



Monitoring of Auditory Discrimination Therapy for Tinnitus Treatment Based on Event-Related (De-) Synchronization Maps

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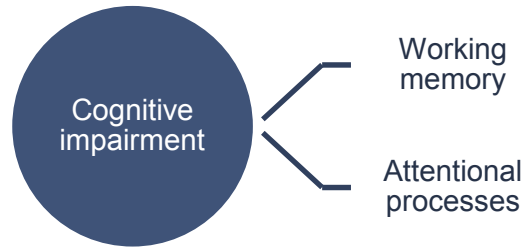
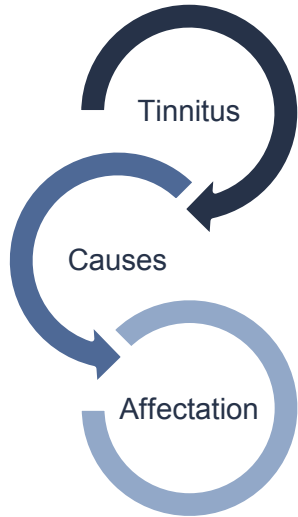


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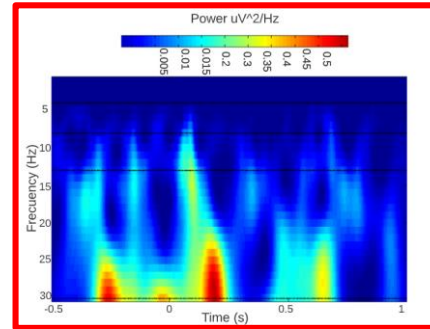
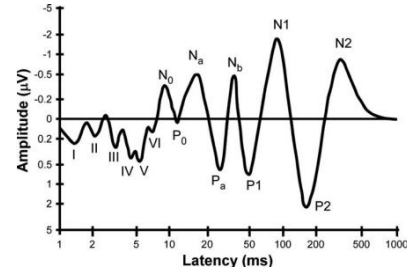
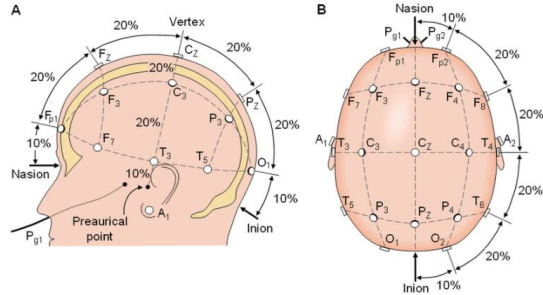
1. Introduction





(Eggermont and Roberts, 2012; Meyer et al., 2012; Hallam et al., 2004)



1. Introduction

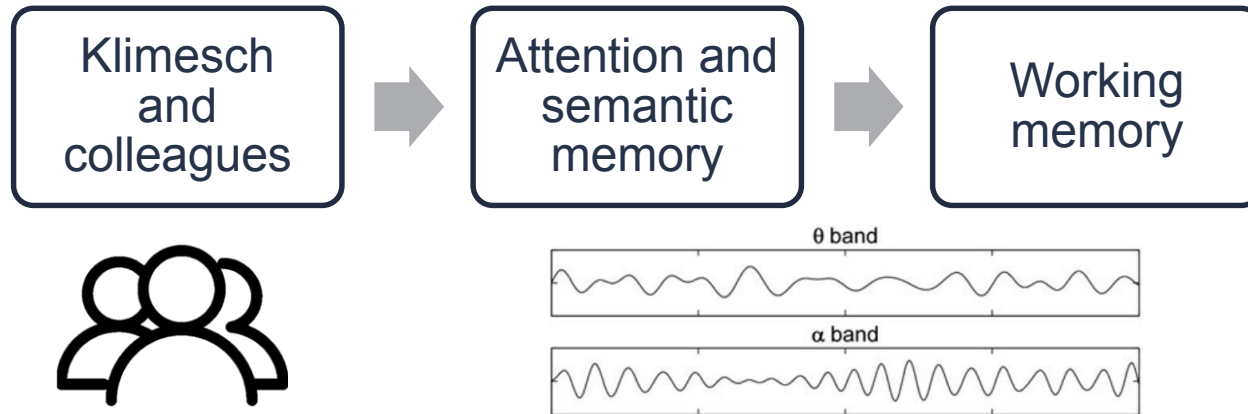


ERS 

ERD 

(Duncan et al., 2009; Krause, 2003)
(Hu and Zhang, 2019)

