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Tinnitus – and QEEG

Diagnostic and therapeutic significance of tinnitus specific EEG signals.

Articel accepted and in press

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Introduction

The presence/existence of subjective tinnitus is still very difficult to prove. However, new technology, **QEEG**, puts us finally in a position to („hopefully“) prove tinnitus.

Questions:

1. Does tinnitus lead to EEG changes?

2. Can tinnitus-specific patterns be detected?

3. Significance of QEEG ?

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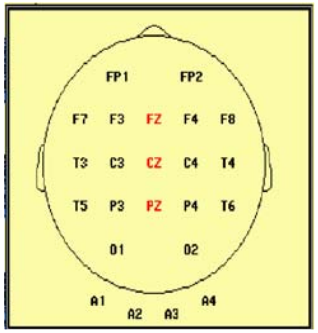
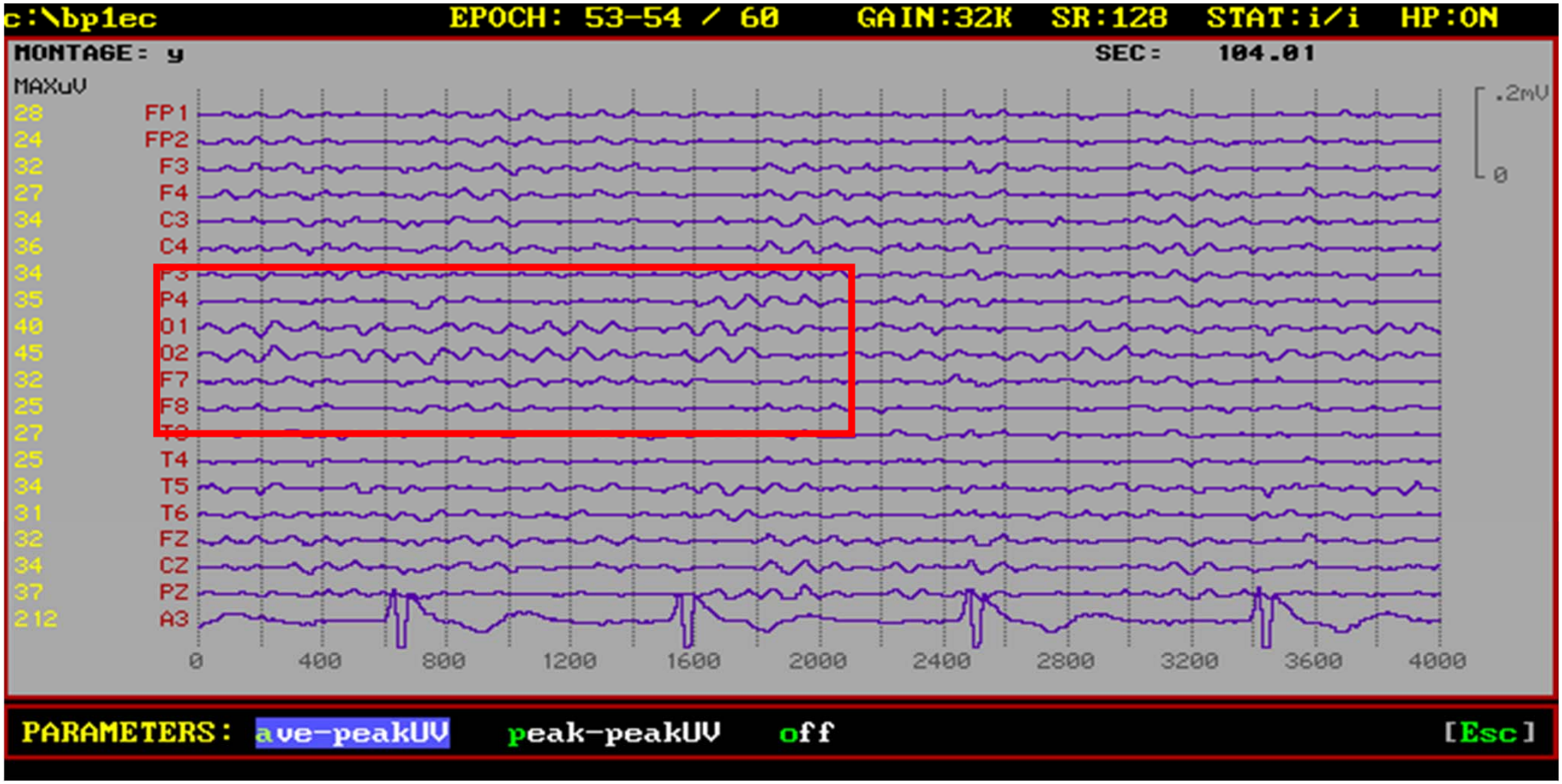
Raw – EEG 4sec

Eyes closed





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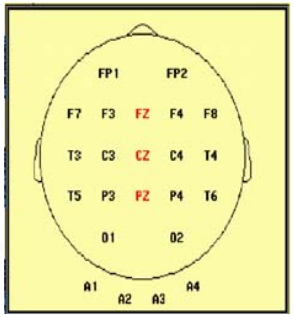
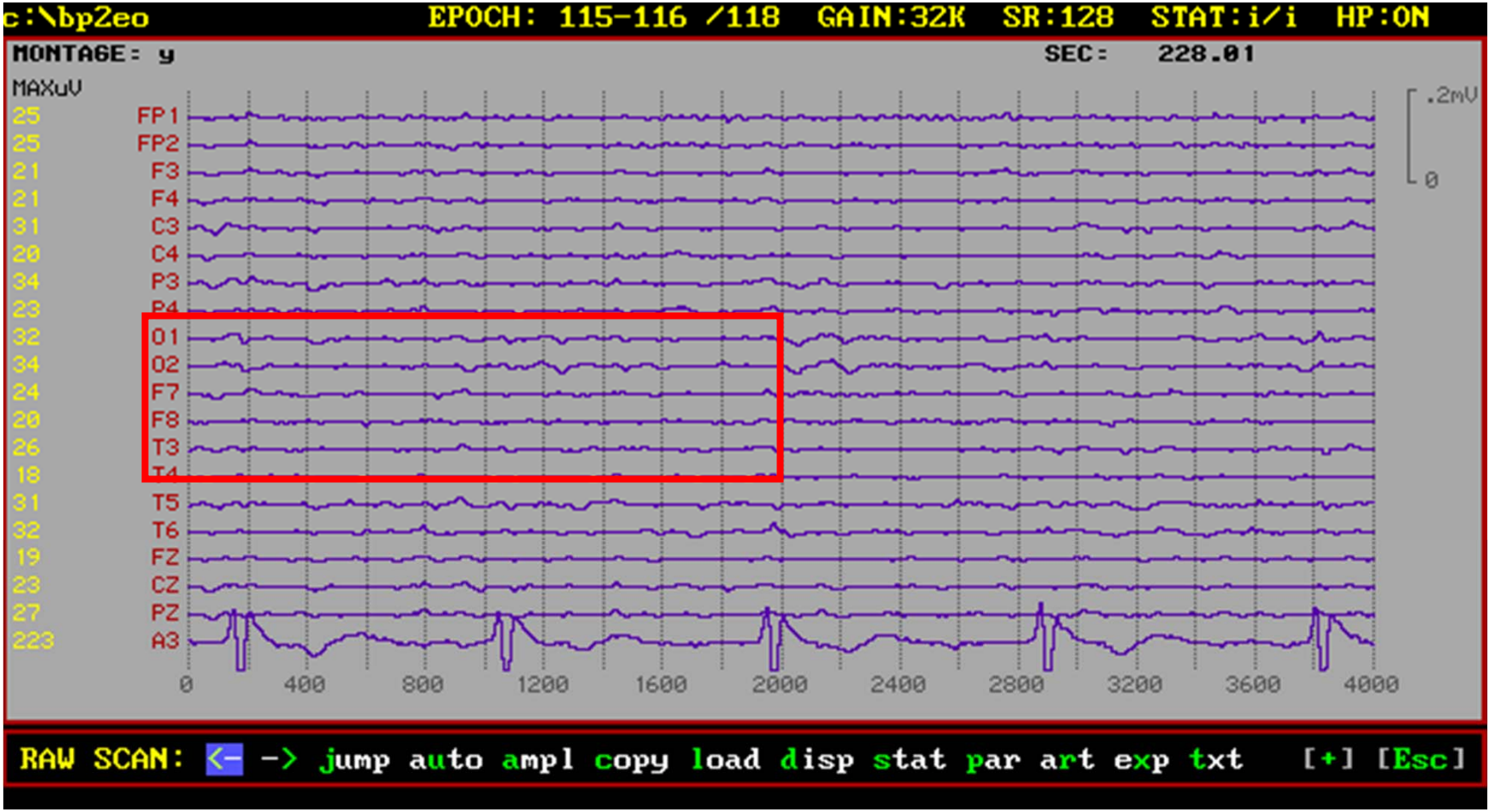
Raw – EEG 4sec

