

Mu-like Rhythms in Autistic Spectrum Disorder: EEG Analyses and Neurofeedback Outcome

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Mu rhythm and suppression in Autism: The Mirror Neuron System

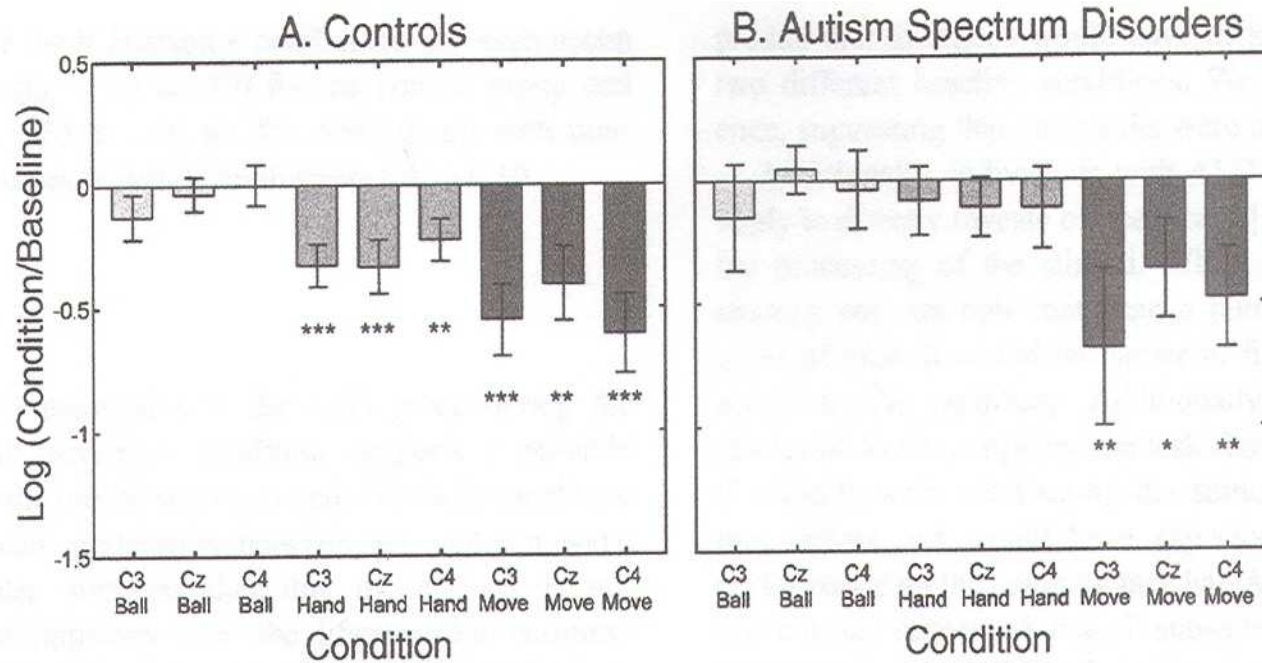
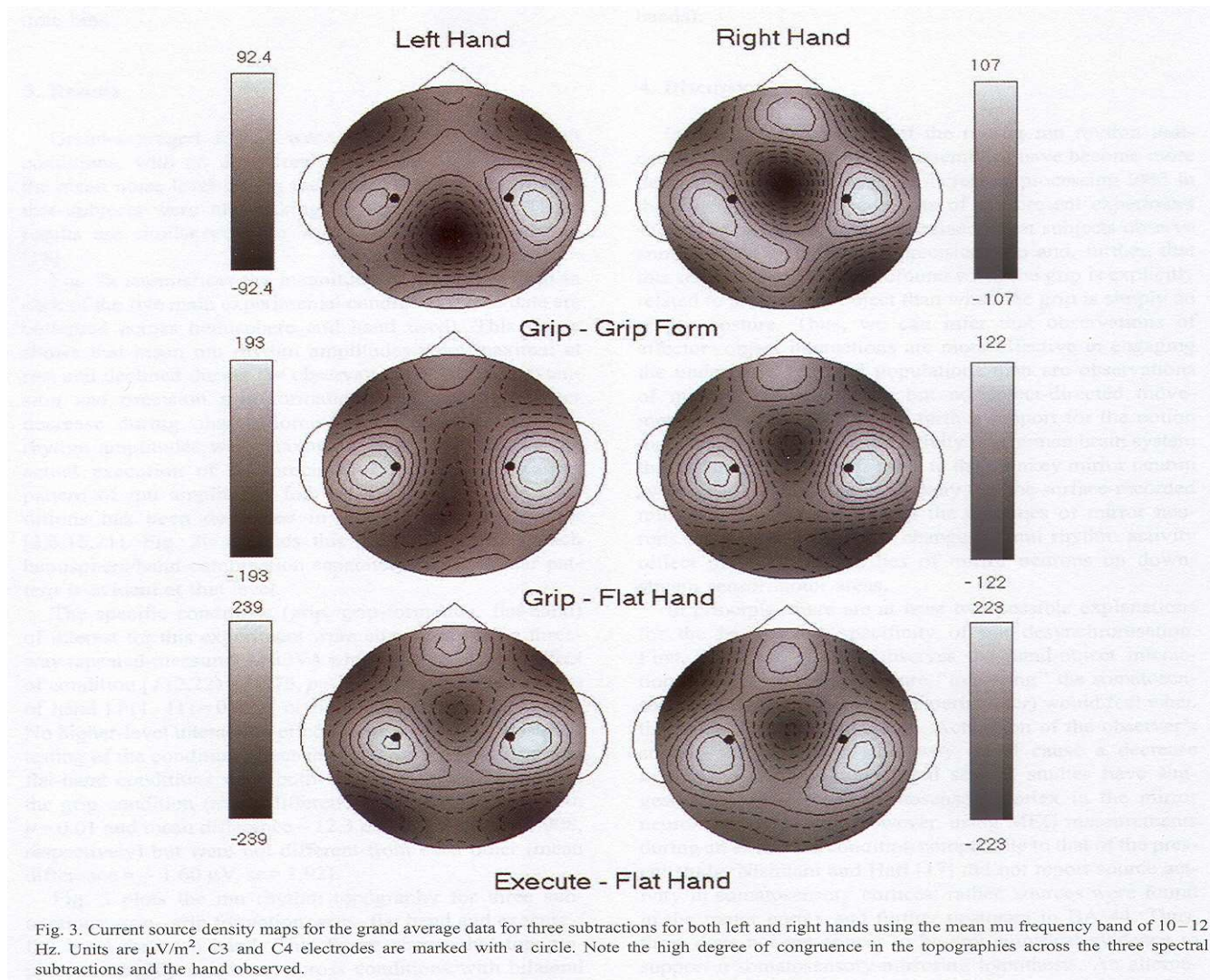


