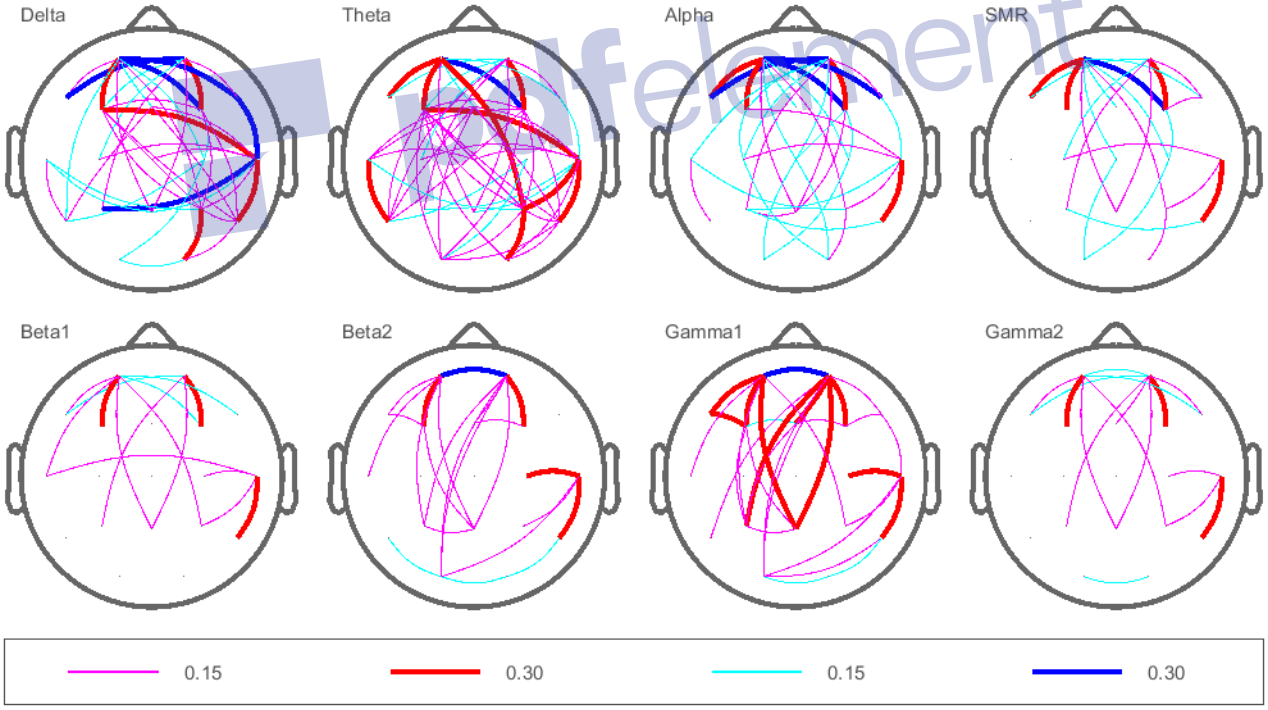
Coherence in eyes closed condition:



Coherence in eyes open condition:



Coherence in VCPT condition:



Without significant findings

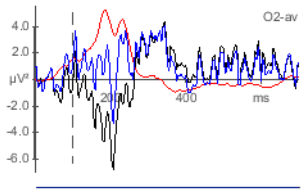
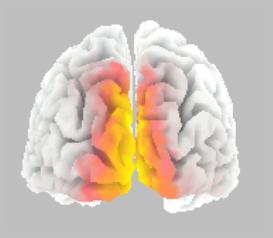
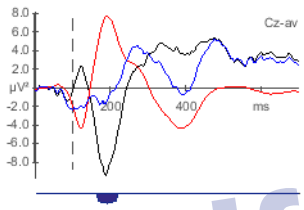
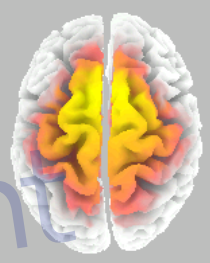
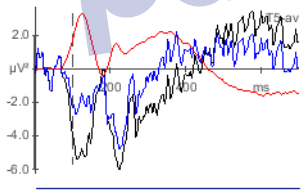
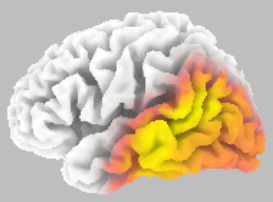
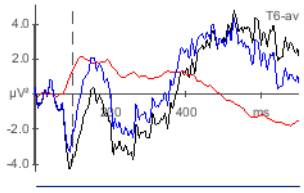
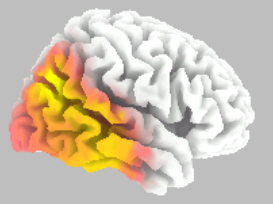
3. Evoked Potentials (in continuous performance task)

The images of the evoked potentials are relevant to information processing in different regions of the brain during the presentation of simple stimuli. In the various potentials, only specific neuronal groups and networks are involved.

Comparison of the components with database:

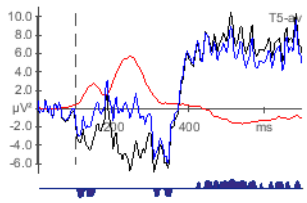
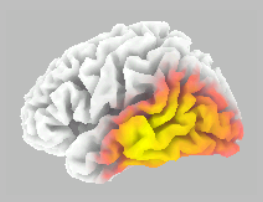
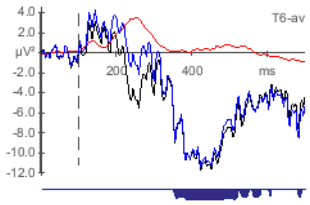
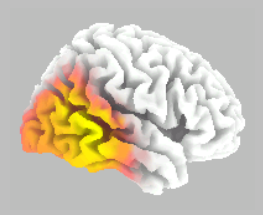
Input areas:

blue: client/red: database/black: difference (significance)

P1N1 Visual Input		*Brodmann area 19* *Cuneus* *Occipital Lobe* *Best Match at 5mm* *Brodmann area 18* *Cuneus* *Occipital Lobe*	
N1P2 Auditory Novelty		*Brodmann area 6* *Superior Frontal Gyrus* *Frontal Lobe* *Best Match at 17mm* *Brodmann area 8* *Superior Frontal Gyrus* *Frontal Lobe*	
P1N1 vTL left Association areas		*Brodmann area 22* *Superior Temporal Gyrus* *Temporal Lobe* *Best Match at 7mm* *Brodmann area 40* *Supremargial Gyrus* *Temporal Lobe*	
P1N1 vTR right Association areas		*Brodmann area 39* *Angular Gyrus* *Parietal Lobe* *Best Match at 9mm* *Brodmann area 40* *Inferior Parietal Lobule* *Parietal Lobe*	

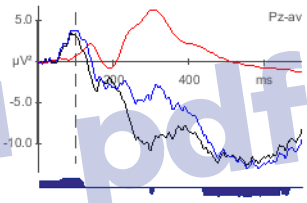
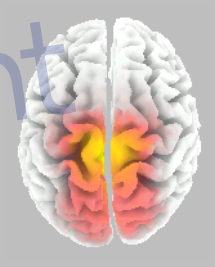
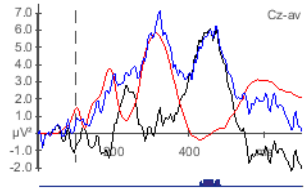
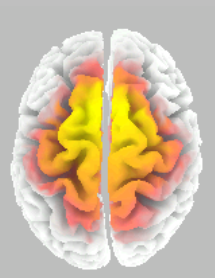
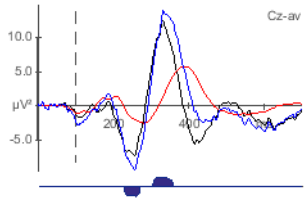
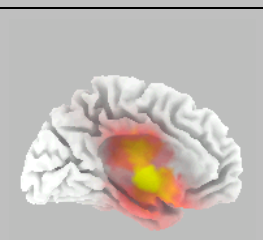
Memory areas:

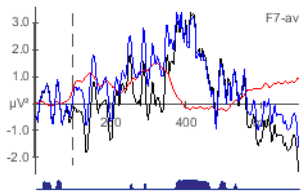
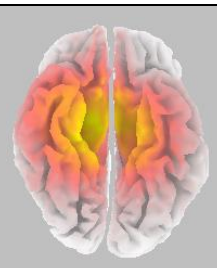
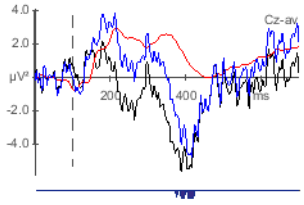
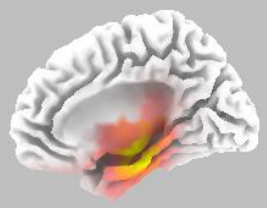
blue: client/red: database/black: difference (significance)

V com TL left Memory areas		*Brodmann area 21* *Middle Temporal Gyrus* *Temporal Lobe* *Best Match at 7mm* *Brodmann area 22* *Middle Temporal Gyrus* *Temporal Lobe*	
V com TR right Memory areas		*Brodmann area 21* *Middle Temporal Gyrus* *Temporal Lobe* *Best Match at 5mm* *Middle Temporal Gyrus* *Temporal Lobe*	

Executive function areas:

blue: client/red: database/black: difference (significance)

P3b Engagement		*Brodmann area 6* *Medial Frontal Gyrus* *Frontal Lobe* *Best Match at 5mm* *Brodmann area 5* *Paracentral Lobule* *Frontal Lobe*	
P3a Inhibition/Suppression		*Brodmann area 6* *Superior Frontal Gyrus* *Frontal Lobe* *Best Match at 17mm* *Brodmann area 8* *Superior Frontal Gyrus* *Frontal Lobe*	
P4 monCC Monitoring		*Brodmann area 25* *Anterior Cingulate* *Limbic Lobe* *Best Match at 15mm* *Brodmann area 34* *Subcallosal Gyrus* *Frontal Lobe*	

P4wmF Working Memory		*Brodmann area 34* *Parahippocampus Gyrus* *Limbic Lobe* *Best Match at 5 mm* *Brodmann area 28* *Parahippocampal Gyrus* *Limbic Lobe*	
SW PHC Slow Wave Activity This component reflects a part of limbic system activity		*Brodmann area 28* *Parahippocampal Gyrus* *Limbic Lobe* *Best Match at 5 mm* *Brodmann area 34* *Parahippocampal Gyrus* *Limbic Lobe*	

Shown are various deviations from the norm:

N1P2 - Auditory Novelty:
Mid potentials: Low amplitude (negative &positive)

V com TL - left Memory areas:
Early potentials: Low amplitude (negative &positive)
Mid potentials: Low amplitude (negative &positive)
Late potentials: Long-lasting high amplitude

P3b - Engagement:
Mid potentials: Low amplitude (negative &positive)
Late potentials: Long-lasting negativity

P3a - Inhibition/Suppression:
Late potentials: Reactivation

P4 monCC - Monitoring:
Mid potentials: High amplitude (negative &positive)

N1P2 - Aud. Novelty

The Novelty stimulus is a good indicator of reactions towards unexpected auditory stimuli. During the task this stimulus is presented in 100 trials together with the picture of a person, but no behavioral reaction is required.

Mid potentials

Low amplitudes indicate low activation of involved cortical networks. This could indicate an inability to activate simultaneously two sensory channels/modalities (auditory-visual) or a reduced sensitivity to perceived auditory input.

V com TL - Left memory areas

The memory areas in left superior temporal cortex and left parietal cortex store information from association areas. These processes are influenced by frontal control functions. The process that happens in memory areas is partially identical to what happens in association areas, namely comparison operations that aim at recognizing percepts. The process of recognition is influenced by time and content.

Understanding and learning is possible because of memory retrieval. According to brain lateralization research, the functions that are attributed to the left hemisphere in terms of memory are involved in the following skills: **Speech, reading, writing and detail-oriented calculation. The left hemisphere is also relevant for speech comprehension and detail-oriented listening.**

Early potentials

The activity of left **early** potentials is related to sensory processing functions that are not under cognitive control and probably are triggered by excitatory mechanisms of sensory registration.

In Keegan Hull, low amplitudes in early potentials of left comparison processes are observed. This leads to inadequate activation. In other words, left comparison processes are being overridden. This generally leads to decreased detail-oriented information processing.

Mid potentials

Mid potentials of the memory areas relate to sensory-cognitive processing functions; the main goal of these is sustaining memory retrieval operations. By maintaining the energy in memory areas, the mid potentials are formed, this is why these are associated with attention processes.

Low amplitudes in mid potentials of left memory areas indicate that sensory-cognitive functions of the aforementioned skills proceed less intensely. This leads in Keegan Hull to a decreased detail-oriented memory retrieval, which is usually associated with insufficient monitoring.

Late potentials

Late potentials of comparison operations are related to control of one's own performance and are affected by emotional factors like security or insecurity. Emotional regulation is in this way essential for the outcome of retrieval processes.

In Keegan Hull, long lasting high amplitudes in late potentials of left sided comparison operations are observed. This is associated with high activation of left sided monitoring processes which is usually associated with a high degree of control and meticulous behavior in everyday life. This leads to exhaustion over time.

P3b - Activation operation

Executive functions/activation: There are two kinds of activation that are regulated by the Reticular formation: tonic and phasic activation. The tonic system of the reticular formation regulates through the hypothalamus the excretion of (nor-)adrenalin and serotonin neurotransmitters, what leads to long lasting tonic activation and modulation of cortical activity, e.g. influencing the day-night cycle.

The center of the phasic system is located in the medial thalamus and is responsible for short-term activation of singular parts of the cortex, what is basically the activity we are measuring. Reticular structures are thin layers that cover the thalamic nuclei of sensory organs that send projections to the cortex. Non-specific reticular structures are activated here through convergent sensory pathways. The thalamus works as a switchboard of information and has a less general effect upon the cortex compared to the reticular formation; instead, the thalamus exerts a selective effect upon specific cortical areas, being able to concurrently activate some areas and shielding others.

The activation operation is relevant as it enables goal-oriented performance. Hereby the cortex is optimally activated in order to achieve the desired goals. We differentiate among early, mid and late phases of activation.

Mid potentials

Mid potentials of the activation operation relate to sensory-cognitive processing functions, which aim at achieving specific goals. Maintaining the level of energy for other functions (perception, memory, monitoring) is the basic element of mid potentials of the activation operation.

Low amplitudes of mid potentials in the activation operation are usually related to low energy expenditure to achieve goals. The origin could be a general state of under activation or a decreased goal-oriented behavior in everyday life.

Late potentials

Late potentials of activation operation contain both a phasic and a tonic part. The tonic activation is related to the general activation and readiness to respond of the cortex. Emotional regulation is also relevant to the activation of late potentials.

Long lasting negativity of the activation operation in late potentials is usually related to decreased level of inner involvement.

P3a - Inhibition/Suppression

Executive functions/inhibition/suppression/selection: This function is highly relevant not only for motor and cognitive (perceptual) control, but also for emotional behavior. Inhibition is a fundamental function of neuronal networks, which regulate the planning, execution and control of different processes. These functions are involved in all processes as inhibition (suppression) of processes represents a fundamental part of neurobiological networks. The **Inhibition** phenomenon works by influencing a neuron through an impulse that prevents the occurrence of an action potential, meaning that it impedes the firing of the neuron. Synaptic inhibition can occur be either pre- or postsynaptic inhibition. This inhibition function is localized in the fronto striatal loop (cortex-basal ganglia-thalamus-cortex).