Eyes open





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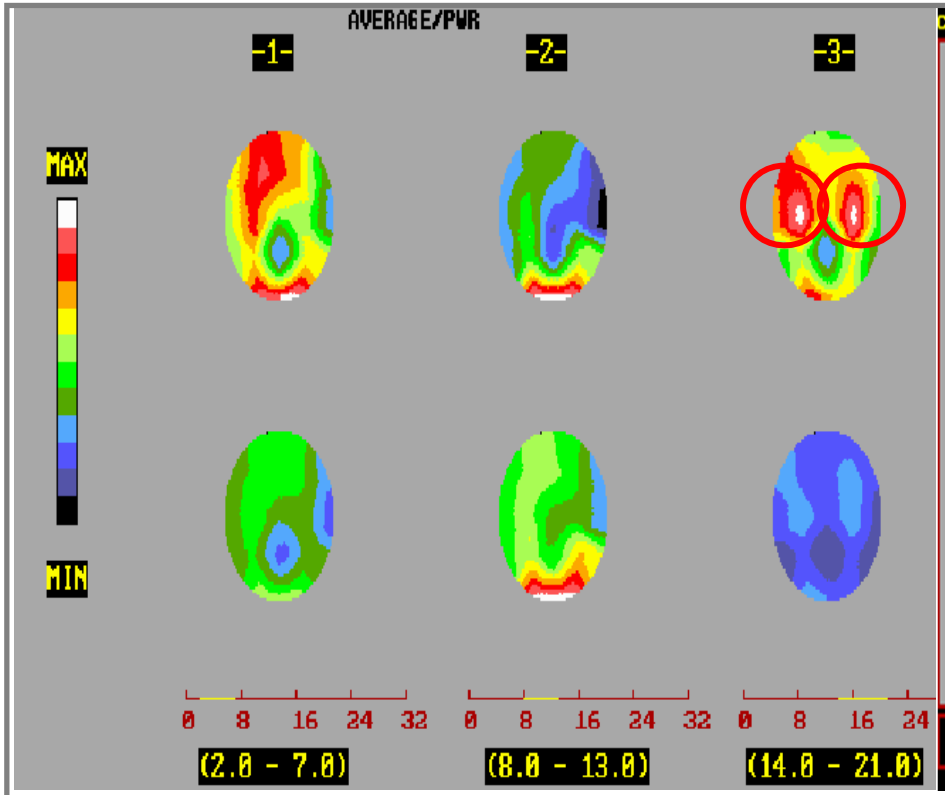
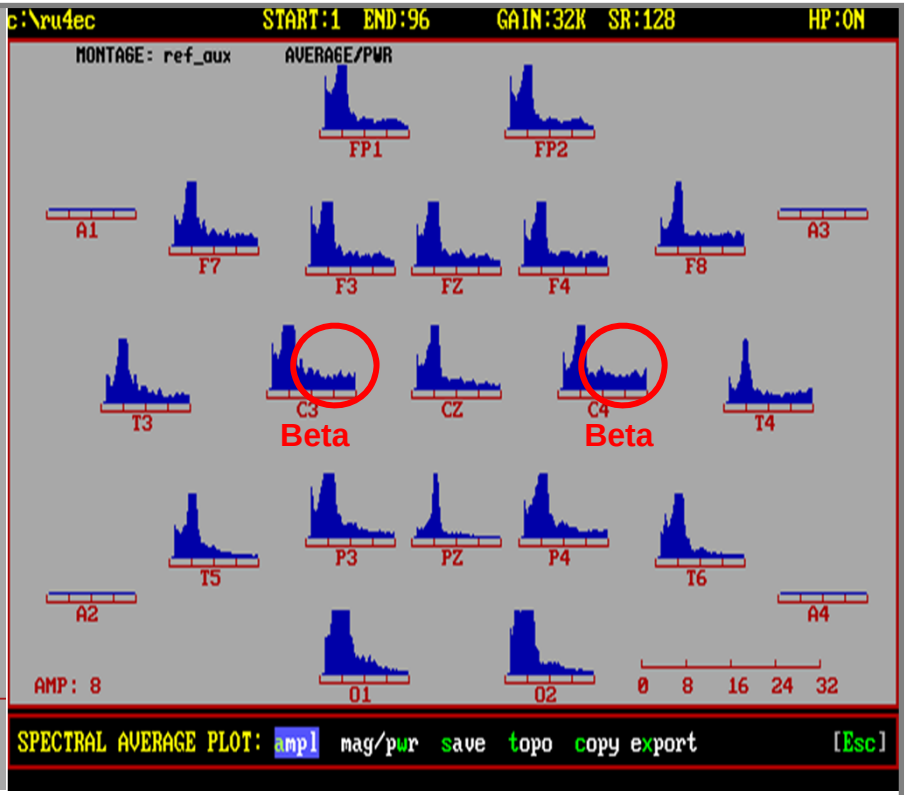
EEG Illustrations



Brain Map



Powerspektrum

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Demographics

Group	Females	Males	TOTAL	Age Females	Age Males
Tinnitus	181	373	554	52 ± 13	49 ± 13
Control	61	94	155	41 ± 12	43 ± 14

Tinnitus Duration Females:	**46 months**
Tinnitus Duration Males:	**63 months**

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TAP: Total average Power: Males

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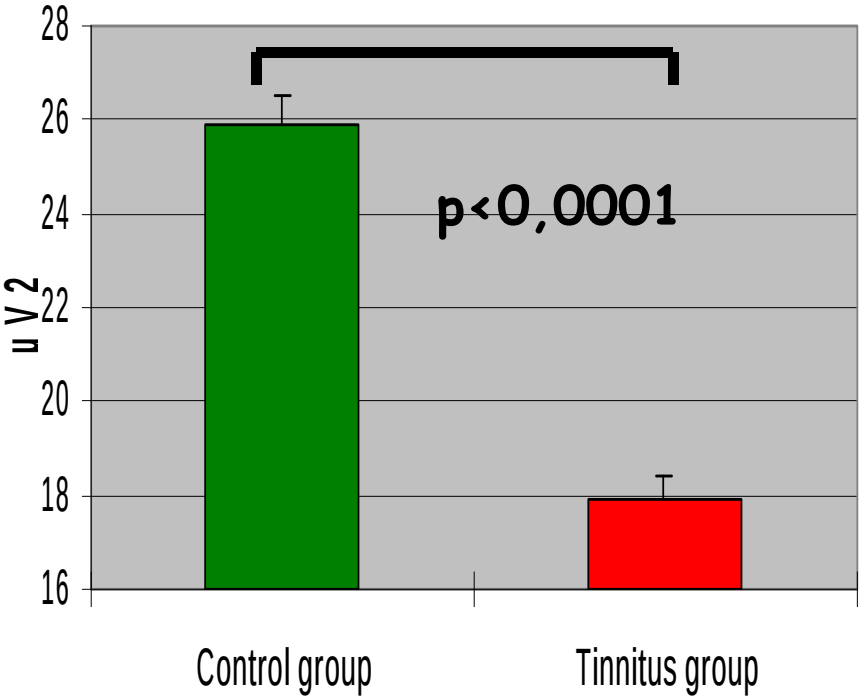

