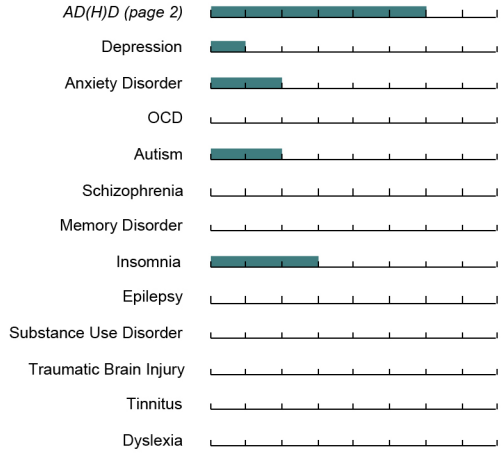
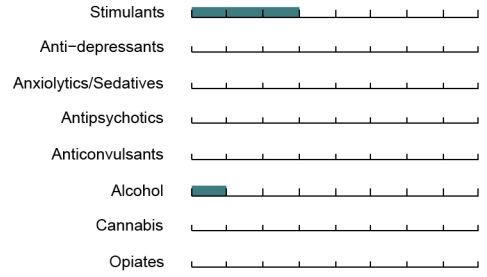
# QEEG Informed
# Protocol Recommendation

**Client ID: John Doe**
Age: 32.45, Gender: Male, Eyes Closed

## Psychopathology Rating




## Substance Use




**Recommended protocols have been determined for the disorders printed in italics.**

## General Information

Input EEG: 123456

EEG recorded on: 07-Mar-2017
Protol recommendation processed on: 07-Mar-2017 12:24h

MONTAGE: Linked Ears

SUBJECT INFORMATION:

Original Filename: JohnDoe_EC.edf
Subject ID: John Doe
Age: 32.45
Gender: male
Handedness: right
Condition: Eyes Closed

ARTIFACT REJECTION/CORRECTION RESULTS:

Noisy channels:
High frequency artifacts will be ignored in these channels.
Percentage rejected data: 44%
(High percentages indicate bad data quality)
Record length: 10:46
Edit length: 5:59

## Relevant EEG Biomarker Overview

**Delta excess**
(Schizophrenia/Memory/Epilepsy)
NO

**Theta excess**
(ADHD/OCD/Schizophrenia/Memory/Tinnitus)
YES

**Alpha excess**
(ADHD/OCD/Autism)
YES

**Alpha deficit**
(Anxiety/Schizophrenia/Memory/Tinnitus)
NO

**Beta excess**
(ADHD/Anxiety/Schizophrenia/Sleep/Tinnitus)
NO

**Beta deficit**
(ADHD/Memory)
YES

**Gamma excess**
(Sleep/Tinnitus)
NO

**Gamma deficit**
(Schizophrenia)
NO

**Low voltage**
(ADHD)
NO

**Low Alpha peak frequency**
(ADHD)
NO

**Frontal Alpha Asymmetry**
(Depression/Anxiety)
NO

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## AD(H)D

### *Rationale*

AD(H)D has been associated with deviant activity in the frontal brain areas. The majority of research has demonstrated that patients suffering from AD(H)D show frontal theta excess (e.g. Arns et al., 2008) or a high frontal theta/beta ratio (e.g. Snyder et al., 2015). However, AD(H)D has also been associated with a number of other deviances, such as excess frontal beta (beta spindling; Clarke et al., 2001) and low alpha peak frequency (Arns et al., 2008). A large body of research has shown that neurofeedback is an effective treatment for AD(H)D (Arns et al., 2009). It has been shown that QEEG informed neurofeedback protocols for ADD are very effective, with a response rate of 76% and an effect size of 1.78 (Arns et al., 2012). The recommended neurofeedback protocol will be selected according to the decision rules described in Arns et al. (2012).