Late potentials

Late potentials of suppression and inhibition are influenced by emotional parts that are integrated in decision processes. The monitoring function is also involved.

Reactivation of suppression and inhibition process during information processing is a sign of difficulties in the course of selection processes. This applies also to decision making processes.

p4 monCC - Conflict monitoring

Executive functions/Monitoring: Like all executive functions, this function is essential for everyday functioning as it enables assessing one's performance and processes. The anterior cingulate cortex occupies about 2/3 of the medial surface in frontal lobes, located ventral, rostral and dorsal to the corpus callosum: a fiber tract that connects both hemispheres. The anterior cingulate cortex corresponds to the Brodmann areas 24, 25 and 32. In the context of executive functions the anterior cingulate cortex is involved in conflict solving between competing responses and arbitrary selection of action alternatives. Furthermore, this structure is involved in learning processes together with basal ganglia, assessing different action alternatives according to relevance. Within the anterior cingulate cortex two parts can be further differentiated: a rostral-ventral area that becomes activated in response to emotional conflicts, and a dorsal area that is more related to controlling cognitive functions. Even if this function is not entirely clear yet, it can be said that through this network a comparison operation takes place: by comparing one's actual behavior (emotional, cognitive, behavioral performance) with the expected outcomes.

Mid potentials

Mid potentials of conflict monitoring are influenced by different functions of the limbic system and vegetative nervous system. The limbic system proceeds over the amygdala/insula to the hippocampus, and from here to anterior nuclei of the thalamus, influencing the anterior cingulate cortex. According to the definition of the anterior cingulate cortex the functions of mid potentials of this component are defined by the monitoring of different action alternatives.

In Keegan Hull, high amplitudes in mid potentials of conflict monitoring are observed. High amplitudes in mid potentials indicate high activation of limbic energy during appraisal of action alternatives. Monitoring is collaterally affected by inner stress.

4. Event related potentials - ERPs

Total number of trials: **400** (a-a GO: **100**, a-p NoGO: **100**, p-p: **100**, p-h: **100**, +: **200**, -: **200**)
Number of processed trials: **386** (a-a GO: **94**, a-p NoGO: **96**, p-p: **98**, p-h: **98**, +: **190**, -: **196**)

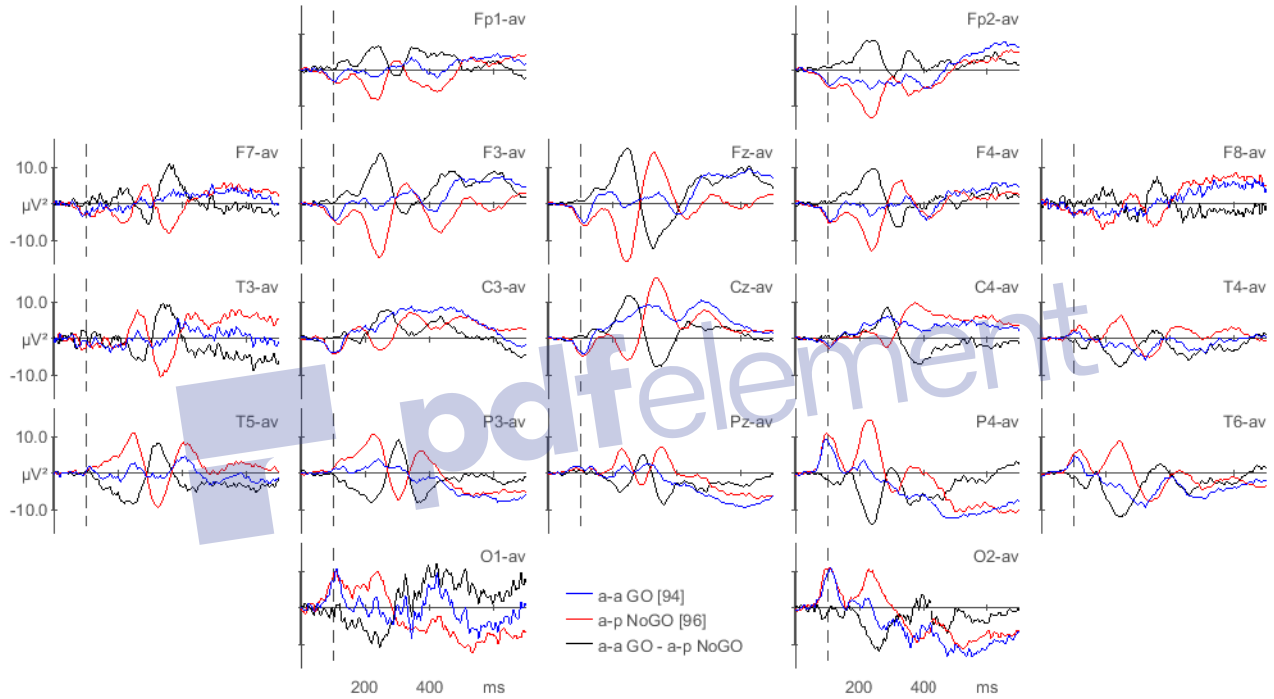
ERP Components

Comparison of the client's GO and NoGO ERPs computed for the second stimulus.

ERPs in the GO-NoGO task computed for GO, NoGO stimuli and ERP differences (GO- NoGO) are presented below.

blue: GO/red: NoGO data/black: difference curve (GO-NoGO)

GO-NoGO:



Differences between GO-condition and NOGO-condition are observed in central cortex and superior temporal cortex. This indicates an ability to perceptually discriminate different situations.

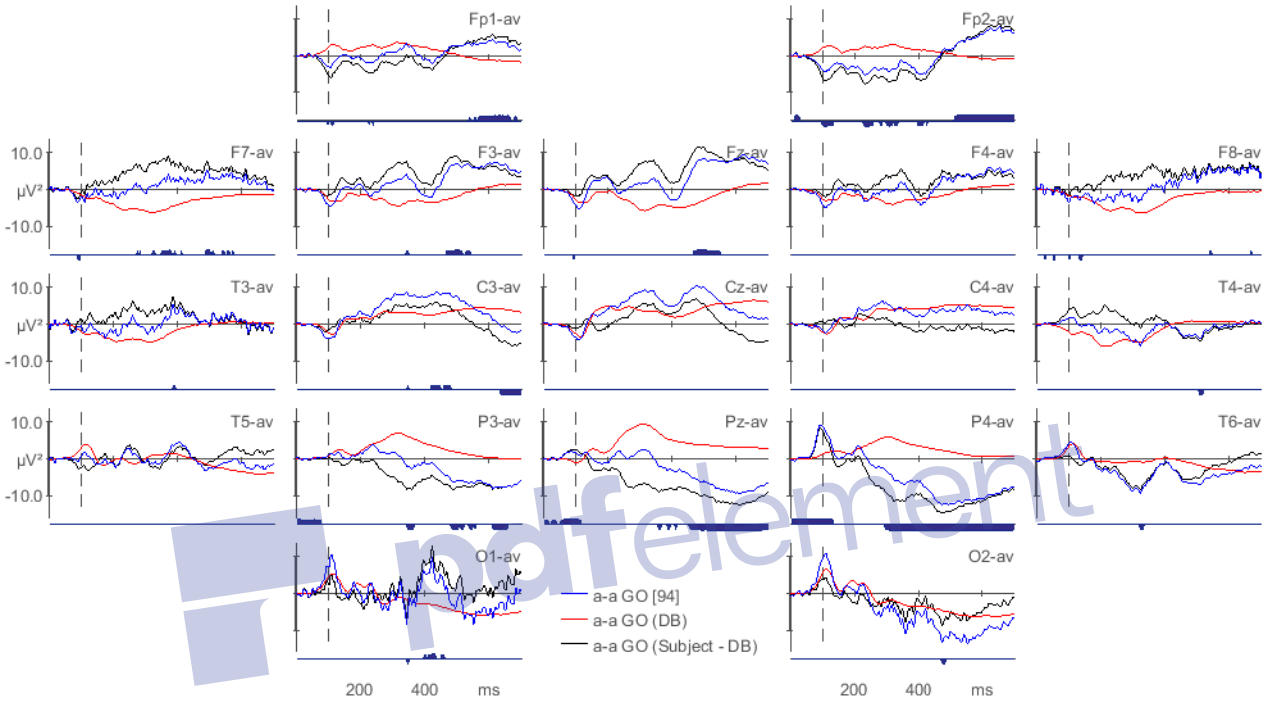
Simple ERPs

Comparison with the normative ERPs computed for the second stimulus.