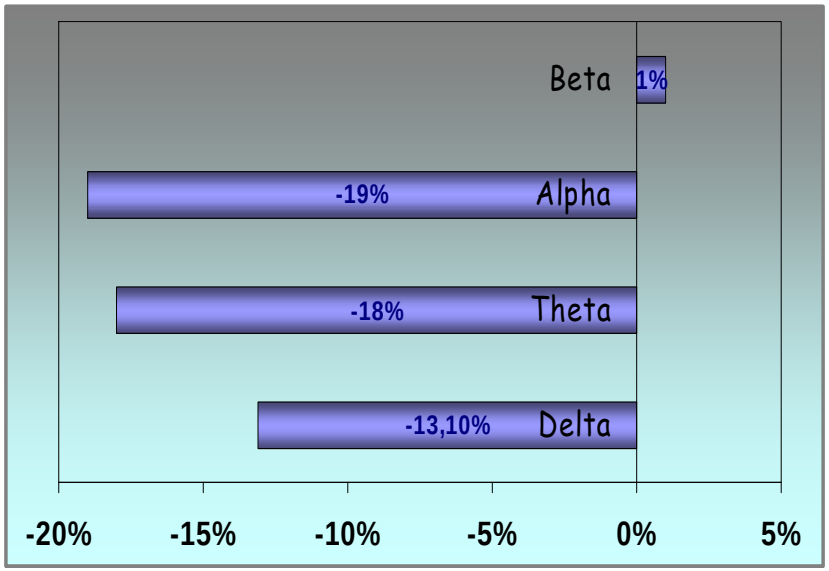

%-changes of TAP(frequency bands) in respect to the control group:

TAP: Total average Power: Females

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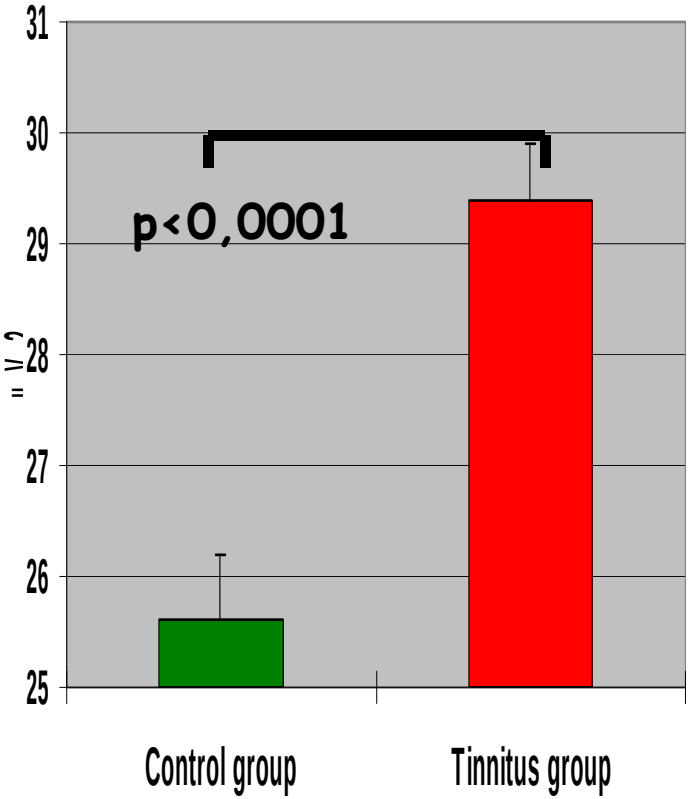

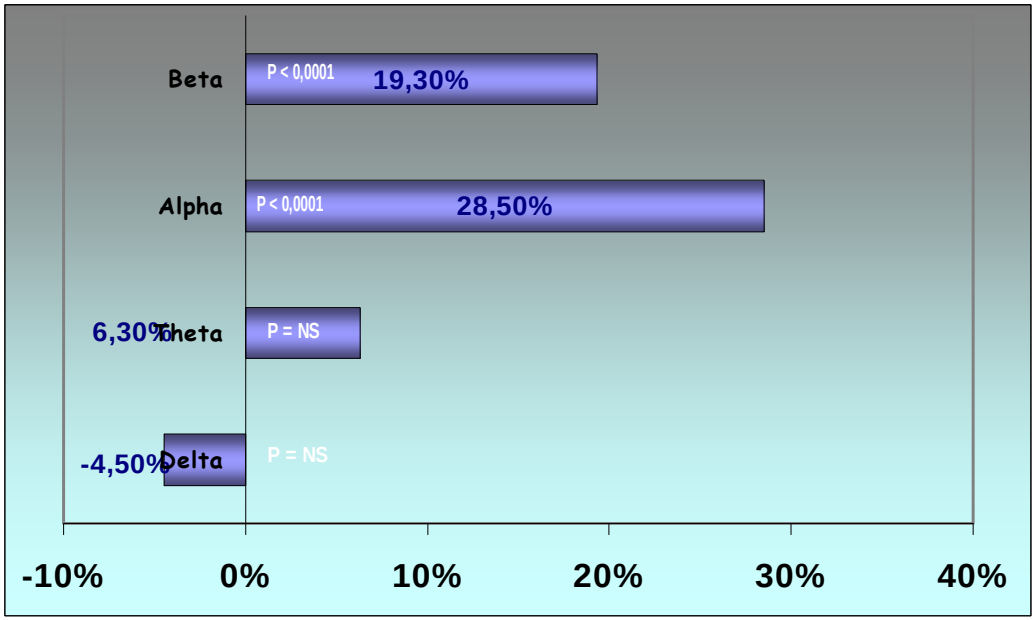

%-changes of TAP(frequency bands) in respect to the control group:

Tinnitus duration / Beck Depression Inventory

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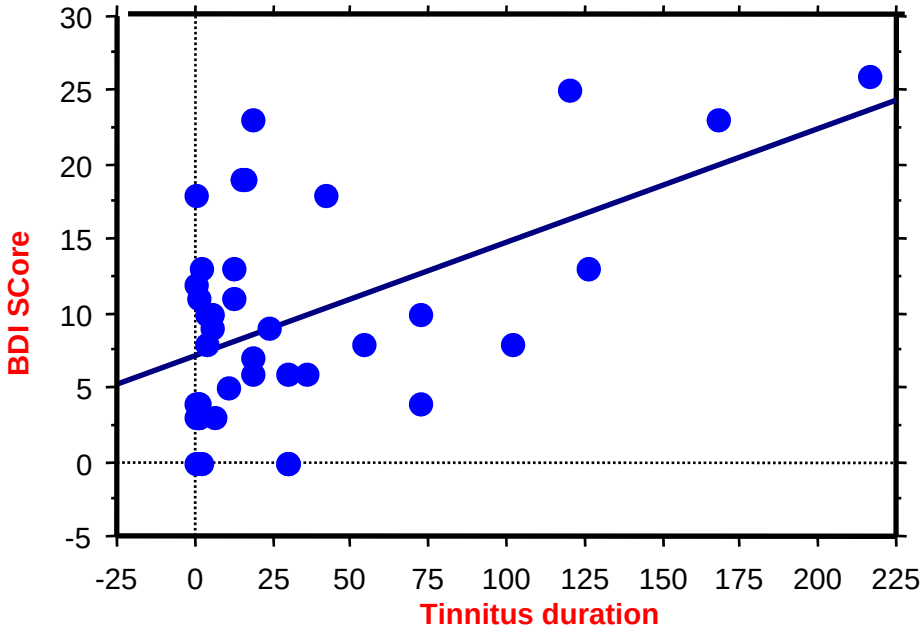
	Females	Males
left	ns	ns
right	p=0.0005	ns
bothsided	ns	ns



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Tinnitus duration / EEG changes: Females

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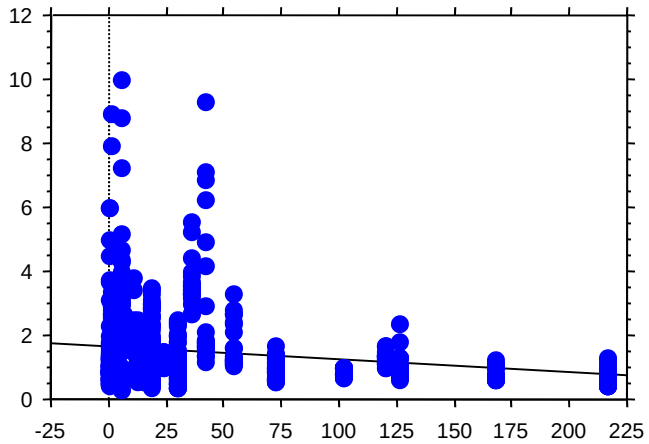
An alpha$_2$ (9-11Hz) /alpha$_1$ (7-9Hz) ratio was calculated in order to determine whether tinnitus duration alters alpha power values.