Fig. 1. Mu suppression in control and ASD participants. Bars represent the mean log ratio of power in the mu frequency (8–13 Hz) during the watching balls condition (light gray), watching hand movement condition (medium gray), and moving own hand condition (dark gray) over the power in the baseline condition for scalp locations C3, CZ, and C4 for typically developing individuals (A) and individuals with ASD (B). Error bars represent the standard error of the mean. For all values, a mean log ratio greater than zero indicates mu enhancement; a mean log ratio less than zero indicates mu suppression. Significant suppression is indicated by asterisks, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.005$.

Mu rhythm oscillations



The importance of Mu/MNS

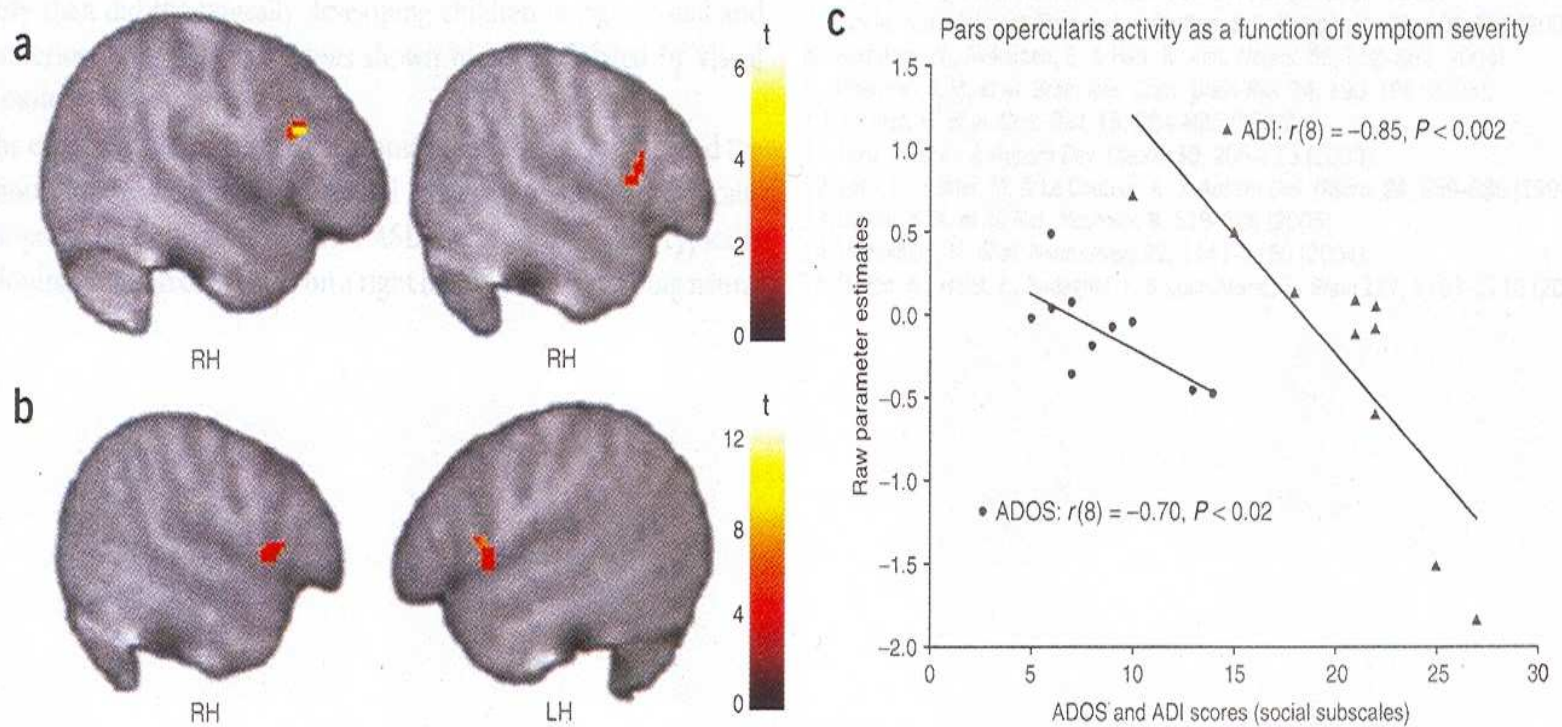


Figure 3 Mirror neuron system activity and symptom severity. (a–c) Negative correlations were found in the ASD group between activity in the pars opercularis of the inferior frontal gyrus and scores on the social subscale of both ADOS-G (a,c) and ADI-R (b,c). $t > 1.83, P < 0.05$, corrected for multiple comparisons at the cluster level.

Localization of Mu/MNS

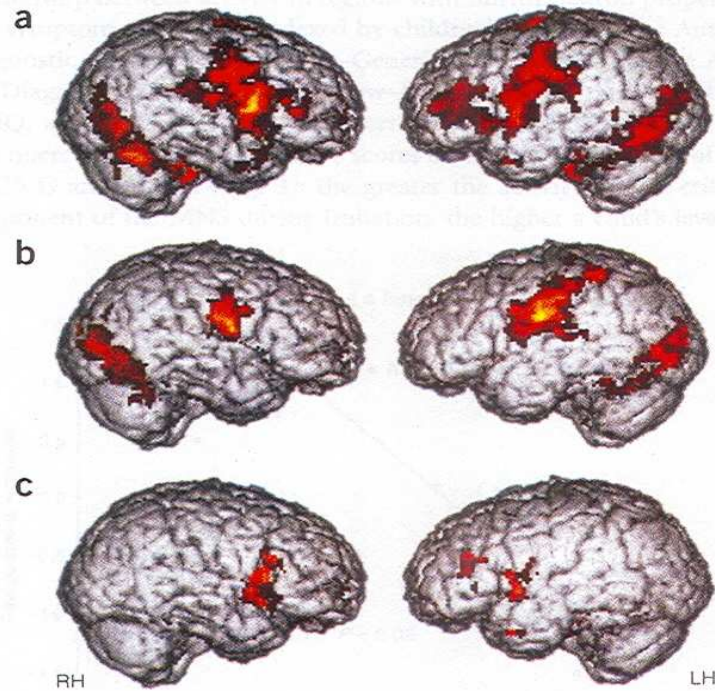


Figure 1 Reliable activity during imitation of emotional expressions. (a,b) Activity in bilateral pars opercularis (stronger in the right) of the inferior frontal gyrus is seen in the typically developing group (a) but not in the ASD group (b). A between-group comparison (c) revealed that this difference was significant ($t > 1.83$, $P < 0.05$, corrected for multiple comparisons at the cluster level). RH, right hemisphere; LH, left hemisphere.