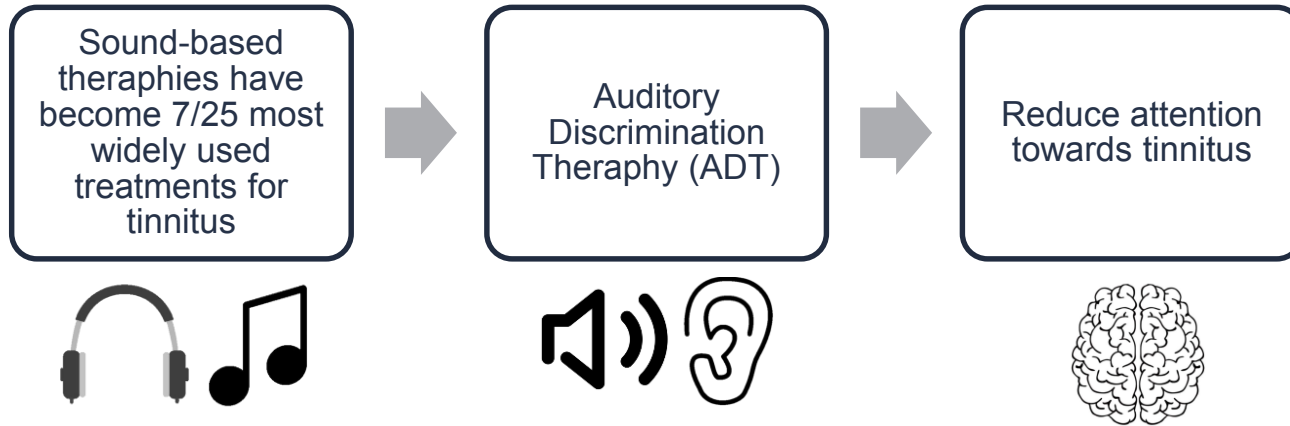
1. Introduction



(Klimesch, et al., 1997; Bastiaansen and Hagoort, 2003; Milne et al., 2003; Krause, 2006)
(Hu and Zhang, 2019)



1. Introduction



(McFerran et al., 2019; Simoes et al., 2019; Herraiz et al., 2007)

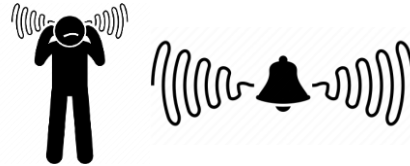


1. Introduction

ERD / ERS maps are currently employed as EEG biomarkers



This method has not yet been applied to assess acoustic therapies in tinnitus patients



(Romagosa et al., 2020; Osuagwu et al., 2016; Park et al., 2015; Krause et al., 2008; Missonnier et al., 2007)



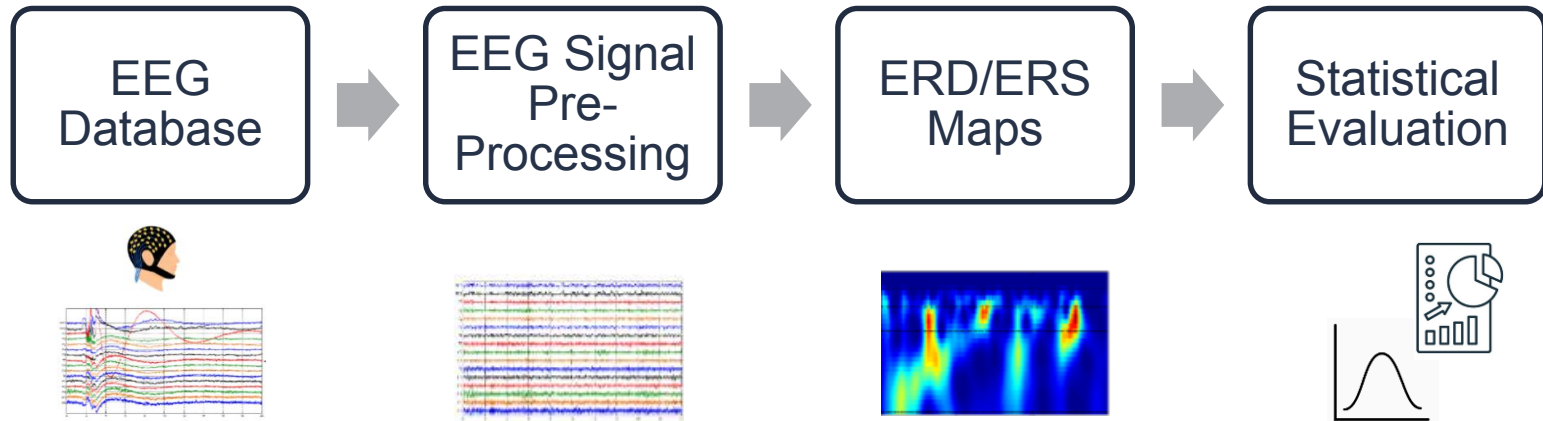
2. Aim



We proposed to evaluate the effect of ADT for tinnitus treatment by mapping ERD and ERS responses before and after the therapy, and decide whether this EEG technique could be feasible to monitor sound effects.



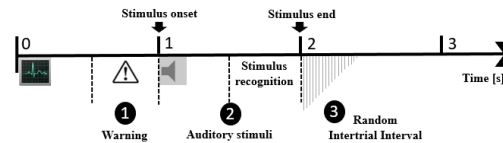
3. Methodology



EEG database

- 11 patients were selected. They were treated with ADT for 8 weeks
- 2 monitoring sessions
- THI, EEG recording

Experimental timing protocol



EEG data collection

- Sampling rate: 256Hz
- 16 channels. International 10-20 system
- Prefrontal (FP1, FP2), Frontal (F7, F3, Fz, F4, F8), Temporal (T3, T4, T5, T6), Central (C3, C4), Parietal (Pz), Occipital (O1, O2)



(Ibarra et. Al.,2021)



Low-frequency components

- Butterworth type Band Pass digital filter with order 6 of zero phase.
- Cutoff frequencies at 0.1 and 30 Hz.

Baseline elimination

- Offset

ASR method

- Artifact Subspace Reconstruction Methodology
- Transient and large amplitude artifacts

ICA

- RunICA function, Infomax algorithm



EEG Database



EEG Signal
Pre-Processing



ERD/ERS
Maps



Statistical
Evaluation

Frontal region

- Fp1, Fp2, F7, F3, Fz, F4, F8

Epochs extraction

- 500 ms before and 1s after the stimulus onset
- There were two types of events: encoding and retrieval of auditory material.