In **females** the bothsided and right sided tinnitus lead to an increase in the power of the alpha$_1$ band over time. However, females with a **leftsided** tinnitus exhibited decreased alpha$_1$ power values over time.

Ratio: Alpha$_2$/Alpha$_1$



Tinnitus duration / EEG changes: Males

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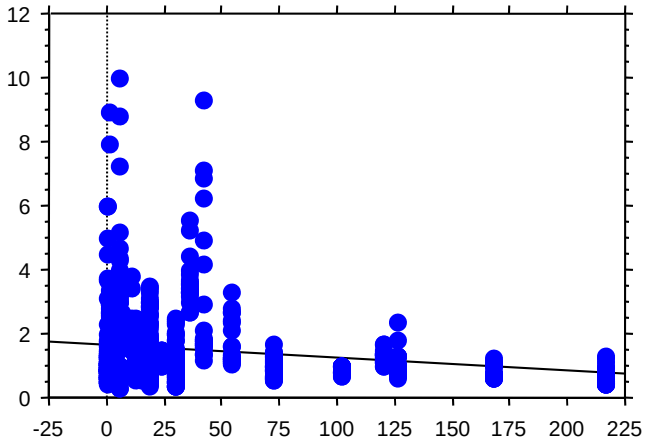
An alpha$_2$ (9-11Hz) /alpha$_1$ (7-9Hz) ratio was calculated in order to determine whether tinnitus duration alters alpha power values.

In **males** the bothsided and right sided tinnitus lead to an increase in the power of the alpha$_1$ band over time. However, males with a leftsided tinnitus exhibited no power changes for the alpha$_1$ band over time.

Ratio: Alpha$_2$/Alpha$_1$



Tinnitus duration / EEG changes: Females

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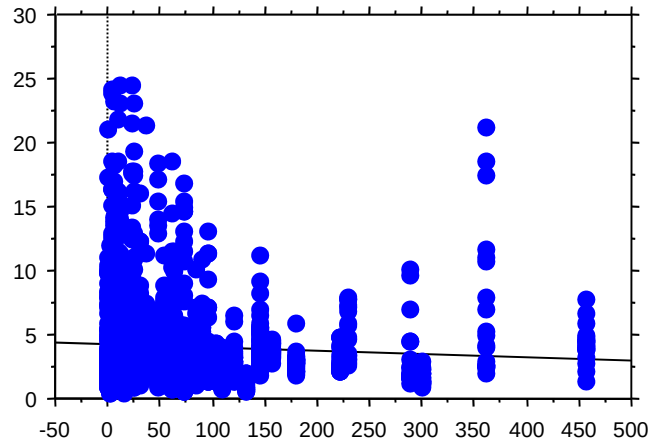
An Alpha/Theta ratio was in order to determine whether tinnitus alters alpha and /or theta power values in respect to tinnitus duration.

In **females** only the both-sided tinnitus subjects exhibited an increase in theta power in relation to alpha power values over time.

No changes were observed for subjects with a left or right-sided tinnitus.

Ratio: Alpha/Theta



Tinnitus duration / EEG changes: Males

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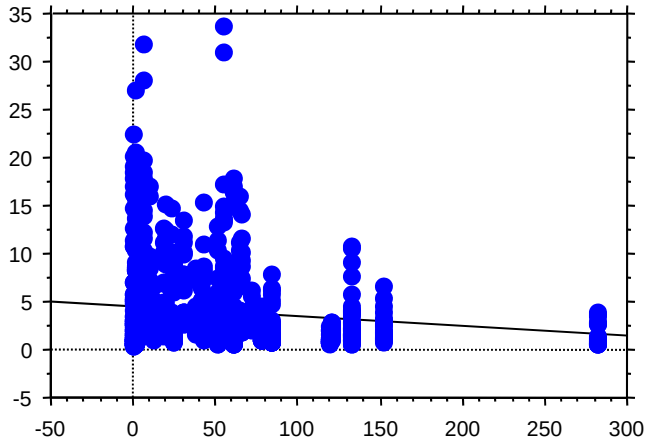
An Alpha/Theta ratio was calculated in order to determine whether tinnitus duration alters theta power values over time.

Males suffering from a right-sided or a both-sided tinnitus revealed an increase of theta power values in relation to alpha power values over time.

No correlation was found for subjects with a left-sided tinnitus.

Ratio: Alpha/Theta



Comparison: Alpha Power values of 3 tinnitus groups

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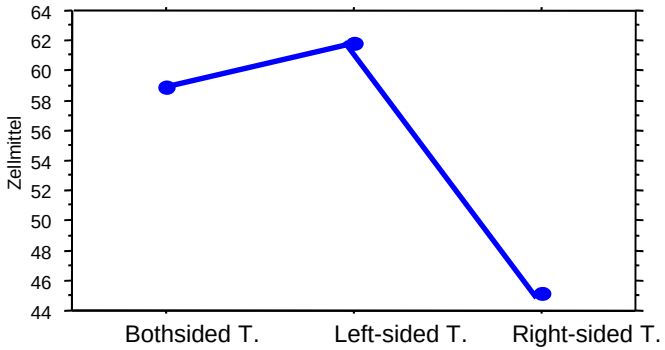
Females

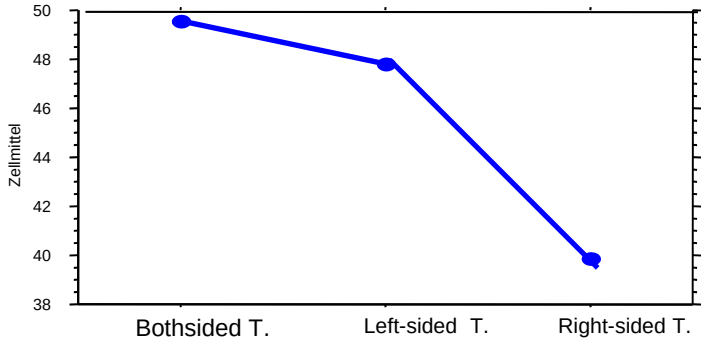
Alpha Power



	Mittelw. Diff.	Krit. Diff.	P-Wert	
beidseits, links	-2,887	7,169	,4298	
beidseits, rechts	13,789	7,658	,0004	S
links, rechts	16,676	8,822	,0002	S

Males

Alpha Power



	Mittelw. Diff.	Krit. Diff.	P-Wert	
beidseits, links	1,753	3,615	,3420	
beidseits, rechts	9,677	4,185	<,0001	S
links, rechts	7,924	4,902	,0015	S

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Comparison: Delta/Theta Power values of 3 tinnitus groups

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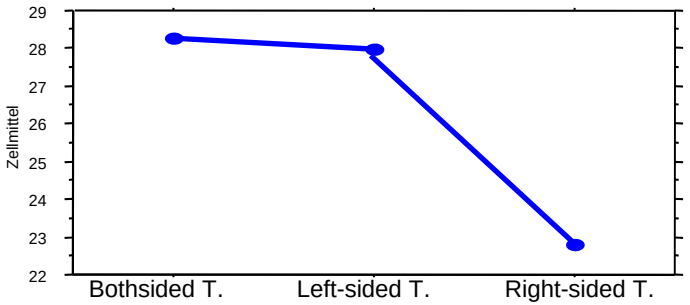
Females

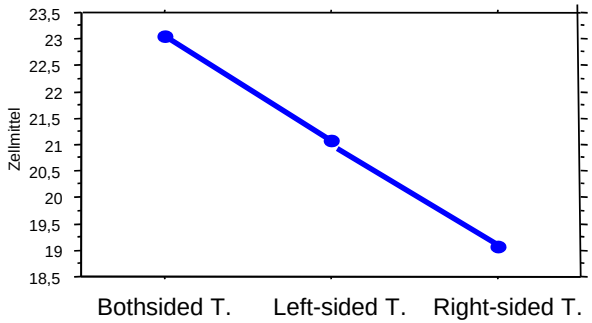
Delta-Theta



	Mittelw. Diff.	Krit. Diff.	P-Wert	
beidseits, links	,319	1,807	,7293	
beidseits, rechts	5,466	1,930	<,0001	S
links, rechts	5,147	2,224	<,0001	S