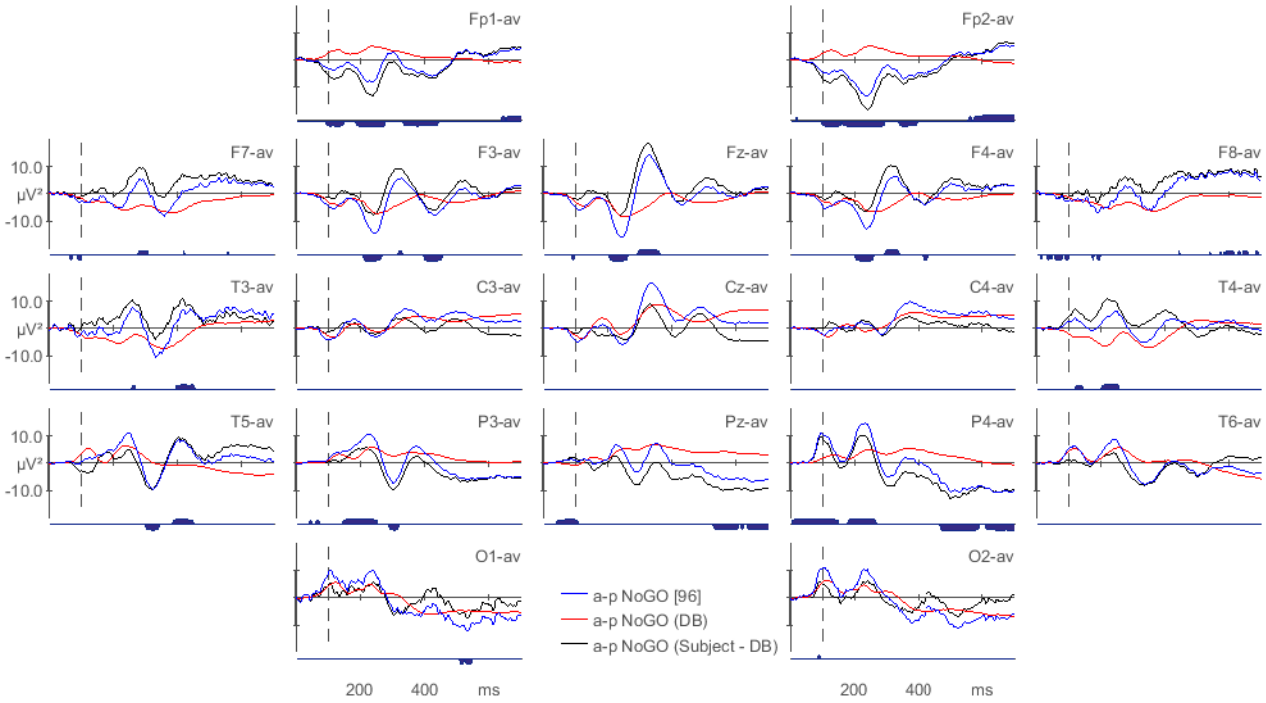
ERPs in the GO-NoGO task computed for GO, NoGO and Novelty (p-h) stimuli are presented on the next pages.

blue: subject/red: reference data/black: difference curve (significance)

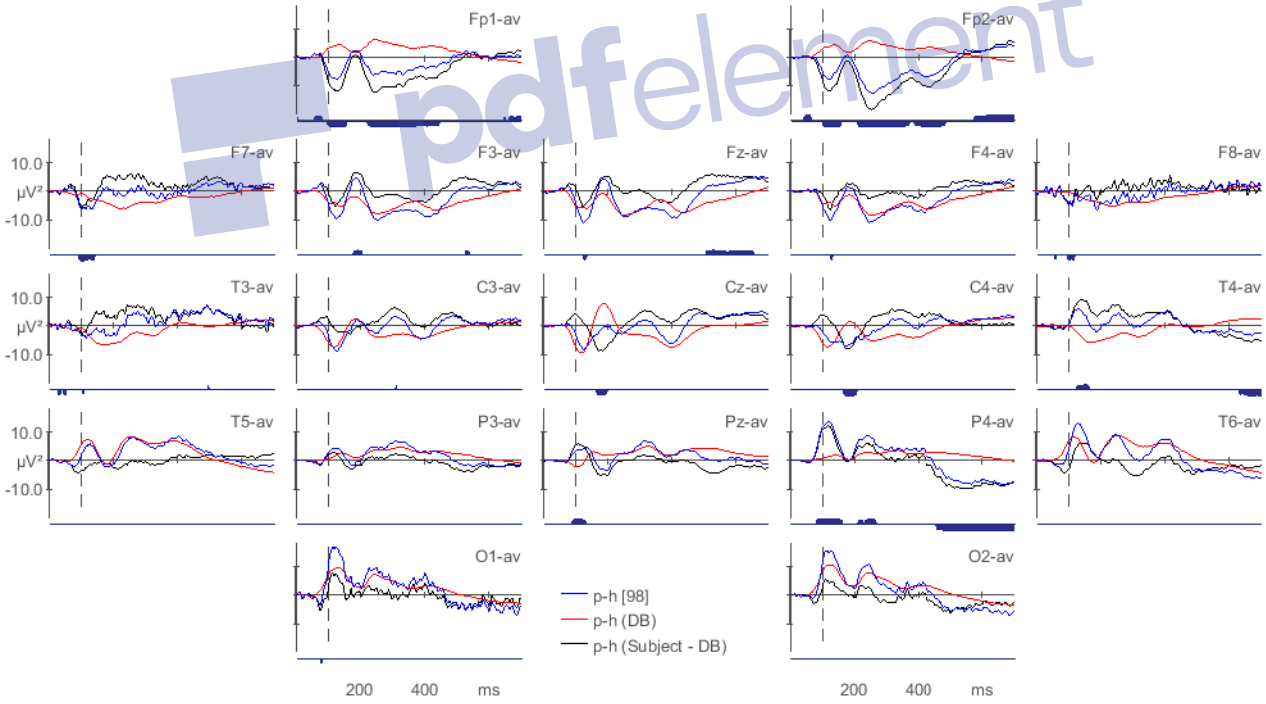
GO condition:



NoGO condition:



Novelty condition (p-h):



5. Diagnostic-Algorithms

According to the medical tradition, a diagnosis is to be made on the one hand by the reported suffering of the patients and, on the other hand, by evidence-based, objective diagnostic procedures. Focusing on neurophysiological characteristics implies that norms have been defined by a meticulous method according to scientifically recognized criteria and compared with patient groups. The patients included in the patient groups were all diagnosed by the usual criteria of the diagnostic and statistical manual (gold standard) as well as by experts. This allows a reliable definition of the patient group and its subtypes.

Psychopathology varies according to age and shows different characteristics depending on age group. Therefore, the patient groups must be divided into age groups. For each age group, the corresponding biomarkers are calculated and validated within the age group. This is done according to the following procedure: several hundred patients from several patient groups were subjected to standardized scientific examinations. This affects patient groups to attention disorders, learning disabilities, autism, depression, schizophrenia, obsessive-compulsive disorder, slight traumatic brain injury and stress disorders (patients after heart attack). For each of these patient groups, algorithms are developed for various age groups using complex statistical methods (big data, learning machines). For each individual patient, the probability of matching to the different patient groups can therefore be calculated using the algorithms. So far, there are algorithms for attention disorders as well as stress disturbances. Further algorithms follow 2017/2018.