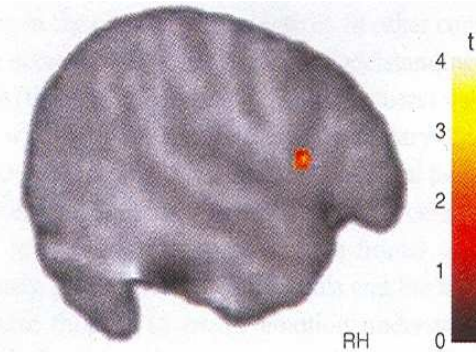
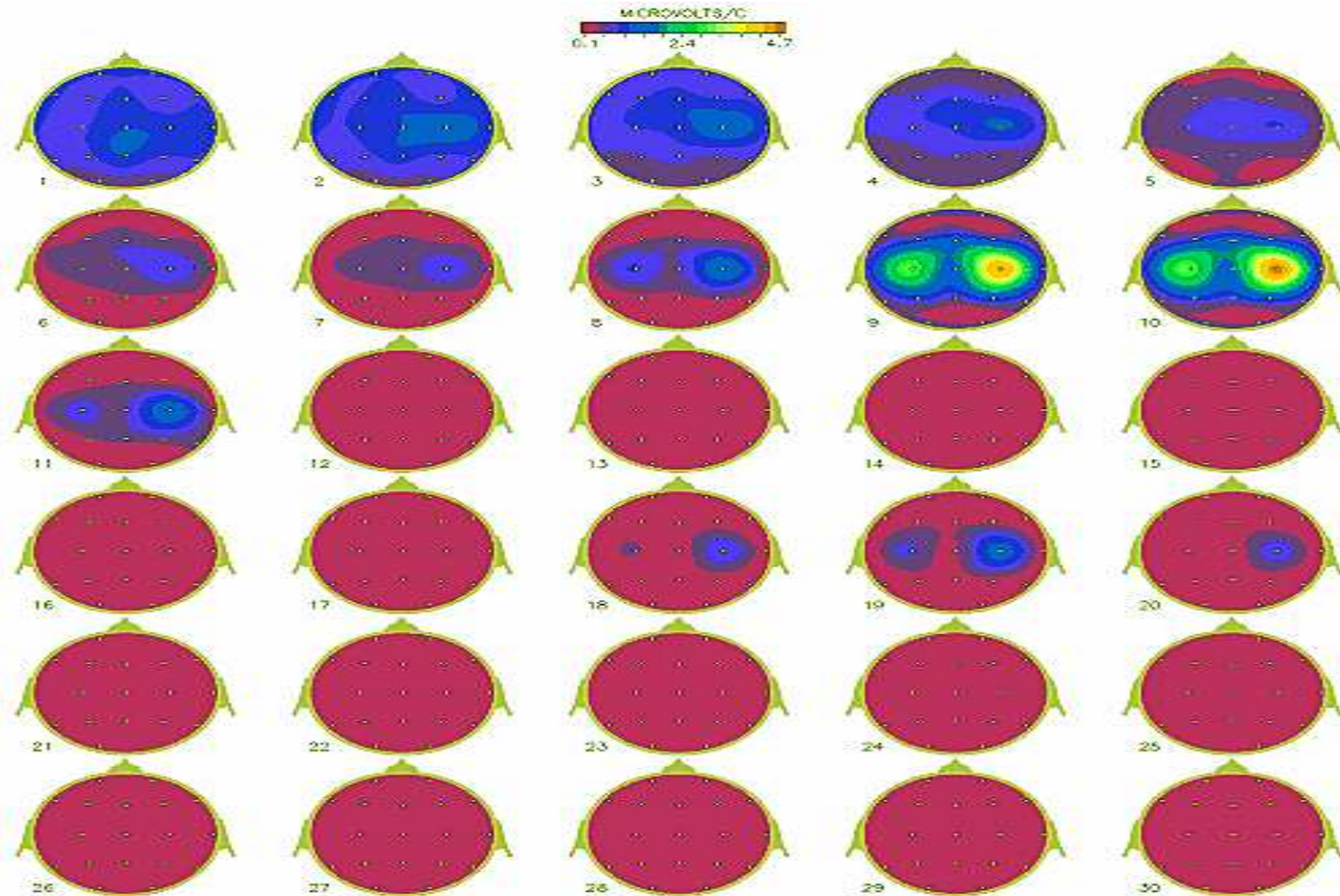


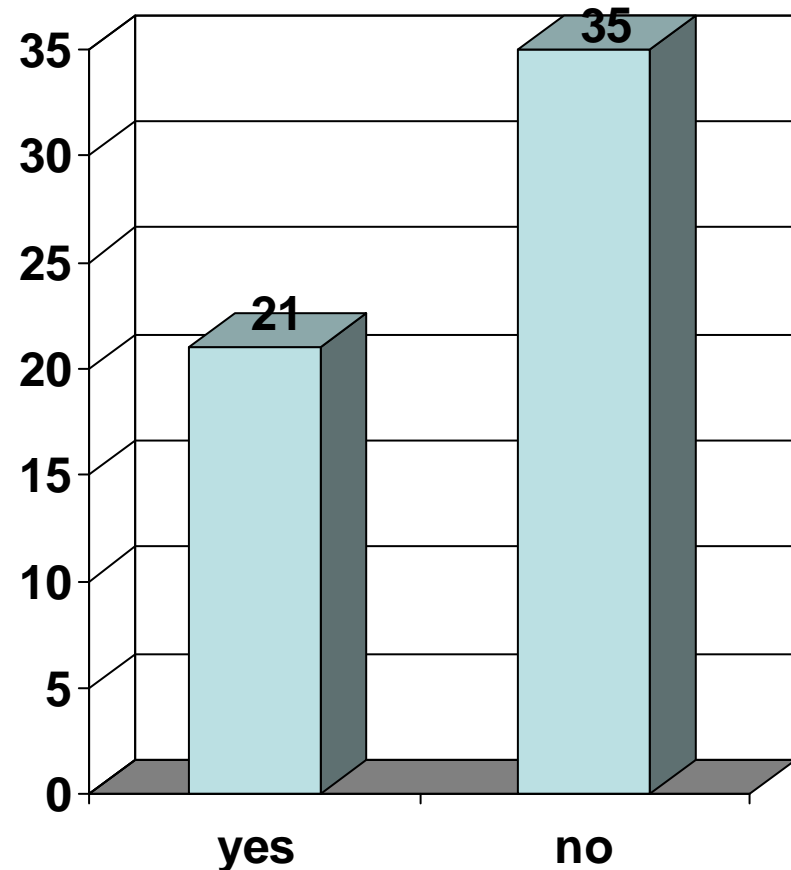
Figure 2 Mirror neuron system activity during observation of emotional expressions. The right pars opercularis showed significantly greater activity in typically developing children than in children with ASD ($t > 1.83$, $P < 0.05$, small volume corrected).