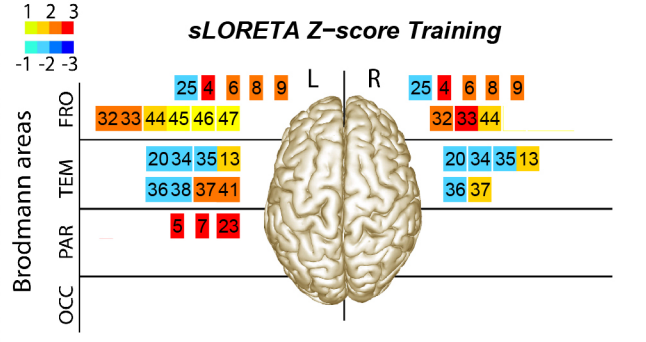
### *Classic Amplitude Training*

1st: 7−9 Hz Down on Fz
Reward percentage: 40%
Sustained reward criterion: 450 ms

### *4 channel Z−score Training*

Locations: C3 Cz C4 Fz
Excess alpha activity found on Fz at 8 Hzv

### *sLORETA Z−score Training*




| | Delta | Theta | Alpha | loBeta | Beta | hiBeta | Gamma |
|---|---|---|---|---|---|---|---|
| Frontal | | L+R | L+R | | L+R | L+R | |
| Temporal | | L+R | | | L+R | | |
| Parietal | | L | | | | | |
| Occipital | | | | | | | |

### *Scientific Support*

### *Specificity*

### *Degree Of Deviance*

### *Data Quality*

*Scientific Support*:
The level of Scientific Support is determined by the current scientific status of neurofeedback treatment of the diagnosis to treat and the level of agreement between the EEG results and the symptoms of the patient.

*Specificity*:
Deviant activity can have a broad or narrow distribution across frequencies and electrode sites. Moreover, the relevant deviant activity can be accompanied by other distinct deviant EEG measures.

*Degree Of Deviance*:
The more extreme the z−score of the relevant deviant activity, the higher the Degree Of Deviance.

*Data Quality*:
The percentage rejected data, the detection of bad channels and the total artifact free recording time contribute to the level of Data Quality.

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## Substance Use

It is not recommended to perform a resting-state EEG recording when the client is under the influence of psycho-active substances.

When the patient was under the influence of psycho-active substances during the recording, the QEEG results should be interpreted with great caution. For example, when a psycho-active substance is known to increase beta band power one must be cautious to interpret the presence of excess beta power when the patient is under the influence of the psycho-active substance in question during the recording. The excess beta band power may purely be caused by the psycho-active substance in this case. In contrast, an absence of high z-scores in beta band power may be caused by relatively low beta power when the patient would not have been under the influence of the psycho-active substance. The psycho-active substance may have caused the deficit in beta band power to increase to normal levels. It is therefore not advised to apply a neurofeedback protocol targeting beta band power in these cases.

Research has shown that the psycho-active substances that the client is using may have the following effects on the EEG recording:

STIMULANTS

Acute effects: Decreased delta and theta power, increased beta power (Johnstone & Lunt, 2011; Fink et al., 1969). Possible changes in measures of connectivity such as coherence and phase lag (Fink et al., 1969).
Long-term effects: Unknown

ANTICONVULSANTS

Acute effects: Increased delta and theta power (Herkes et al., 1993; Salinsky et al., 2007).
Long-term effects: Decreased alpha peak frequency and increased delta and theta power (Knott et al., 2001; Gross et al., 2004).

ANTIDEPRESSANTS

Acute effects: Selective Serotonin Reuptake Inhibitors (SSRIs) can result in increased beta power (Siepmann et al., 2003). Tricyclic antidepressants can result in increased of delta and theta power, decreased alpha power and increased beta power (Saletu et al., 1983).
Long-term effects: Unknown

ALCOHOL

Acute effects: Increased delta and theta power (Little, 1999).
Long-term effects: Decreased delta and theta power, increased beta power (Coutin-Churchman et al., 2006).

SEDATIVES

Acute effects: Increased beta power (Fink et al., 1969), decreased alpha power and increased delta power for high doses (Saletu et al., 1983).
Long-term effects: Unknown.

CANNABIS

Acute effects: Increased alpha power (Lukas et al., 1995). Decreased power and connectivity in frequencies below 30 Hz, increased gamma power (Nottage et al., 2015).
Long-term effects: Increased frontal alpha power and alpha coherence, decreased alpha peak frequency (Struve et al., 1989; 1994; 1999) decreased posterior alpha power (Herning et al., 2008) and decreased gamma power (Skosnik et al., 2012).