Such an extended approach can provide support for diagnostics and statements regarding sensitivity and specificity. The probability of the diagnosis being accepted in percentages is calculated and output in the individual case. It is recommended that these markers be clinically validated in individual cases. However, the result of the algorithm comparison is not the clinical diagnosis!

It is clinically evident that diagnoses are a generalization and thus always an approximation to the actual, individually very different processes and circumstances of the individual humans. This is currently the best possible representation of a membership of a patient group. Our data, which are not yet used in clinical studies so far, help to better characterize the characteristics and to differentiate between the subtypes with consequences for prognosis and therapeutic measures, which is a step closer to the individual as a matter of fact. To this extent, it must also be emphasized once again that the information of the neurophysiological constellations represents a complementary mosaic piece of the findings which extends the previous diagnostics. It is also clear that the demarcation to other patient groups is necessary. This will be all the more possible, the more algorithms of other patient groups are present and the patient's affiliation to existing patient groups can be defined as precisely as possible. It is also clear that the quality of the algorithms is closely linked to patient numbers and patients in general. The higher the number of patients, the clearer the patient's diagnosis, the better the algorithms. Since the present algorithms are dynamic variables, they will be constantly updated over time.

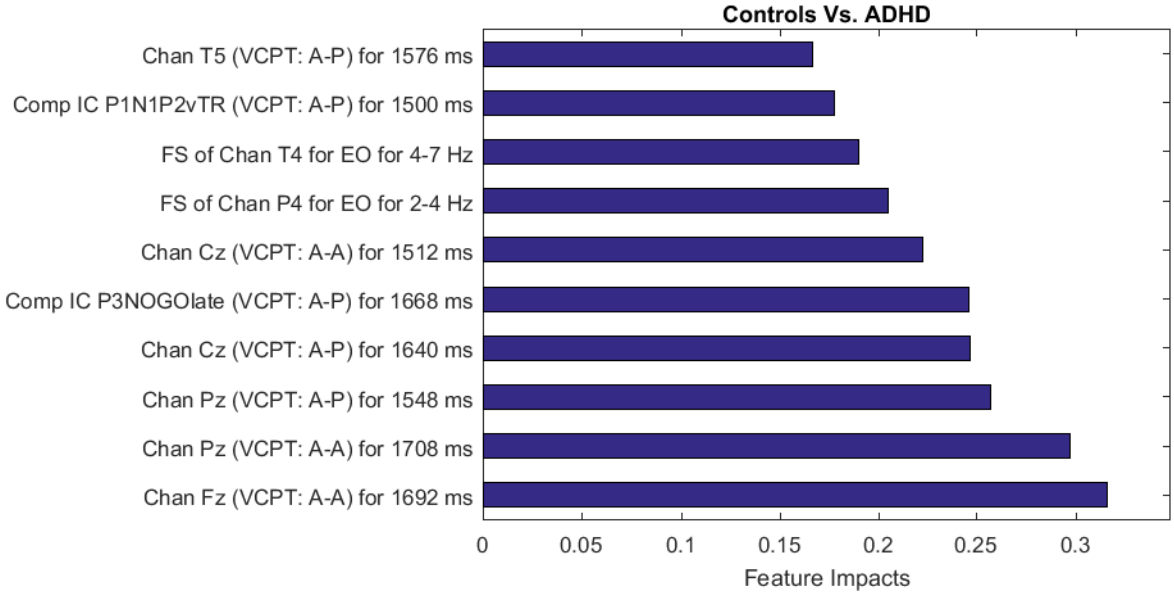
A. ADHD-Diagnose-Index

The ADHD algorithm or ADHD index was realized in the context of the CH-ADHS project on three different samples. The following algorithm was used: Regularized Logistic Regression.

belongs to the age group 12 - 18.

The following probability of belonging to this group is shown:

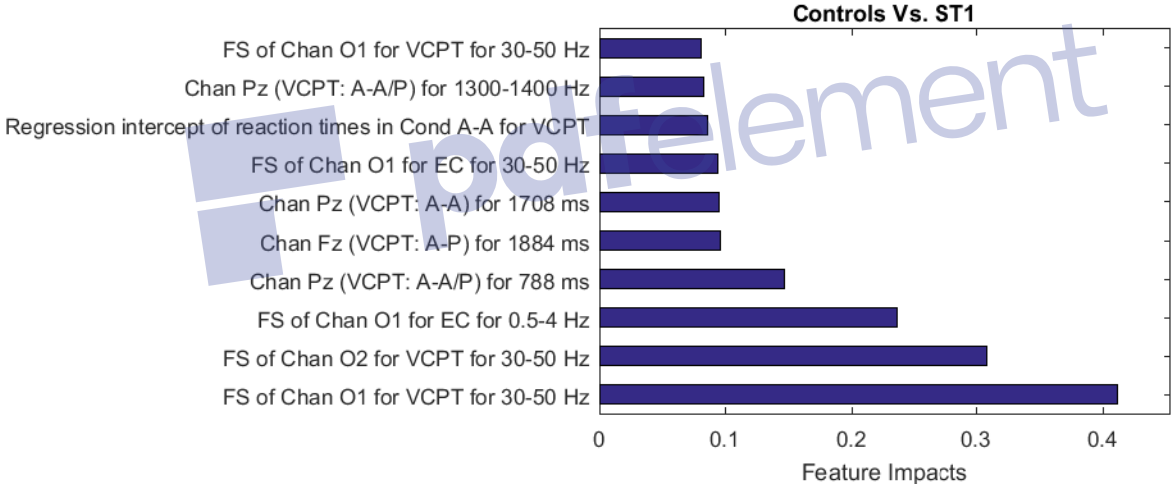
ADHD: 96%



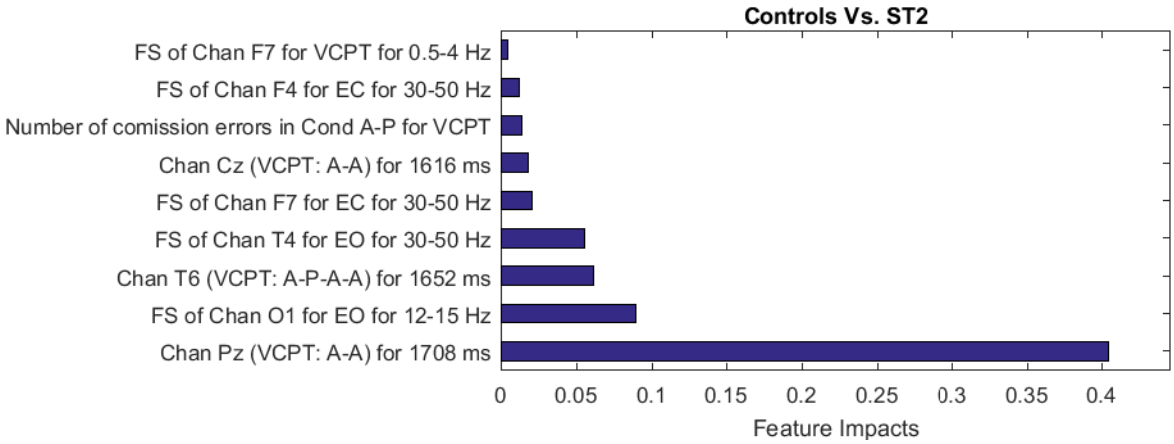
Subtypes

[description]