Example of Mu-like Rhythm Oscillations



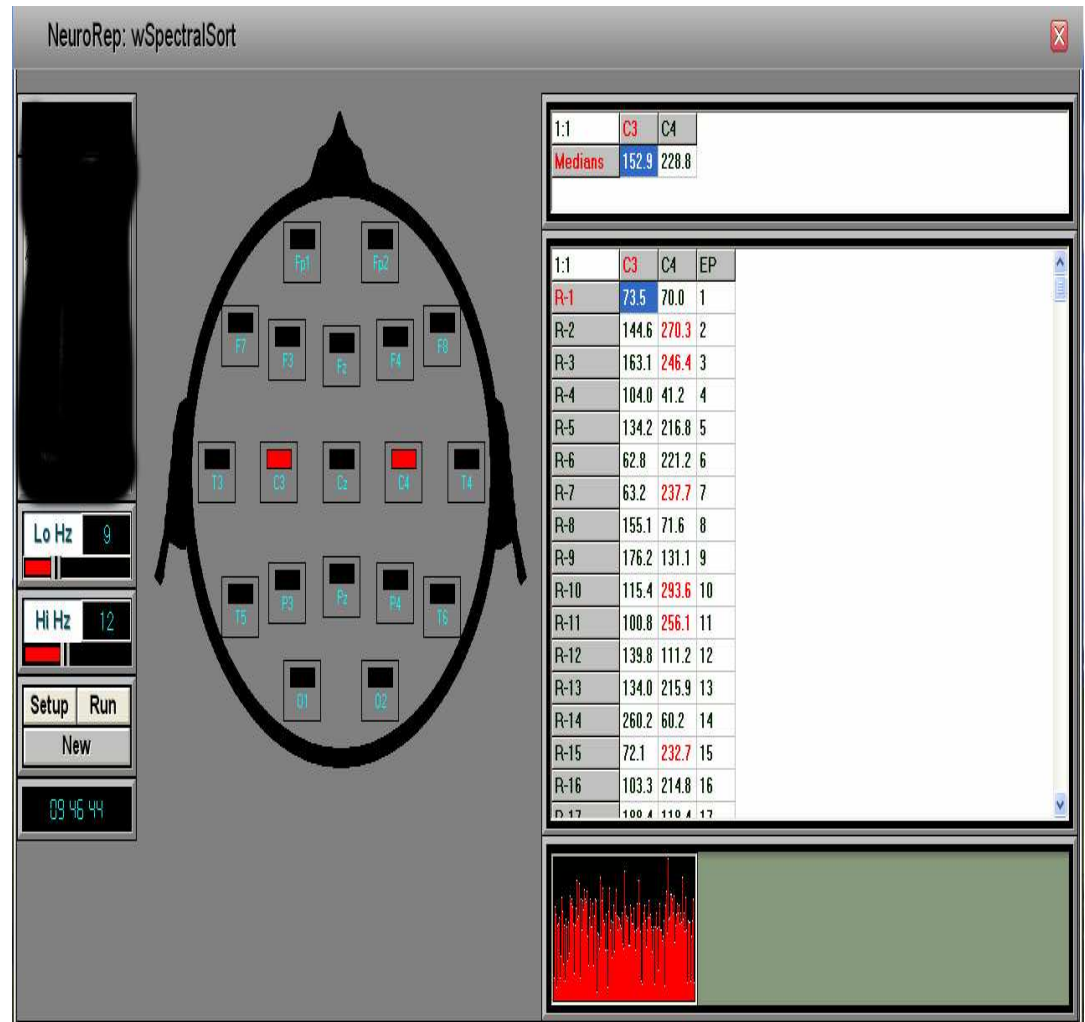
Part 1: EEG Analyses

- Sampled 56 QEEG profiles diagnosed with ASD and not taking any medications.
- Selected for mu-like rhythm oscillations over C3, C4.
- Activity did not diminish upon eye opening (lack of mu suppression).