ANTIPSYCHOTICS

Acute effects: Overall increase of power across frequency bands (Knott et al., 2001). Decreased gamma power (Jones et al., 2012). Possible increase of epileptiform activity (Olanzapine; Amann et al., 2003).
Long-term effects: Decreased alpha and beta power, increased delta and theta power (Knott et al., 2001; Gross et al., 2004).

OPIATES

Acute effects: Increased delta and theta power, decreased alpha peak frequency (Volavka et al., 1970; 1974).
Long-term effects : Increased delta and theta power, decreased alpha peak frequency (Shufman et al., 1996).

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## General Information

Protocol recommendations are based on four factors:

1. The psychopathology of the patient
2. The QEEG of the patient
3. Scientific publications on psychopathology related deviations in resting−state EEG
4. Scientific publications on the effectivity of neurofeedback for the patient's psychopathology

The raw EEG should always be inspected before implementing the recommended protocol. The protocol recommendations are based on the qEEG−Pro results. With the exception of Burst Metrics, these results are based on averages of the EEG time course. Therefore, many of the temporal dynamics of the raw EEG signal are not represented in the qEEG−Pro reports. For example, when there are strong fluctuations in theta power over the course of an EEG recording in which periods with abnormaly low and high theta power alternate, the average z−score for theta power may be close to zero. Burst Metrics captures one specific temporal dynamic and should always be consulted before implementing the recommended protocol. Significant deviances in Burst Metrics can exist in the absence of significant deviances in average power.

Always make sure that there is no epileptiform activity present in the raw EEG. SARA contains an Epileptiform Episode Detection algorithm which detects high−voltage epileptiform episodes. When these episodes have been detected by SARA it is adivised to consult a neurologist for the treatment of your client. SARA does not detect low voltage epileptiform activity, so it is advised to inspect each raw EEG signal for these events before applying the protocol recommended by SQIPR. If low voltage epileptiform activity is present in the raw EEG signal, it is adivised to consult a neurologist as well. in such cases, it is recommended to apply a neurofeedback protocol that focuses on enhancing SMR (12−16Hz on C3 and C4) power.

EEGs that are contaminated with a high amount of artifacts can lead to protocol recommendations that are suboptimal. For example, ocular artifacts (eye blinks or eye movements) lead to increases in power of frontal slow frequencies. Similarly muscle tension leads to increased power in a broad range of high frequencies.SARA will remove most artifacts from the data but it cannot be ruled out that some artifacts remain presentin the de−artifacted EEG, which may influence the z−score results. Optimal protocol recommendations require at least 5 minutes of artifact−free EEG and no more than 50% of the EEG to be contaminated with artifacts.

The current protocol recommendation is based on a Linked Ears montage. The Linked Ears montage is the most commonly used montage for neurofeedback training. However, The Linked Ears montage can result in a z−score distribution on the scalp that is the result of a neural signal that has been measured on the earlobes. For example, this may lead to a distribution of z−scores in which there are high z−scores on a broad range of electrodes with the exeption of temporal electrodes. Using a different montage for neurofeedback training may then lead to a suboptimal neurofeedback treatment.

EEG biomarkers should not be interpreted as diagnostic tools. In general, a biomarkers are associated with certain disorders because they occur more often in patients suffering from these disorders compared to healthy controls. This means that on an individual level, it is not unlikely that certain biomarkers are present in the absence of the disorders that are associated with it. However, when an individual suffers from a particular disorder and shows one or more of the biomarkers that are associated with it, it is likely that these biomarkers reflect (part of) the neural mechanisms underlying the disorder.

There may be differences between the recommended protocols for different EEGs of the same client. For example, the recommended protocol based on the eyes closed EEG recording may be different than the recommended protocol based on the eyes open EEG recording. The following criteria should be taken into account when selecting among the different recommended protocols:

1. The accordance between the deviances in the QEEG and the the expected deviances in relation with the pathology of the client.
2. The quality of the data (the amount of artifacts).
3. The accordance between the different recommended protocols.
4. The likelyhood that the recommended protocol is based on deviances with non−neural causes, such as ocular artifacts or muscle artifacts.
5. The likelyhood that the recommended protocol is based on deviances caused by psycho−active substances.

qEEG−Pro is not intended to be used for medical diagnoses or treatment of medical conditions.