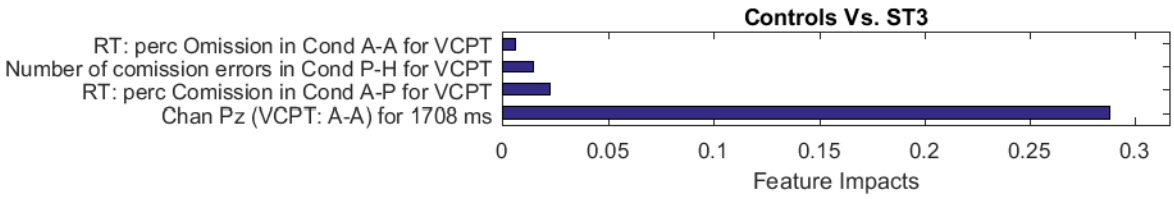
ST1: 91%



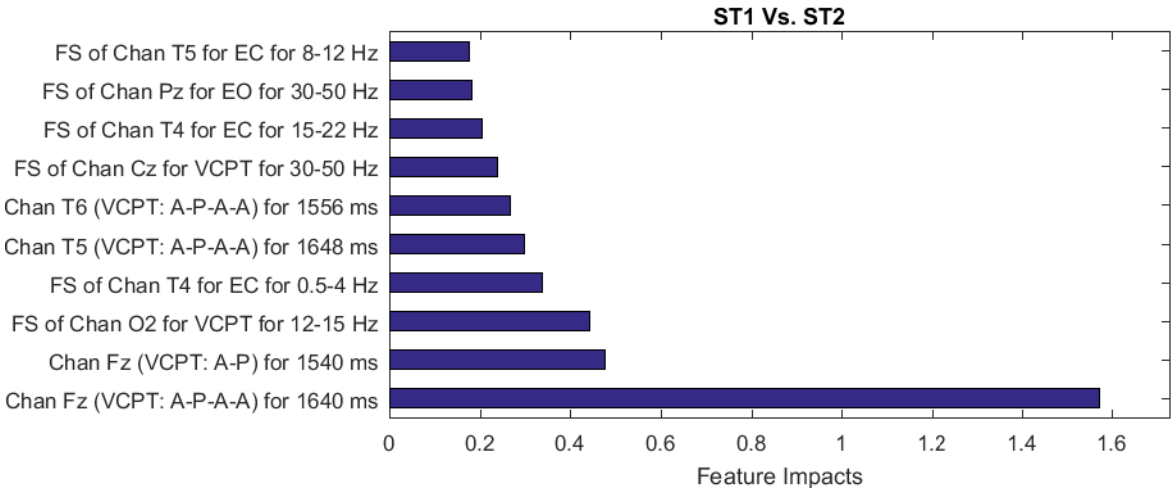
ST2: 43%



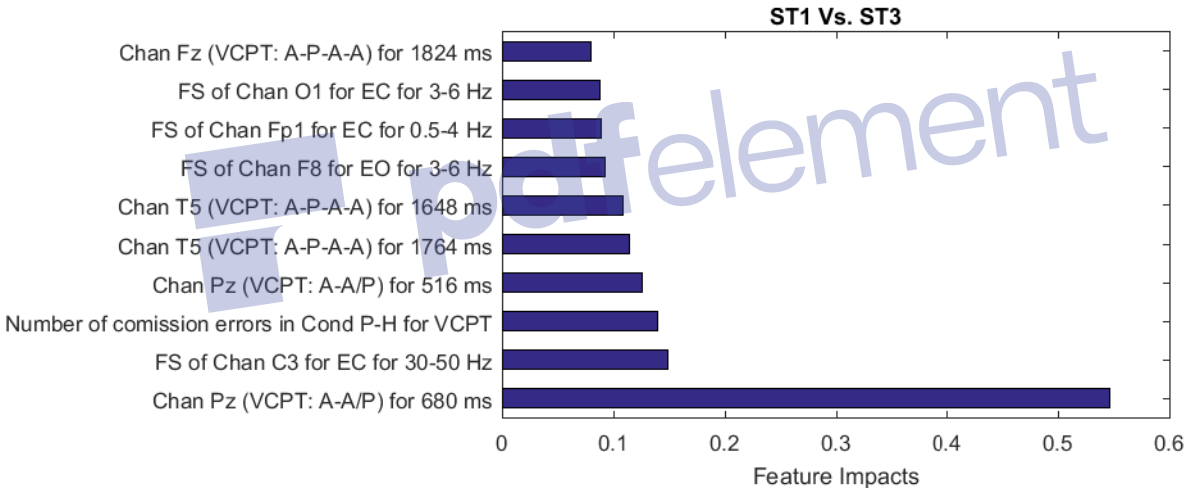
ST3: 41%



ST2 (ST1vsST2): 15%



ST3 (ST1vsST3): 54%



V. Recommendations

We would like to point out that the therapeutic approach must be holistic and include various aspects of life. This means that in addition to cognitive, behavioral and emotional aspects, a person's physiology must also be considered. An all-inclusive change strategy is beyond the scope of this report. However, we believe that difficulties must be addressed in a multi-modal approach that takes into consideration a variety of aspects involved in the individual. The recommendations that follow seek to do that within the scope of the information provided by the results of this evaluation.

1. Medication

These medication recommendations are based merely on the reported neurobiological parameters. Different people react differently to medication. Side effects are especially hard to predict. The responsibility for any given medication lies in the hands of the prescribing medical doctor.

It is difficult to make medication recommendations as Keegan is currently taking medications that may be impacting the EEG. With that in mind, theta activity typically responds to psychostimulants and slower frequency frontal alpha has been reported to respond better to amphetamine-based stimulants such as Adderall or Vyvanse. A norepinephrine reuptake inhibitor such as Strattera may also be helpful.

2. Everyday Life/School

General statement: Our basic principle is that a high degree of neurobiological change is possible. Thanks to worldwide, intensive research in the field of neuroplasticity, we know that new neuronal connections can be formed in every area if the right information is given. Personalized interventions are listed which are based on research and rated highly as potential facilitators of change.

Daily Life: will benefit from incorporating as much routine and structure into his day as he can. For example , routines can be instituted for waking in the AM, around meals, times for academics, pre-sleep routines, household chores, etc. It may take discipline to follow the routines initially, but once they become actual routines, life will become easier, better organized and more efficient. It will also put less strain on his brain .

Sleep: Sleep can reportedly be an issue. These results do indicate a relatively high level of drowsiness in the day the recordings were obtained. This could be suggestive of a general issue with his getting enough good quality sleep. It will be important to review and implement sleep hygiene practices. More information can be found on the Sadar Psychological Services website (https://sadarpsych.com/take-care-of-your-brain/sleep/). Sleep is expected to improve with good sleep hygiene and biofeedback.

Diet: He may benefit from increasing calories and protein. The following guidelines are offered for consideration. There is considerable science suggesting that a diet higher in protein (leaner meat, eggs, fish and dairy products) and lower in simple carbohydrates (sugar, rice, pasta, potatoes, flour and bread) improves concentration and general brain function. Meals that are primarily simple carbohydrates (breakfast cereal, pastry, pasta, French fries, etc.) cause an initial rapid surge in blood sugar making the individual more hyperactive. Soon thereafter, there is a rapid fall in blood sugar leading to mental fatigue. Meals with more protein and complex carbohydrates (vegetables, fruits and whole grains) keep blood sugar more stable, give steady energy and reduce chances of storing excess fat.

There is significant evidence that increasing Omega-3 oil benefits learning, helps stabilize mood and helps overall wellness. A good source of this is oily fish such as salmon and tuna, although there is significant

controversy regarding mercury contamination of ocean raised, farm raised and even canned fish. An alternative is fish oil capsules and/or fish oil liquid supplements. These can be found in most health food sections and are not expensive. Our research review shows that fish oils produced in triglyceride form are the best source of Omega-3, when taken as recommended on the bottle. Vitamin D3 is also being recommended by the scientific community as being important for efficient brain functioning. For example, it is a being recommended at the Amen Clinics in addition to Omega-3 fatty acids. It is important to have one's D3 level checked before beginning such supplementation.

Exercise: He reportedly engages is a lot of exercise, but he may benefit from incorporating activities like yoga into his routine.

Drugs/Alcohol: Not reported to be an issue.