TF analysis

- Continuous Wavelet Transform (CWT) applied to each epoch

Baseline correction

- Subtraction method

Mean scalograms

- The coefficient matrices resulting from the CWT per epoch were averaged and the absolute value was carried out to obtain only real estimations

ERD\ERS response
quantification

- Based on the reference and the two experimental conditions, the ERD/ERS values were determined for each of the subjects in the different frequency bands





Lilliefors
test

- Non-normal distribution

Kruskal-
Wallis test

- P-values were stated at 5%

4. Results and Analysis

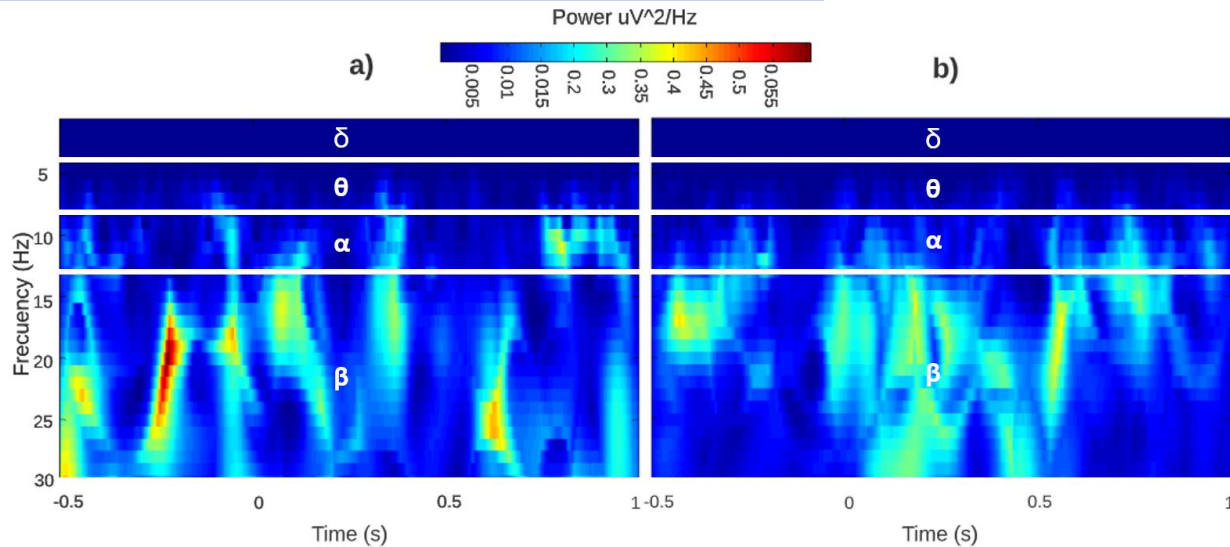


Figure 1. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (a-b) Median of 6 patients who exhibited normal condition in the THI

4. Results and Analysis

Auditory cognitive demands may not be altered.

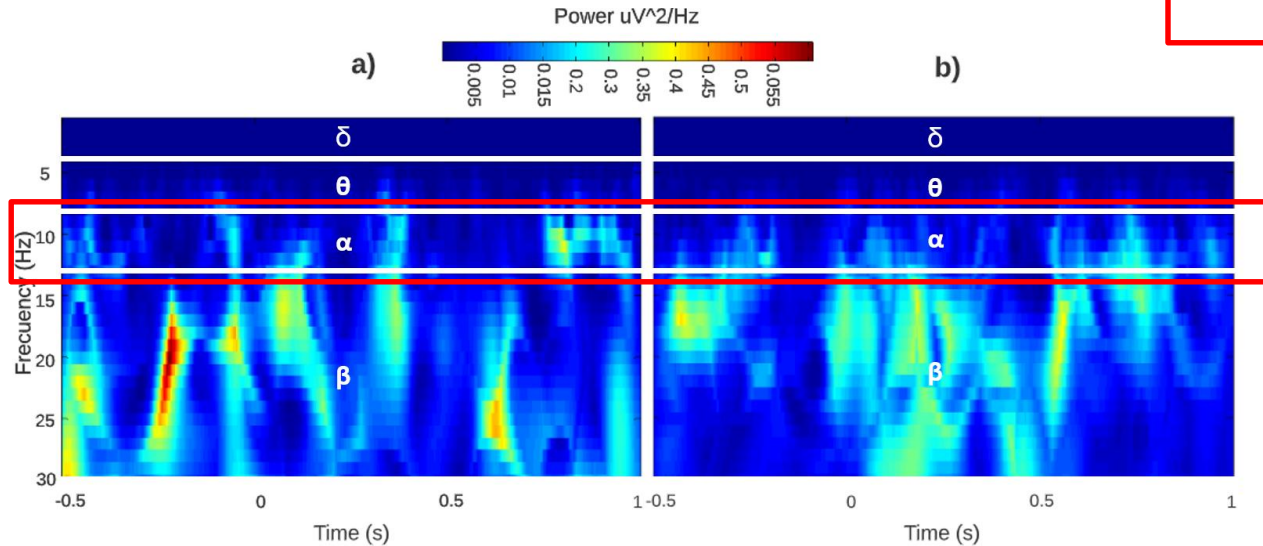


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(Klimesch, et al., 1997)