Males

Delta-Theta



	Mittelw. Diff.	Krit. Diff.	P-Wert	
beidseits, links	1,962	,848	<,0001	S
beidseits, rechts	3,985	,982	<,0001	S
links, rechts	2,022	1,150	,0006	S

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Tinnitus duration/Tinnitus Questionnaire

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Females

problems	Tinnitus location		
	both	left	right
emotional	ns	ns	0,002
cognitive	ns	0,04	0,05
psychological	ns	ns	0,006
annoyance	ns	ns	0,003
hearing	0,05	ns	ns
sleep	ns	0,04	ns
somatic	ns	ns	ns
total score	ns	ns	0,005

Males

problems	**Tinnitus location**		
	both	left	right
emotional	ns	ns	0,01
cognitive	ns	ns	ns
psychological	ns	ns	0,03
annoyance	ns	ns	0,05
hearing	0,03	0,01	ns
sleep	ns	ns	0,007
somatic	ns	ns	ns
total score	ns	ns	0,03

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Tinnituspattern: Delta and Theta Focus

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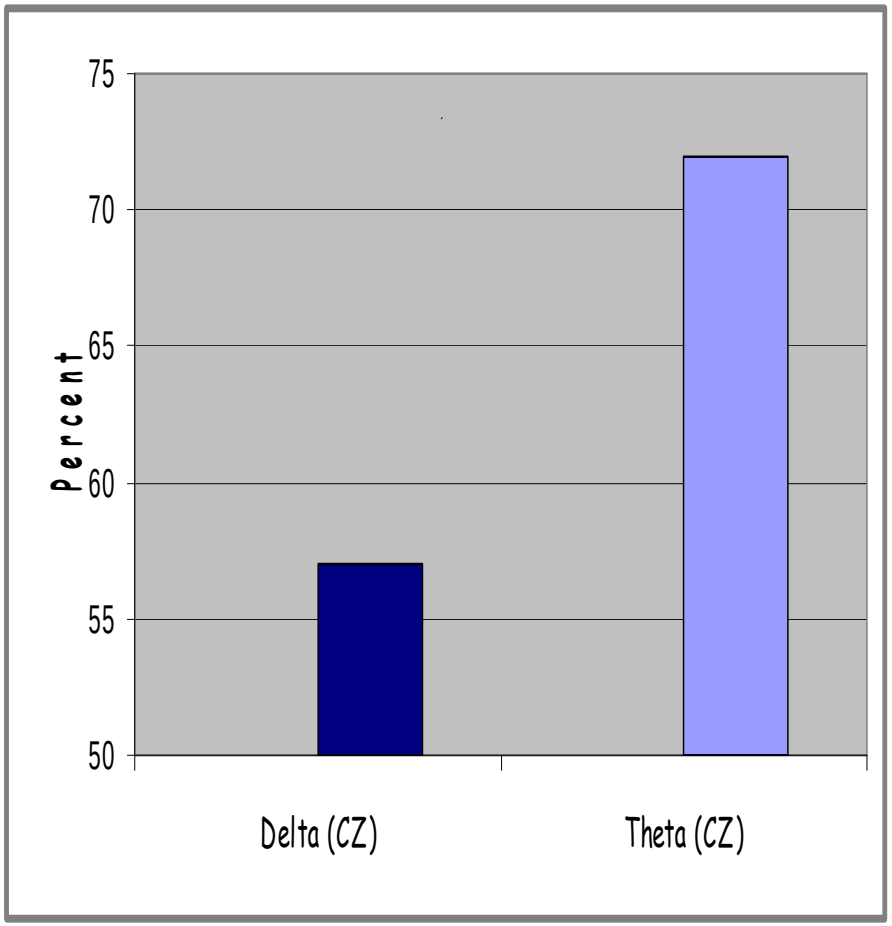

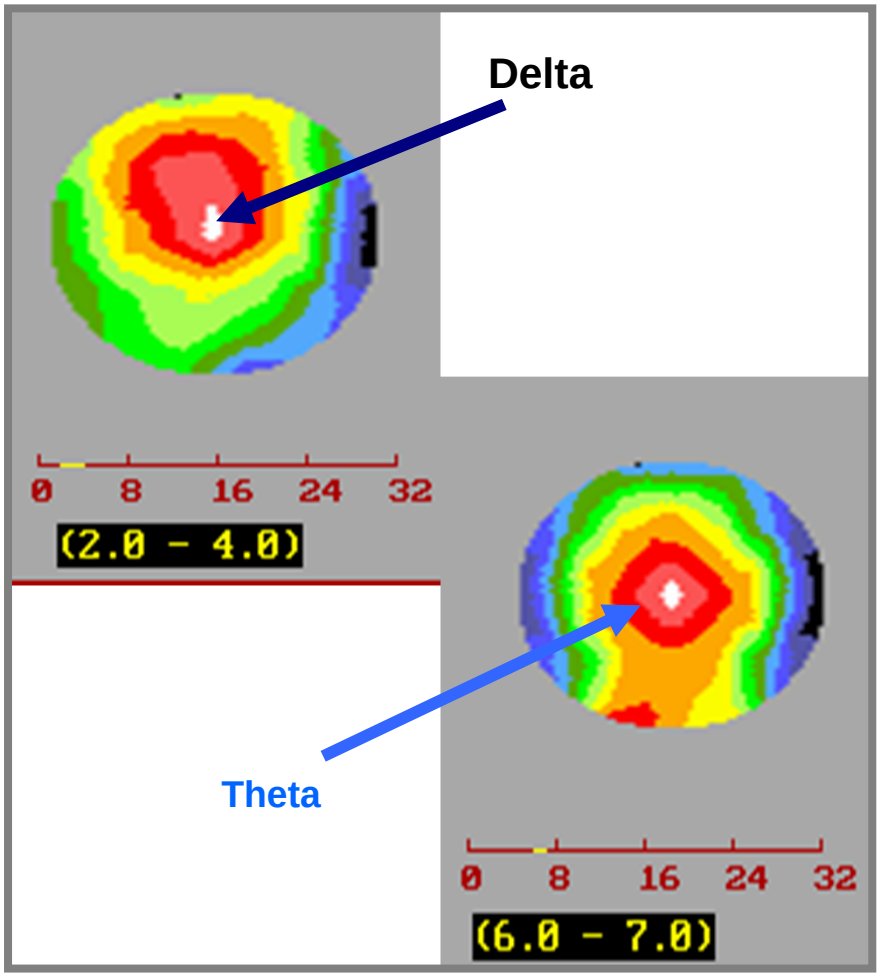

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Tinnituspattern: temporal$_{Delta}$>temporal$_{Alpha}$