Electronic Screen Use: His current usage does not appear to be excessive but keep in mind the general recommendation is to limit screen time to 2 hours per day.

3. Other Recommendations

Psychotherapy: Adolescents with this neurobiological constellation can develop issues with self-confidence, motivation, self- image, etc. If seems to be struggling with anything like this, individual psychotherapy can be helpful. He may also benefit from ADHD coaching.

Biofeedback:

sEMG Biofeedback: sEMG is a measure of the electrical signals produced by the muscles during contraction. Excessive muscle tension is often an indication of over arousal of the central nervous system and can also fuel over activation. Excess muscle tension can contribute directly to numerous symptoms such as chronic headaches and muscle soreness. Given the excessive muscle tension noted during the physiological profile and the EEG recording, several sessions of sEMG biofeedback may be useful to facilitate self-regulation training.

Heart Rate Variability (HRV) is a measure of the beat-to-beat variations in heart rate. HRV is an important indicator of both physiological resiliency and behavioral flexibility, reflecting the individual's capacity to adapt effectively to stress and environmental demands. It is a skill that can be learned and practiced to improve health, performance, and overall well-being. This technique, once learned and practiced, can give Keegan a way to regulate his arousal. The more balance in the autonomic nervous system, the easier it is to concentrate and to control one's emotions and behaviors. If there are any symptoms of panic, incorporating capnography may be helpful.

Neurofeedback: EEG Biofeedback (also called neurofeedback, neurotherapy, or neurobiofeedback) is a type of biofeedback that uses real-time measurements of brainwaves (EEG) to provide a signal that can be used by a person to receive feedback about brain activity, often with a goal of controlling and enhancing central nervous system activity.

During training, sensors are placed on the scalp and then connected to sensitive electronics and computer software that detect, amplify, and display specific brain activity. Resulting information is fed back to the trainee virtually instantaneously with the conceptual understanding that changes in the feedback signal indicate whether or not the trainee's brain activity is within the designated range.

Based on this feedback, changes in brain patterns occur and are associated with positive changes in physical, emotional, and cognitive states. Often the trainee is not consciously aware of the mechanisms by which such changes are accomplished although people routinely acquire a "felt sense" of these positive changes and often are able to access these states outside the feedback session. Generally, trainees do not experience adverse effects.

If EEG-bf is pursued, the following protocols are recommended:

1. C3-C4 (T5-T6 for memory) reward 11-14 Hz (or 12-15 Hz depending on response), inhibit 2-8 Hz and 22-36 Hz.
2. Fz-A1 reward 13-16 Hz (or higher depending on response), inhibit 2-8 Hz and 22-36 Hz.
3. Pz-A2 reward 9-11 Hz, inhibit 6-8 Hz and 22-36 Hz.
4. Infra-Low Frequency training is also a consideration. If pursued the suggested initial sites would be T4-P4.

pirHEG (passive infrared Hemoencephalography): pirHEG involves wearing an infra-red sensor over one's forehead. This allows for the reading and the feeding back of the amount of blood flow occurring in the regions of the prefrontal and frontal lobes. Blood flow is an indication of the amount of metabolic activity. When the metabolic activity in the frontal and prefrontal areas increases, executive brain functioning occurs. Outcomes include improved attention, improved mental flexibility, improved emotional/behavioral control, improved planning and organization, etc. This type of training has been referred to as a type of neurofeedback as it impacts the functioning of the brain. Its' strength, relative to forms of EEG biofeedback, is its focus on frontal lobe functioning.

Home Training Options:

Unyte is a computer software program that you control with your heart rate variability. The program - developed by a team of doctors and spiritual leaders - artfully combines state of the art technology with beautiful visuals, soothing sounds and effective meditation and breathing techniques to help you master your body's natural ability to counter the effects of stressful situations and live a happier, more balanced life. https://unyte.com/ . There are also several apps available for smart phones which can be explored by searching: HRV telephone apps. Two of the better known are Inner Balance and Elite, but there are many others available. These options can be considered if Keegan seems to need ways to facilitate his regular practice of the HRV breathing technique. This is something that needs to be practiced on a regular basis to enjoy the maximum benefits it has to offer.

Fast ForWord is an online training program that can be completed at home. It targets auditory processing, attention and memory. https://www.fastforwordhome.com/

All decisions regarding the implementation of these suggestions are the responsibility of the individual practitioner. I recognize the utility of ongoing consultation and welcome discussion of the clinical progress of individual patients, or related questions and suggestions.

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Licensed Psychological Associate

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Licensed Psychologist

HBImed AG
Brain Diagnostics

Dr. Andreas Müller

VI. Appendix

Amen Questionnaire:
Symptoms rated 'frequently' (3) and 'very frequently' (4):

- Excessive fear of being judged or scrutinized by others (4)
- Poor handwriting (4)
- Easily embarrassed (4)
- Frequent feelings of nervousness or anxiety (3)
- Symptoms of heightened muscle tension (headaches, sore muscles, hand tremor) (3)
- Tendency to predict the worst (3)
- Lacks confidence in their abilities (3)
- Excessive or senseless worrying (4)
- Upset when things do not go your way (4)
- Tendency to be oppositional or argumentative (4)
- Tendency to have repetitive, negative thoughts (4)
- Tendency toward compulsive behaviors (3)
- Trouble shifting attention from subject to subject (3)
- Trouble shifting behavior from task to task (3)
- Difficulties seeing options in situations (3)
- Tendency to hold on to own opinion and not listen to others (3)
- Short fuse or periods of extreme irritability (4)
- Periods of rage with little provocation (4)
- Often misinterprets comments as negative when they are not (4)
- Periods of forgetfulness or memory problems (4)
- Difficulties with memory (4)
- Difficulties to understand a reading text (4)
- Irritability tends to build, then explodes, then recedes, often tired after a rage. (3)
- Period of spaciness or confusion (3)
- Fails to give attention to details or makes careless mistakes (4)
- Trouble sustaining attention in routine situations such as homework, chores, paperwork (4)
- Trouble listening (4)
- Fails to finish things (4)
- Poor organization for time or space such as backpack, room, desk, paperwork (4)
- Forgetful (4)
- Poor planning skills (4)
- Impulsive, i.e. saying or doing things without thinking first (4)
- Difficulty to learn from mistakes. Tends to make same mistakes over and over again. (4)
- Lack clear goals or forward thinking (3)
- Difficulty expressing empathy for others (3)
- Feeling spacey or "in a fog" (3)
- Loses things (3)
- Interrupts or intrudes on others (e.g. butts into conversations or games) (3)
- Negativity (4)
- Forgetful (4)
- Irritability (3)
- Decreased interest in others (3)
- Feelings of hopelessness about the future (3)
- Chronic low self-esteem (3)
- Difficulties with concentration (3)

van Deusen Questionnaire
Symptom intensity rating:

Symptoms rated 'frequently' (6) and 'very frequently' (7):