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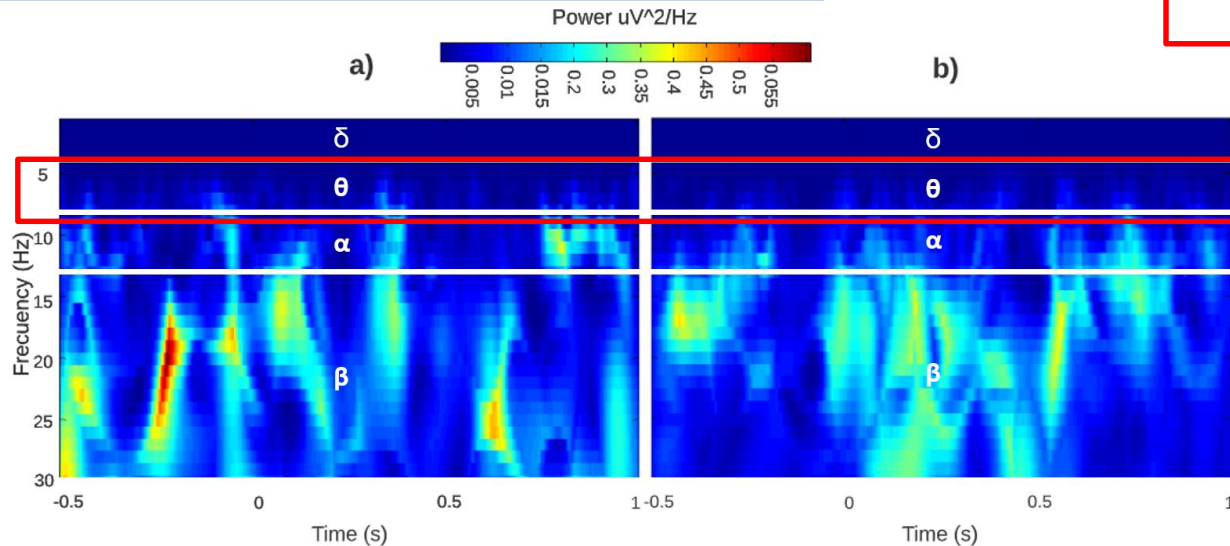


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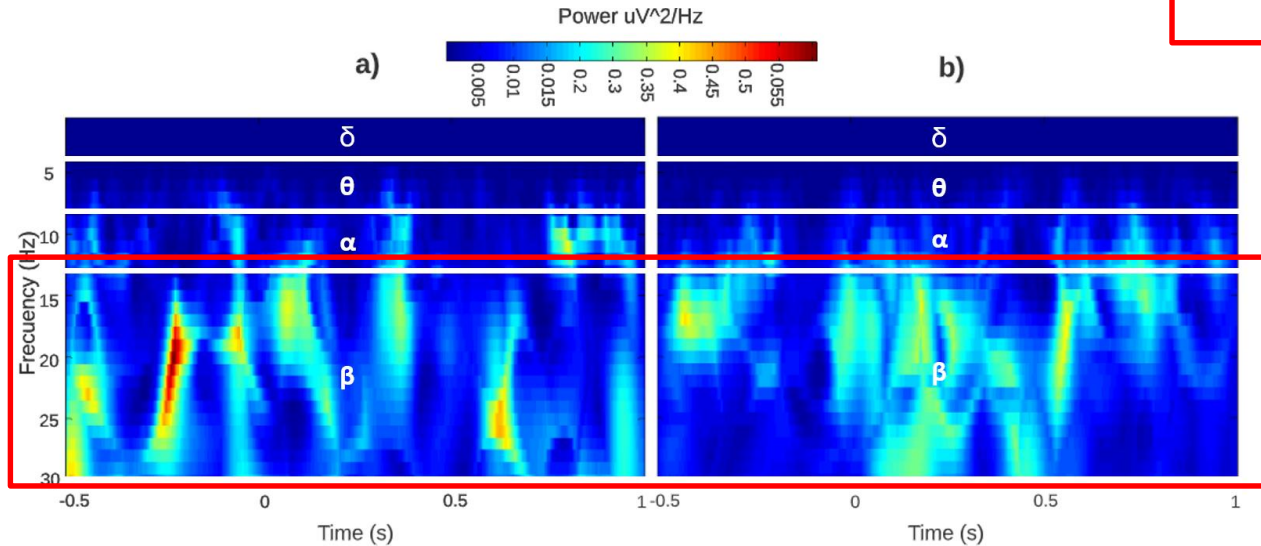


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(Krause, 2006)