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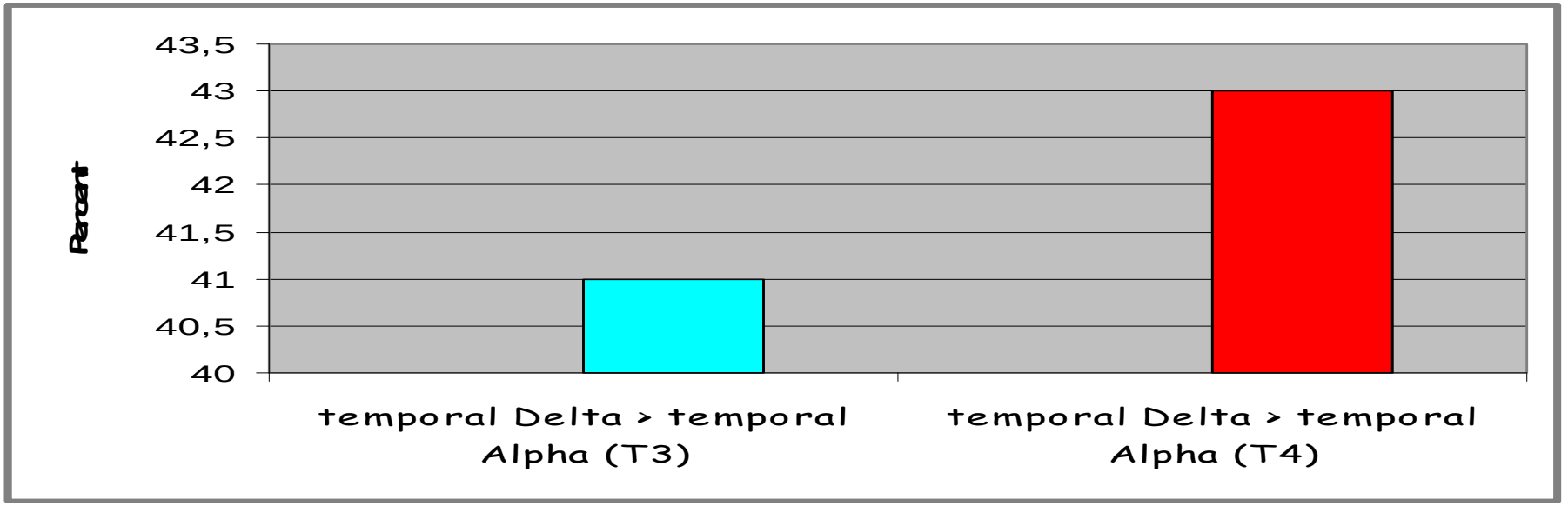

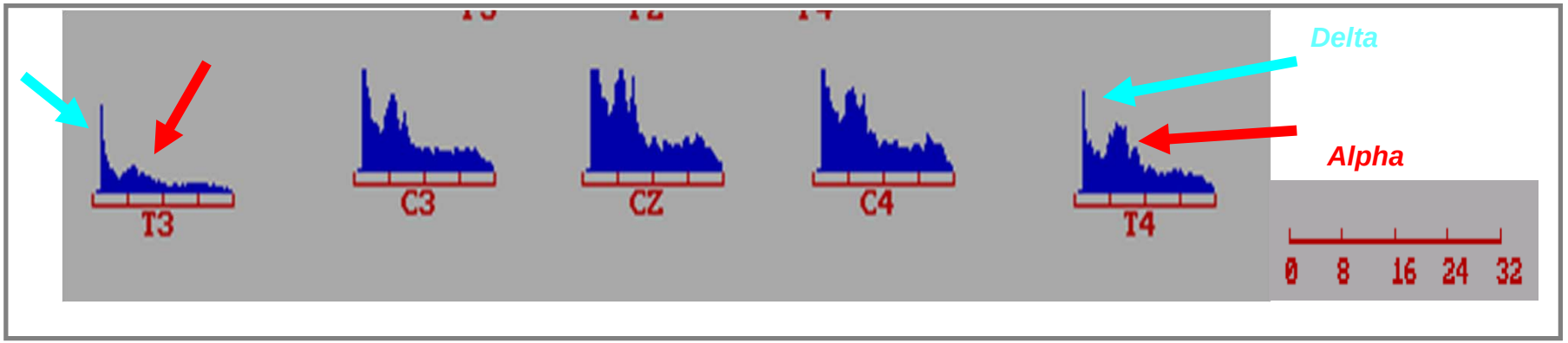

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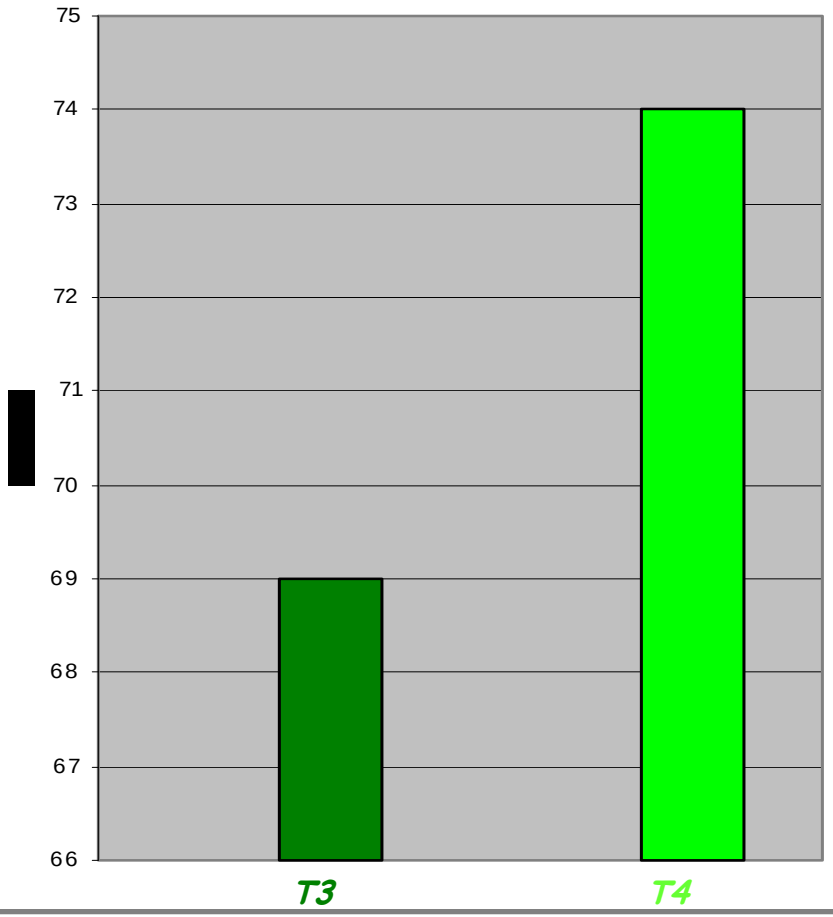
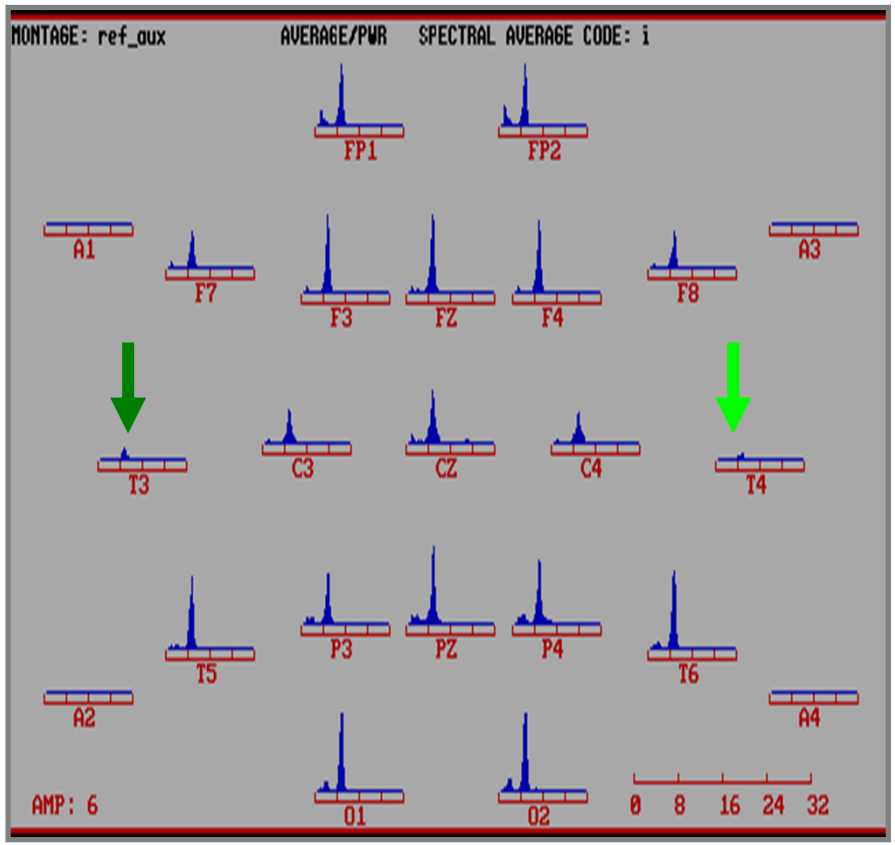
Tinnituspattern: Temporal$_{Alpha}$ Suppression