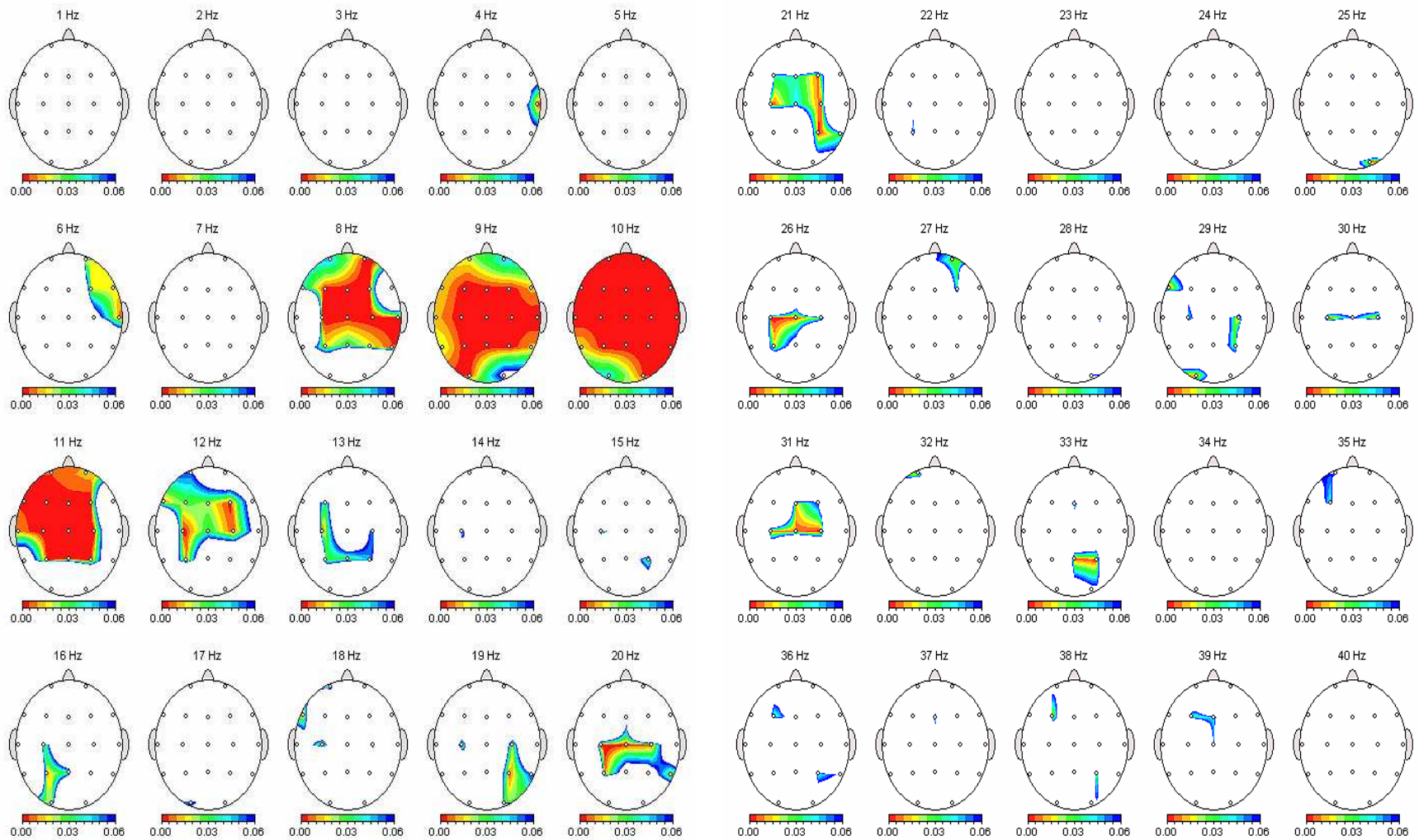


Part 1: EEG Analyses

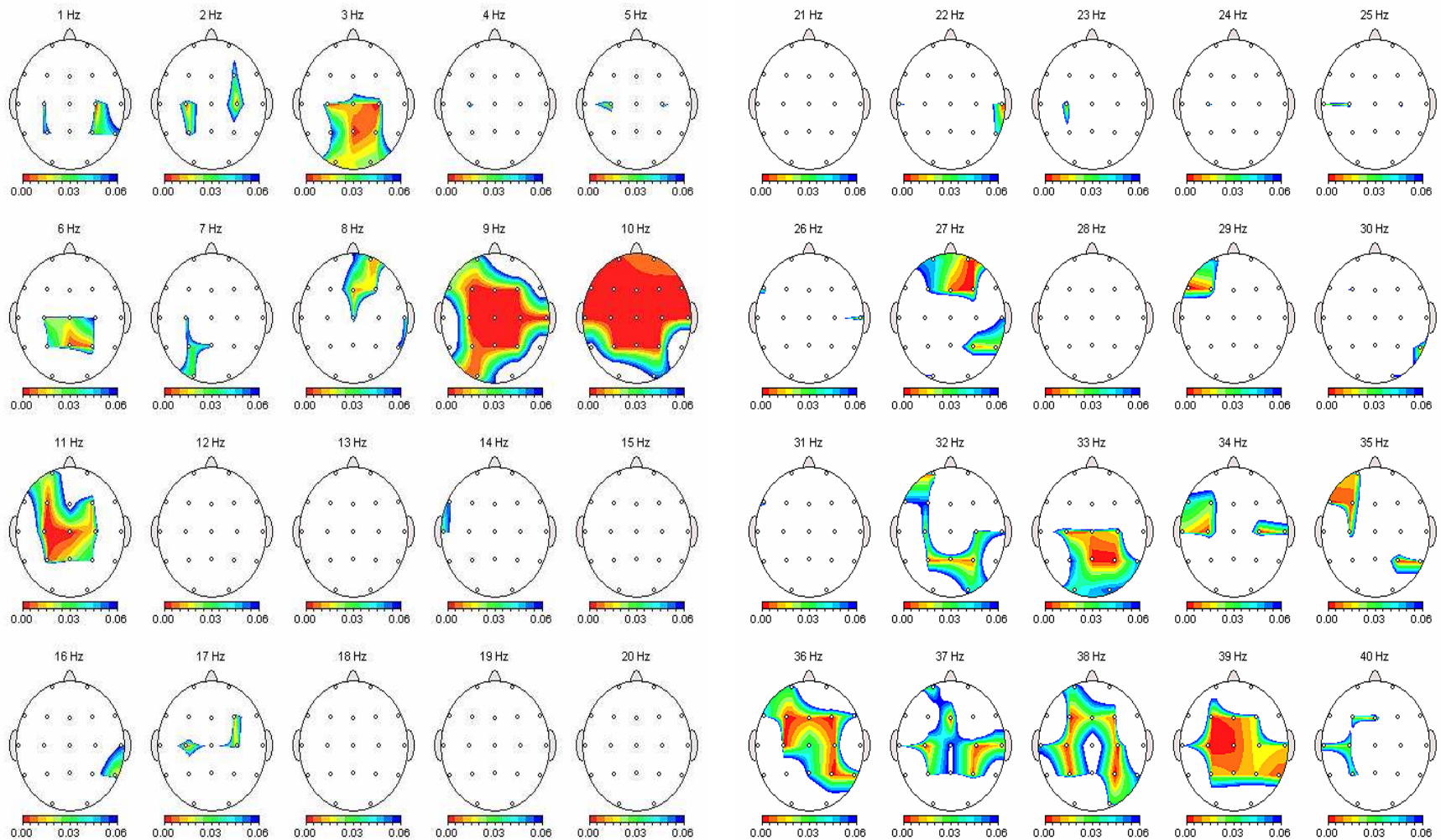
- C3, C4.
- 9 – 12 hz. Maximal
- 8 – 13 hz. Range
- Spectral Sort
Median splits
- C3: $p < .015$
- C4: $p < .021$
- Sorted into high
and low mu-like
records