4. Results and Analysis

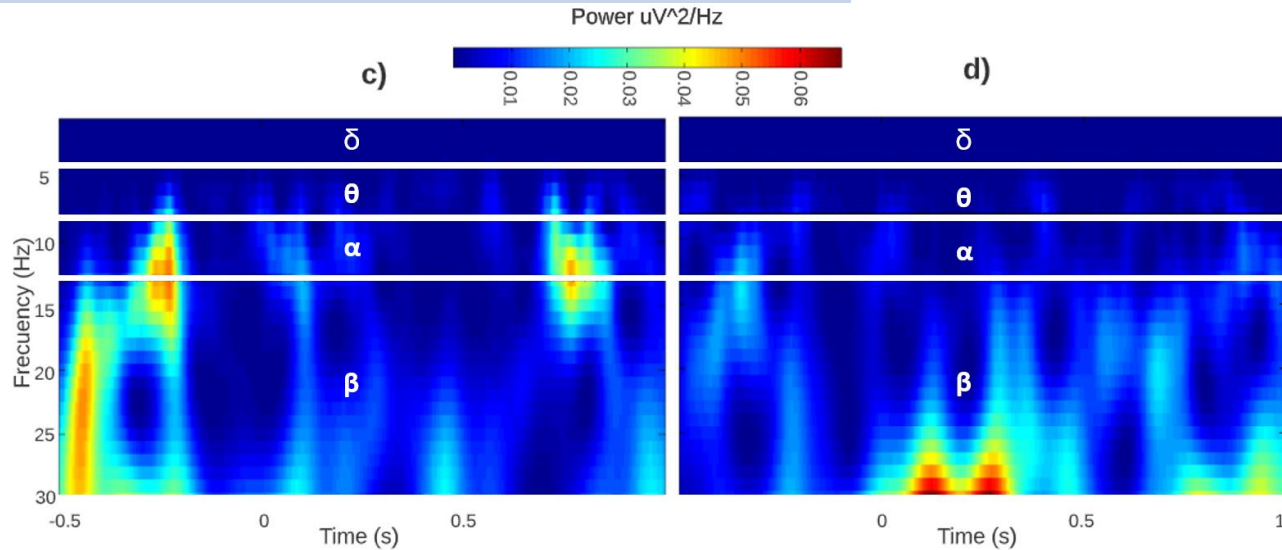


Figure 2. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (c-d) A patient who exhibited abnormal condition in the THI.

4. Results and Analysis

This could suggest difficulties in the cognitive processing.

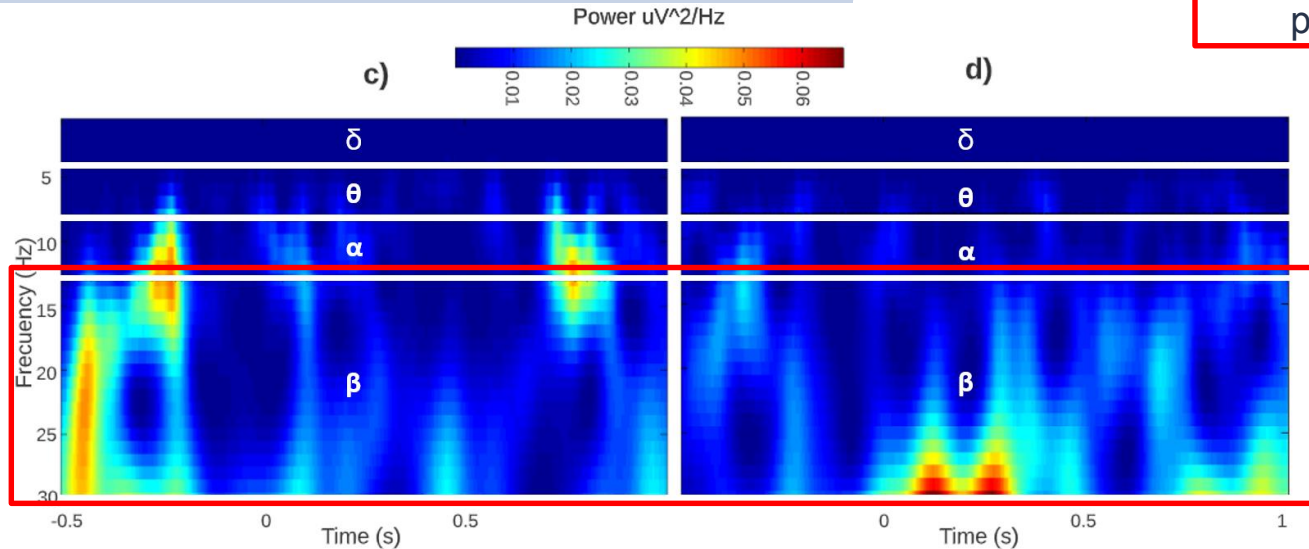


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(Krause, 2006)



4. Results and Analysis

Decrease in attention processes, semantic memory, working memory.