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Powerspectrum

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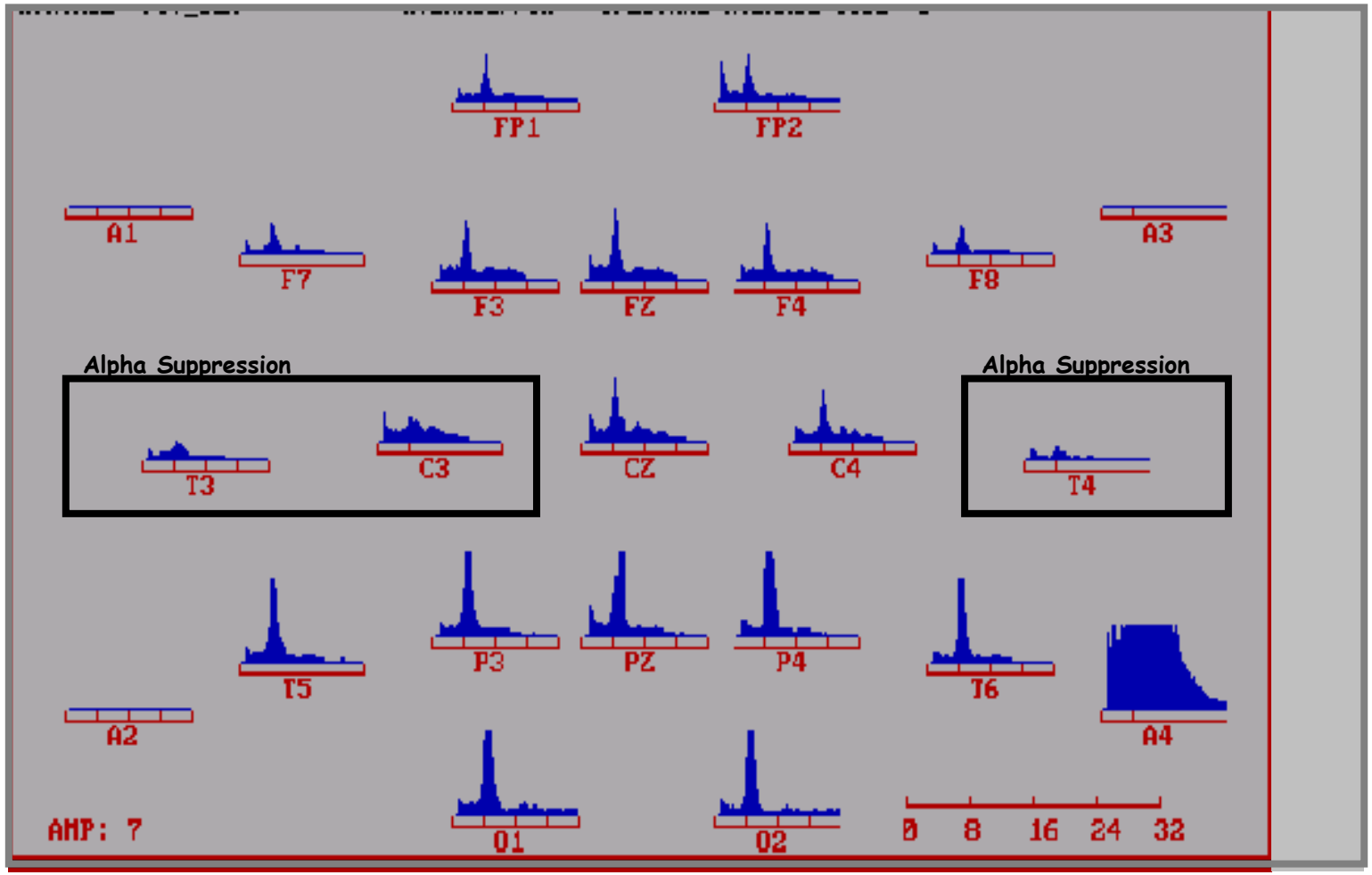

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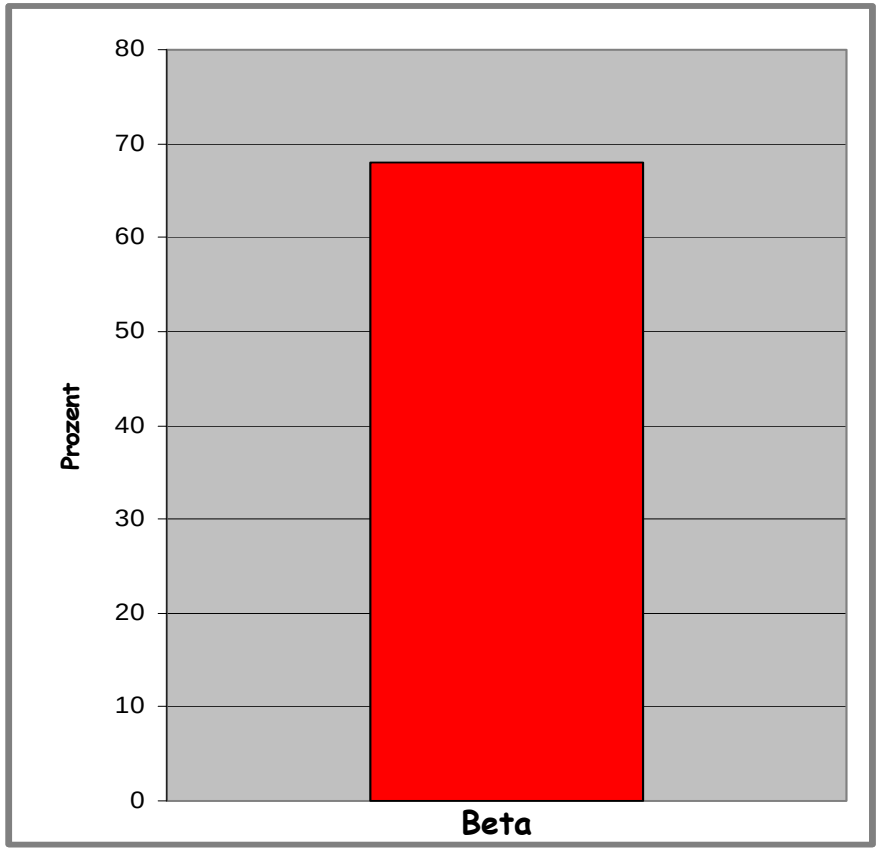
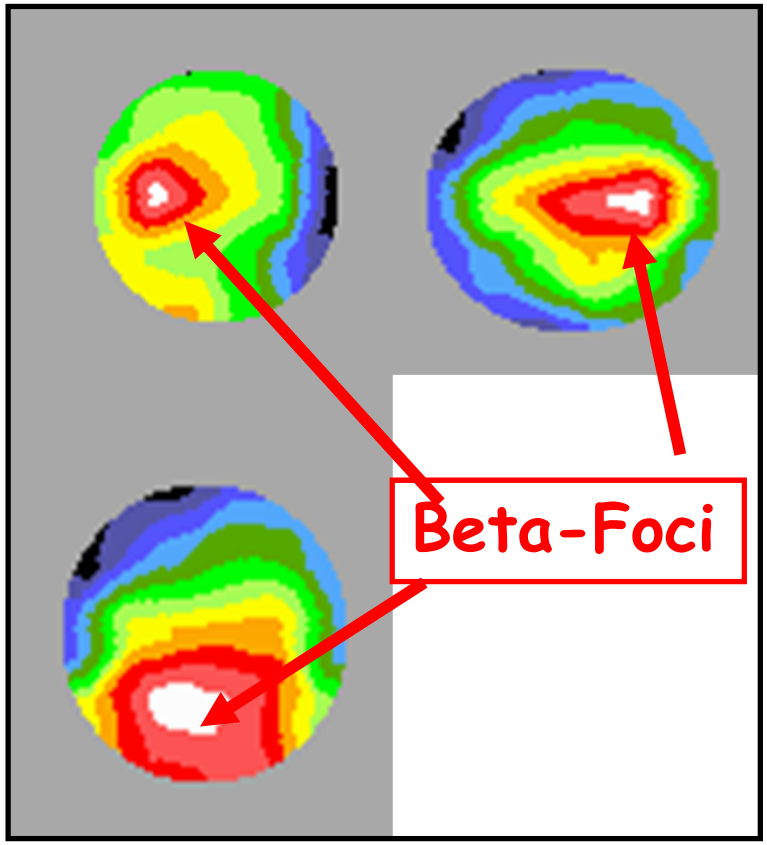
Tinnituspattern: Beta Power