Part 1: EEG Analyses: Comparison of High to Low Mu for Absolute Power



Part 1: EEG Analyses: Comparison of High to Low Mu for Relative Power



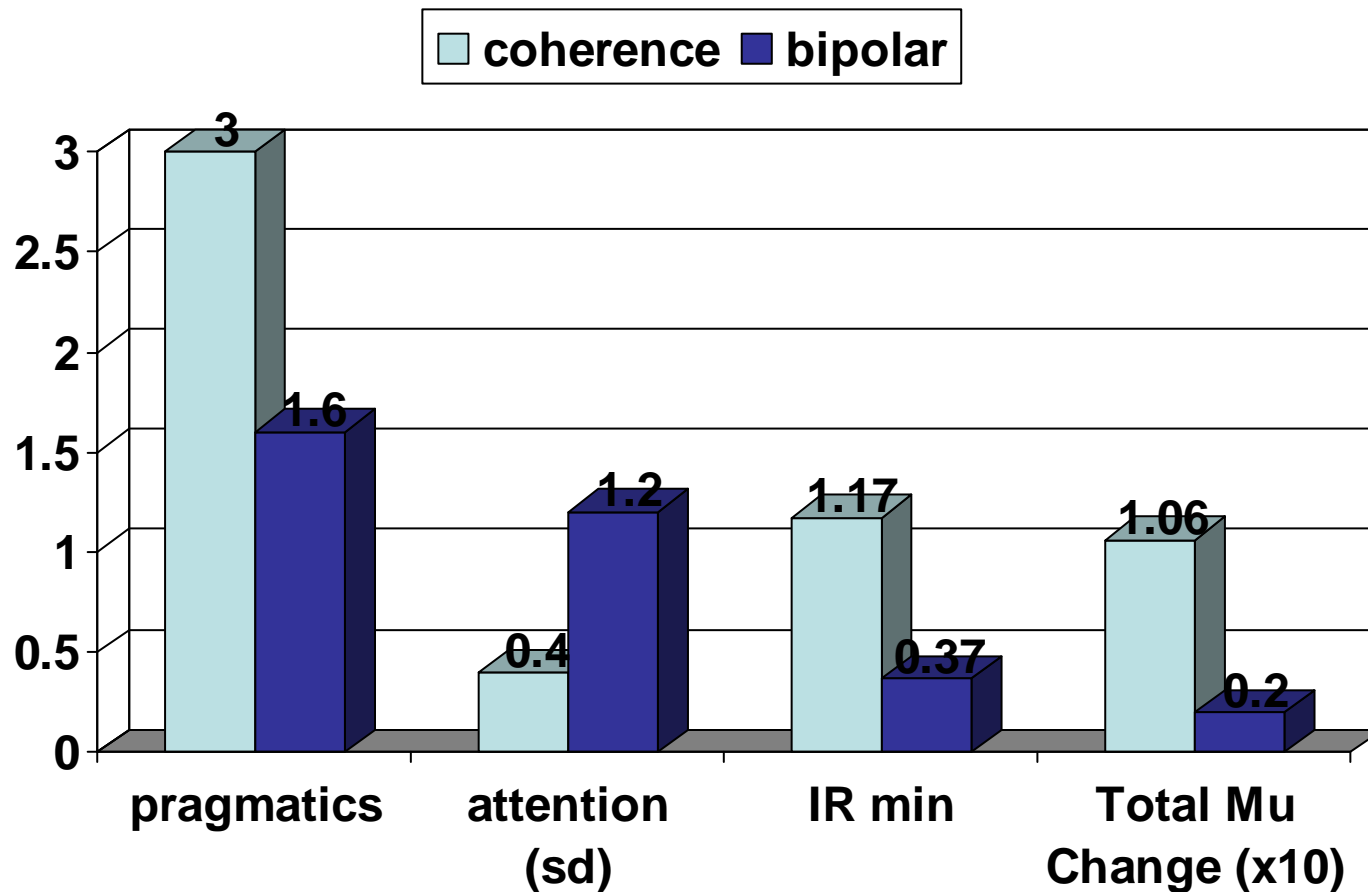
Part 2: Neurofeedback Outcome Study

- 14 patients underwent 20 sessions EEGBF.
- Pre-post NP tests, NB rating scales, IR imaging, QEEG.
- Two comparison groups:
 - Coherence training
 - Interhemispheric, bipolar training

Part 2: Neurofeedback Outcome Study

- Total NF group (14 patients) had significant changes in :