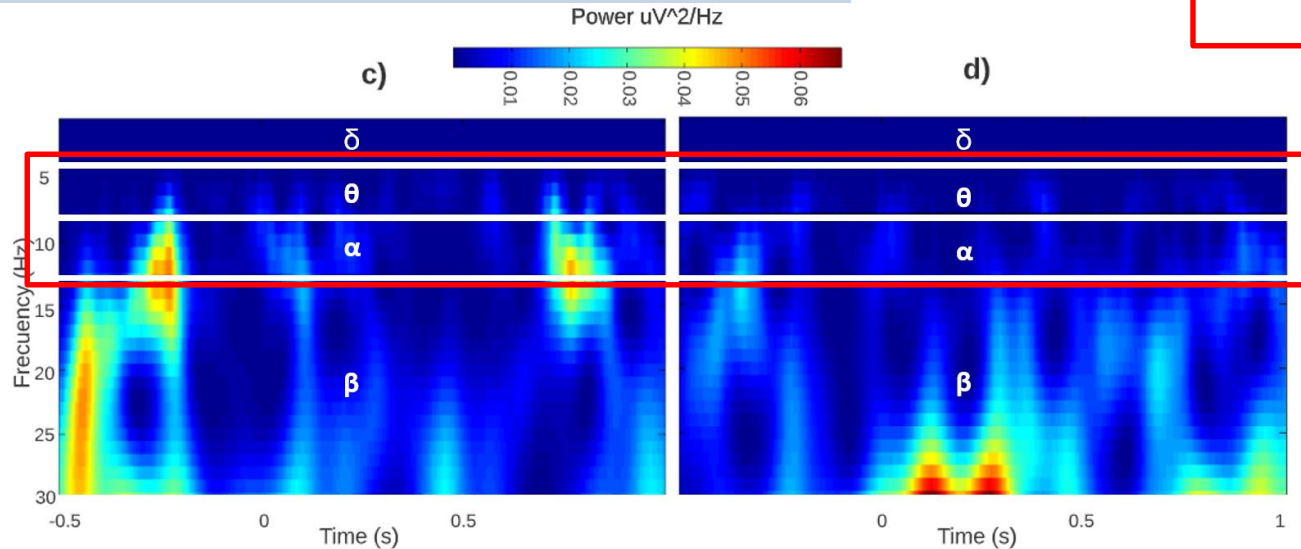


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(Klimesch, et al., 1997)



4. Results and Analysis

Attention completely redirected to tinnitus.

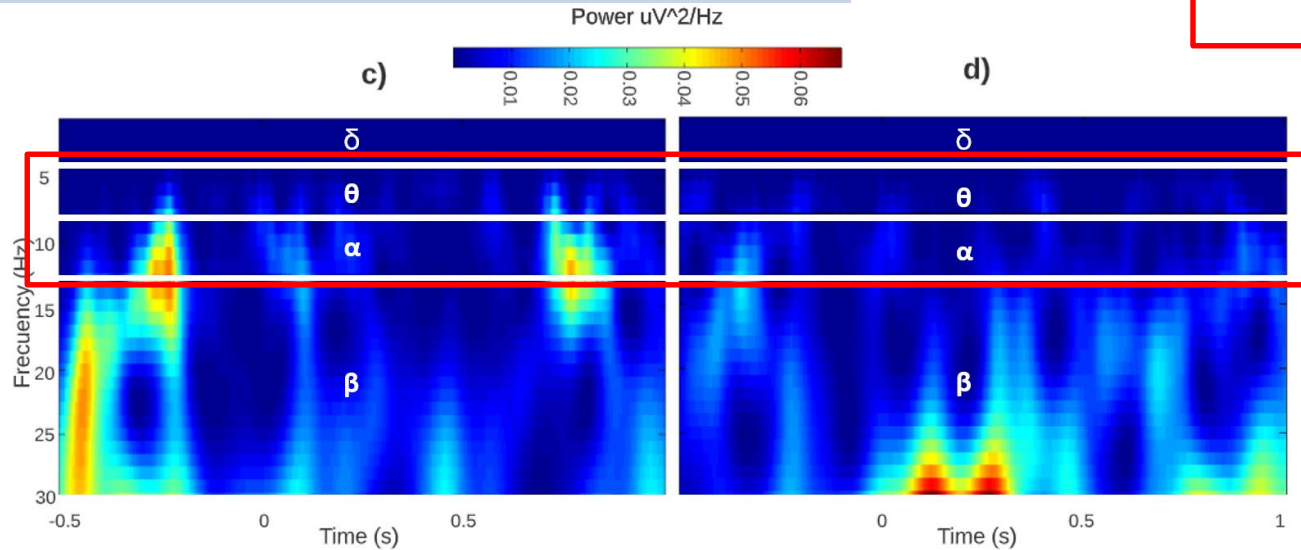


Figure 2. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (c-d) A patient who exhibited abnormal condition in the THI.

(Weisz, et al., 2005)



4. Results and Analysis

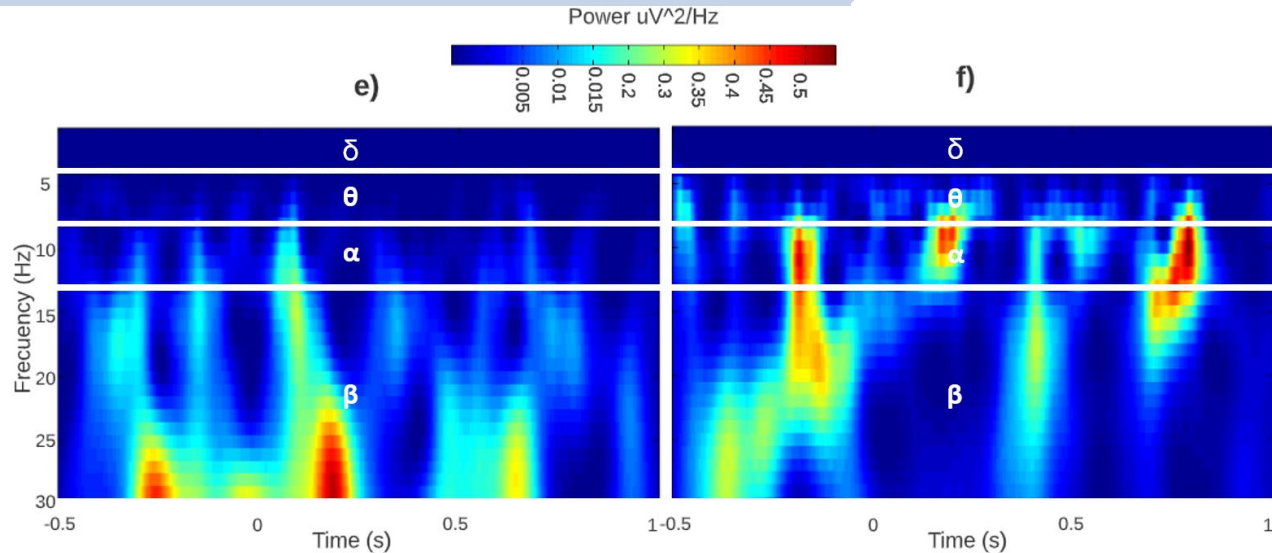


Figure 3. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (e-f) A patient who exhibited borderline condition in the THI.