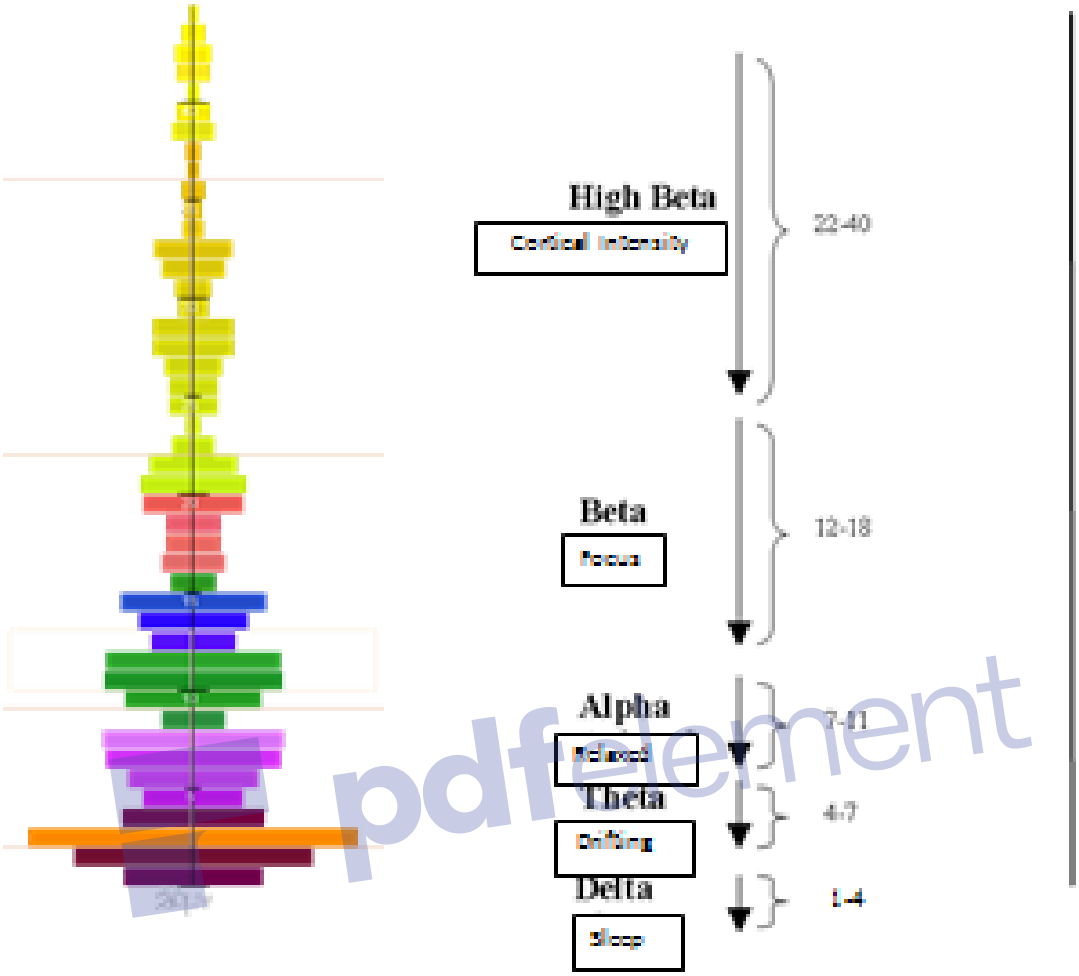
- Forgets tasks/appointments (7)
- Loses/misplaces things (7)
- Disorganized verbal expression (7)
- Difficulty with fine-motor tasks (7)
- Gets stuck with problems (6)
- Doesn't plan (6)
- Doesn't organize tasks well (6)
- Struggles with details (6)
- Makes careless mistakes (6)
- Poor listener (6)
- Starts but doesn't finish (6)
- Negative and unhappy (6)
- Uncomfortable socially (6)
- Poor self-image (6)
- Writes poorly (6)
- Makes grammar/punctuation errors (6)
- Compulsive repetition of speech or behaviors (6)
- Argues for the sake of arguing (6)
- Poor temper control (6)
- Blames others (6)
- Impulsive actions (6)
- Argumentative/gets into fights (6)
- Interrupts often (6)
- Speaks without thinking of others' feelings (6)
- Overreacts to anger-provoking situations (6)
- Messy handwriting (6)
- Clumsy, breaks or bumps into things (6)
- Never satisfied with performance (6)
- Difficulty repeating what has been said (6)
- Difficulty following spoken instructions (6)
- Hard time following discussions (6)
- Quickly forgets heard information (6)
- Reads slowly for age (6)
- Difficulty reading at appropriate level (6)
- Can't repeat or explain what was just read (6)
- Difficulty with comprehension of read material (6)
- Overreacts to anger-provoking situations (6)

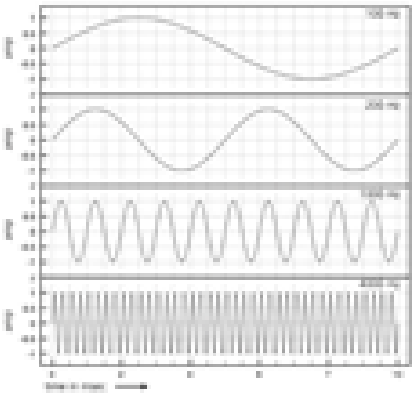
ADHD-Questionnaire:
Summary of high and very high rated behaviors (🔵 Attention, 🔴 Hyperactivity/Impulsivity, 🟢 Emotion regulation und 🟡 Over Focusing):

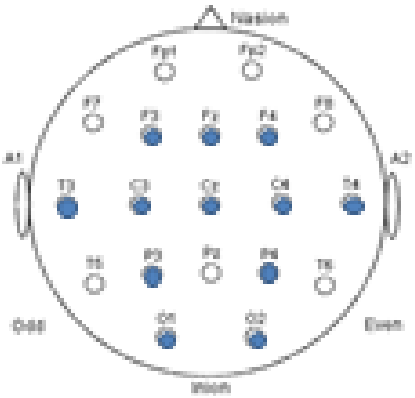
- 🔵 miss details or makes careless mistakes in work (e.g. overlook or disregard of details) (4)
- 🔵 has trouble to maintain attention in tasks or play activities for a long time (e.g. difficulty sustaining attention during lessons, lectures and conversations or reading longer texts) (4)
- 🔵 executes instructions only partially and cannot finish work (starts tasks, loses focus easily, easily distracted, cannot finish tasks, assignments or duties in the workplace) (4)

- has difficulty with time, is often too late or in a hurry, tasks take longer than expected, projects or assignments are done in the last moment / too late (4)
- loses items needed for tasks or activities (homework, pencils, books, tools, wallets, keys, forms, glasses, cell phone, train and bus tickets) (4)
- easily distracted by external stimuli (for teenagers and adults: unsuitable thoughts) (4)
- does not listen when others speak to him (seems absent even if no obvious distractions are present) (3)
- avoiding, dealing in a reluctant way or unwilling to do work that requires prolonged mental effort (such as schoolwork or homework or for teenagers and adults: report writing, filling out forms, checking of longer reports) (3)
- is often restless, in situations when remaining seated is expected (leaves his seat in the classroom, in the workplace) (4)
- fidgets with hands or feet or squirms in the chair (3)
- interrupts and interferes with others (interfering in conversations, games and other activities, uses items that don't belong to him without asking, for teenagers and adults disturb others while performing their affairs) (3)
- interprets comments as negative, even if they are not (4)
- can be provoked quickly, explodes and lets the excitement dissipate; After such an outburst often tired (4)
- has periods of forgetfulness or memory problems (4)
- is negative, everything is criticized and questioned (4)
- is often irritated, shows periods of extreme irritability, followed by impulsive acts (4)
- has a chronically low self-esteem, good performances are attributed to others (4)
- bears no praise, praise has a demotivating effect, cannot be happy with their own good performance (4)
- Solutions are driven by anger and aggression with no regard for consequences (4)
- has often or recurrent mood swings (4)
- is inflexible, rigid in thinking cannot give up (4)
- requests his / her own way, even if others repeatedly say "no" (4)
- has periods of irrational, stupid or unreasonable behavior (4)
- tendency to "grandiose", unrealistic thinking (4)
- thinks quickly, goes in his mind much faster than he can speak or others can follow (4)
- has periods of brief, intense and violent outbursts for any old reason (3)
- is socially isolated, has no friends, is avoided and sometimes expelled (3)
- has periods of increased talkativeness (3)
- shows erratic behavior, reactions do not correspond with reality (3)
- worries excessively or with no reason (4)
- makes opposition, quarrelsome (4)
- difficulty seeing different options / possibilities in a situation (4)
- tendency to cling to their own ideas and not to listen to others (4)
- continue to provide a once exercised / initiated action, even if it is not successful (4)
- struggles to shift attention from one thing to another (3)

10-20 Head Review Example with GO-NOGO







10-20 Head Review