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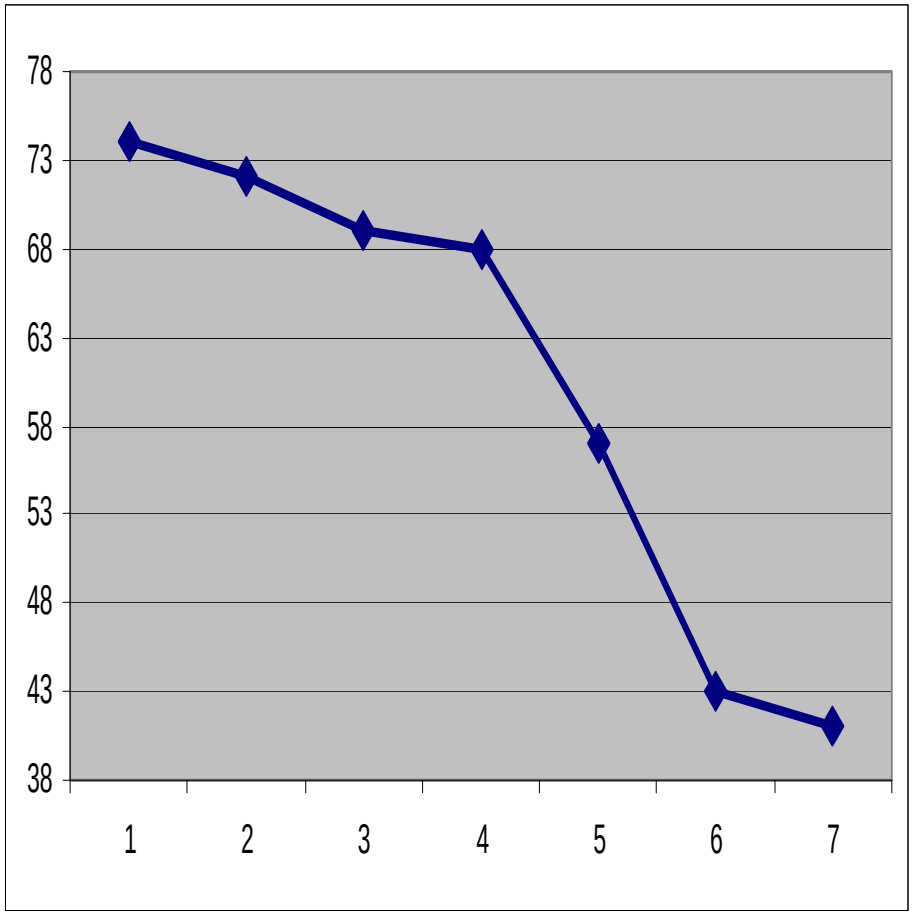
Incidence (%) of Tinnituspatterns



		%
1	T4 Alpha Suppression	74
2	Theta (CZ)	72
3	T3 Alpha Suppression	69
4	Beta: temp.-zentr.-pariet.	68
5	Delta (CZ)	57
6	T4 Delta>Alpha	43
7	T3 Delta>Alpha	41

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Tinnitusscore

Ranking	Items	Score (value)
1	**TAP**: Total average power	**3**
2	Alpha Suppression (T3)	**3**
3	Theta Fokus (CZ)	**3**
4	Beta-Fokus (temporo-zentro-parietal)	**3**
5	Alpha Suppression (T3)	**3**
6	Delta Fokus (CZ)	**1**
7	$T4_{Delta} > T4_{Alpha}$	**1**
8	$T3_{Delta} > T3_{Alpha}$	**1**

Score of	**5 to 6**	**Tinnitus**	**possible**
	7 to 11		**likely**
	11 to 13		**very likely**
	> 14		**certain**

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Summary

1. **Chronic Tinnitus leads to specific EEG changes:**

   in female & male tinnitus patients the alpha and theta bands seem to play a critical role.

2. **Brain maps and power spectrum revealed tinnitus specific patterns.**

3. **Right – sided tinnitus seems to be more stressful, than both- or left-sided tinnitus as reflected in EEG changes.**

3. **An EEG tinnitus score could be developed**

Tinnitus – measurable/visible with QEEG!

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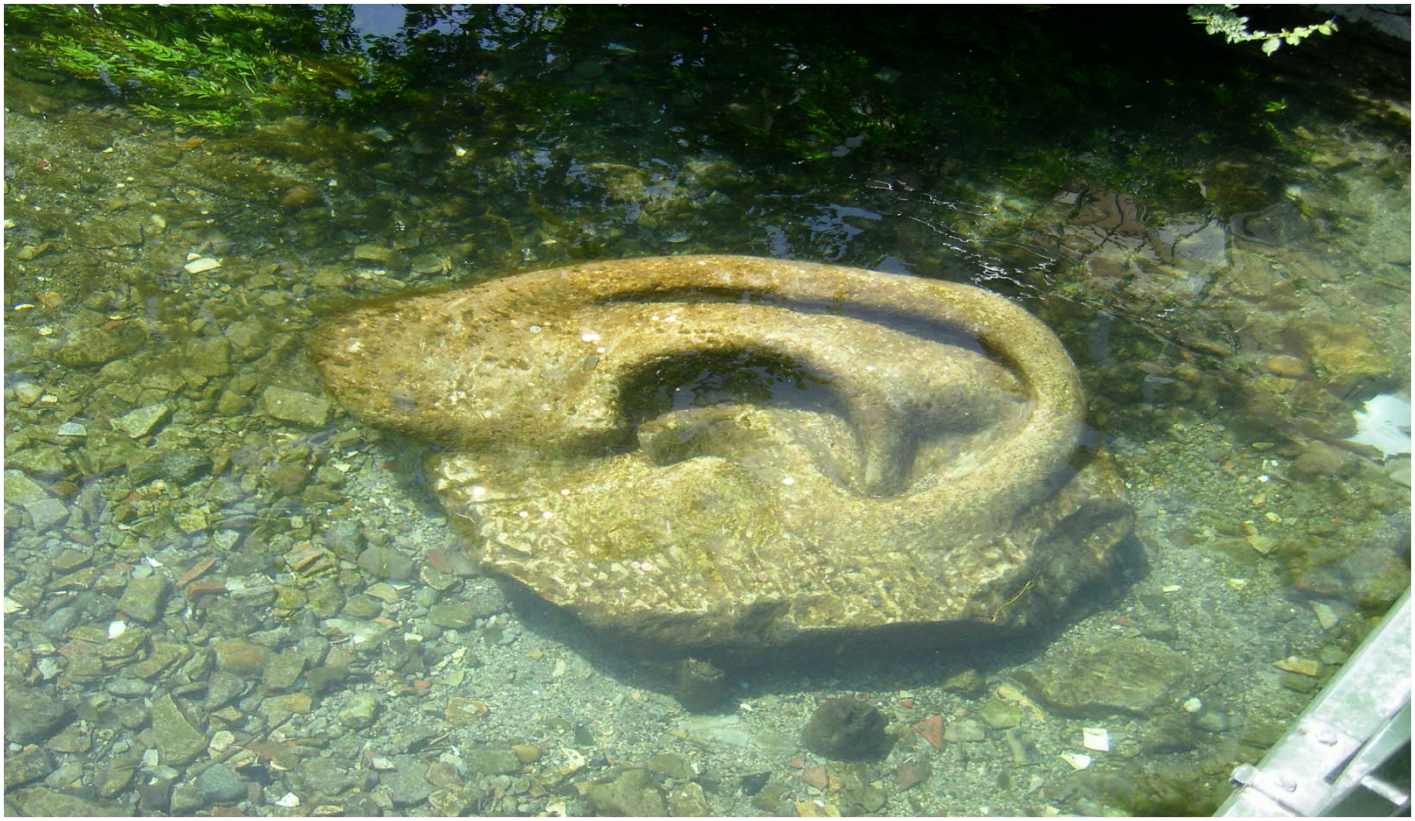

Thank you for your attention

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