4. Results and Analysis

Increase in attention processes, semantic memory, working memory.

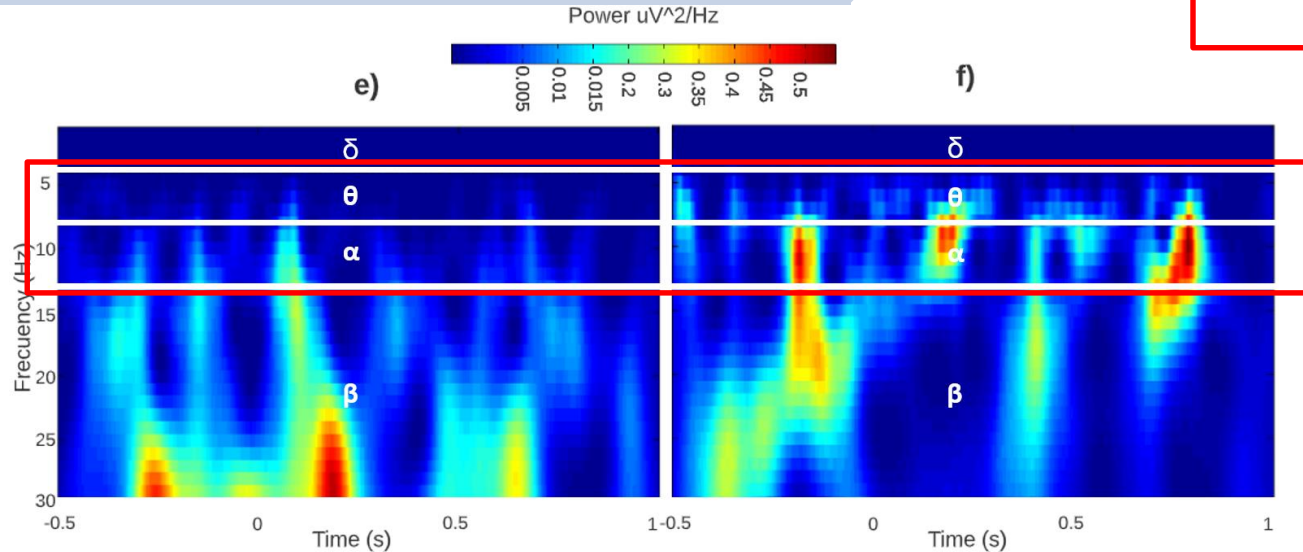


Figure 3. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (e-f) A patient who exhibited borderline condition in the THI.

(Klimesch, et al., 1997)



4. Results and Analysis

ADT-based treatment has increased attention to everyday acoustic environments

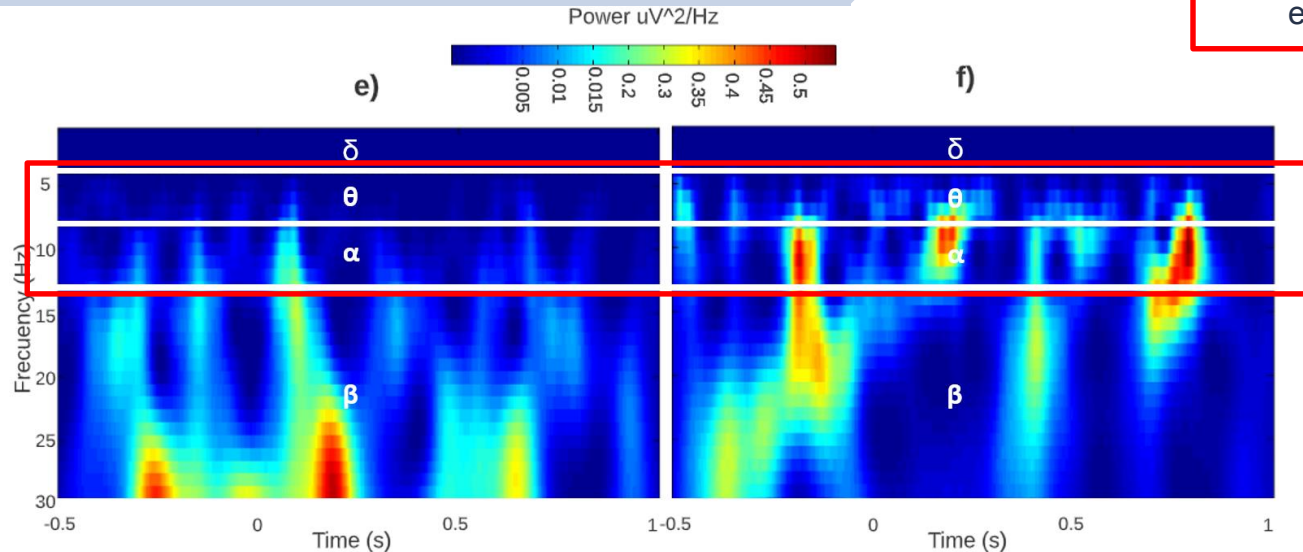


Figure 3. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (e-f) A patient who exhibited borderline condition in the THI.

(Weisz, et al., 2005)



4. Results and Analysis

Improvements in the auditory cognitive processing

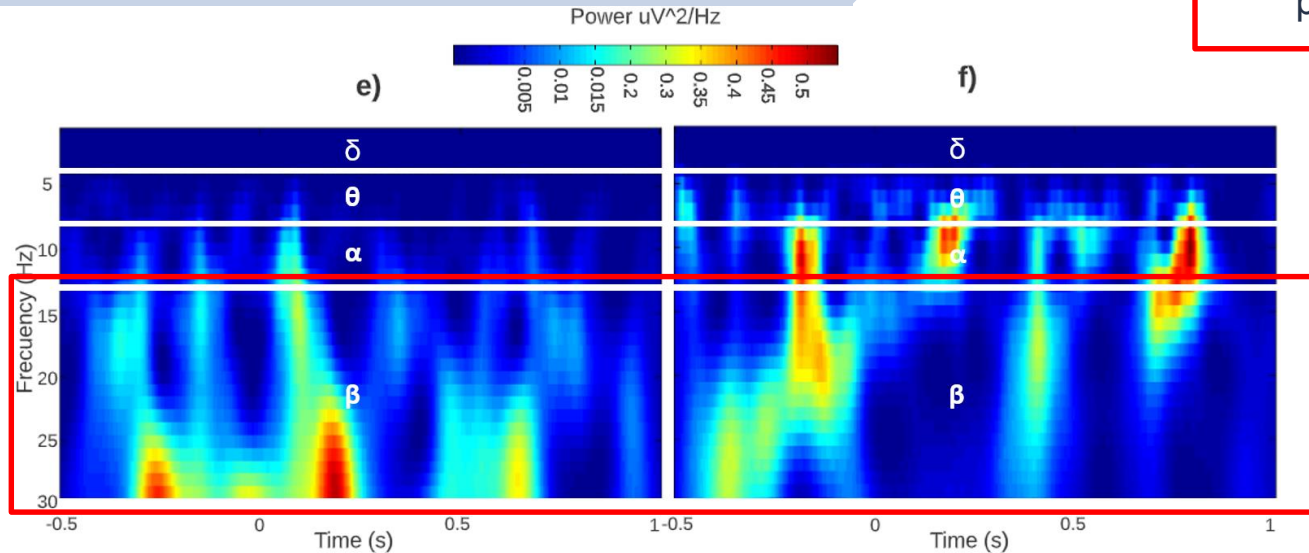


Figure 3. (ERD/ERS) responses over the frontal lobe before and after the ADT-based treatment during the auditory material encoding event. (e-f) A patient who exhibited borderline condition in the THI.

(Krause, 2006)



4. Results and Analysis

Tabla 1. P-values as a result of the Kruskal-Wallis test to obtain the statistical significance differences between patients with tinnitus before and after the ADT-based treatment by frequency bands

Subjects	EEG rhythms	Encoding of Acoustic Material	Recognition of Acoustic Material
Subject 1	Theta rhythm	P>.05	*
	Alpha rhythm	P>.05	*
	Beta rhythm	P<.05	*
Subject 2	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P<.05
Subject 3	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P>.05	P<.05
	Beta rhythm	P<.05	P<.05
Subject 4	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P<.05
Subject 5	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P>.05
	Beta rhythm	P<.05	P>.05
Subject 6	Theta rhythm	P<.05	*
	Alpha rhythm	P<.05	*
	Beta rhythm	P<.05	*

* Missing values

(Klimesch, et al., 1997; Krause, 2006)



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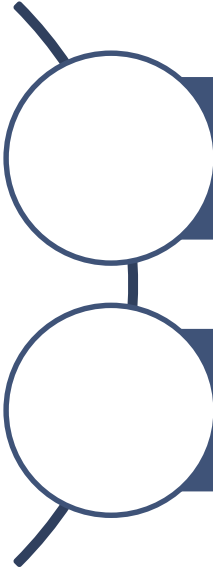
Subjects	EEG rhythms	Encoding of Acoustic Material	Recognition of Acoustic Material
Subject 7	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P<.05
Subject 8	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P>.05
Subject 9	Theta rhythm	P<.05	*
	Alpha rhythm	P<.05	*
	Beta rhythm	P<.05	*
Subject 10	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P<.05
Subject 11	Theta rhythm	P<.05	P<.05
	Alpha rhythm	P<.05	P<.05
	Beta rhythm	P<.05	P<.05

* Missing values

(Klimesch, et al., 1997; Krause, 2006)



5. Conclusions



In conclusion, the ERD/ERS technique seems to be feasible to detect alterations in cognitive functioning in terms of attentional and memory processes, hence it could function as a method to assess event-related (de-) synchronization of neural activity in tinnitus patients treated with an auditory discrimination therapy

Future work will entail measuring sensitivity by performing either a longitudinal or cross-sectional study, comparing the patient with his own evolution or with regard to a control subject at the end of the ADT-based treatment.

6. References

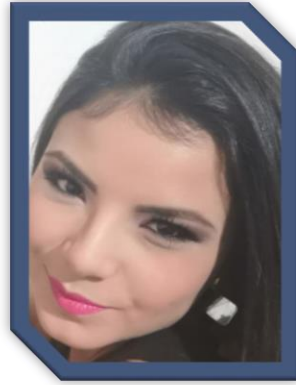
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Thanks

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