 - GADS Pragmatics – $p < .006$
 - GADS Social Interaction – $p < .027$
 - GADS ADQ – $p < .014$
 - Executive Functioning – $p < .0001$
 - Visuospatial Skills – $p < .004$
 - Attention – $p < .005$
 - IR enduring change – min value – $p < .033$
 - IR enduring change – range – $p < .05$

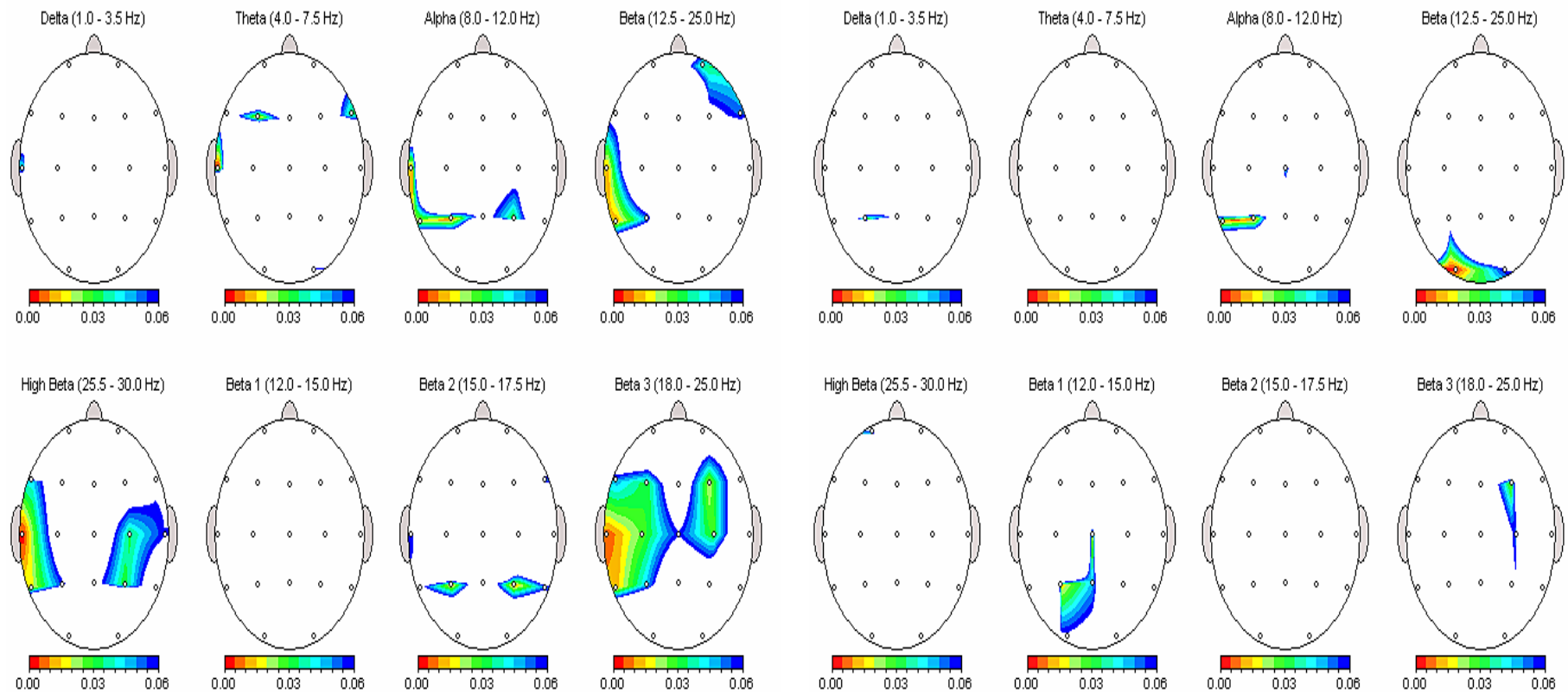
Part 2: Neurofeedback Outcome Study: Comparative Analyses



Part 2: Neurofeedback Outcome Study: Comparative Analyses: QEEG changes

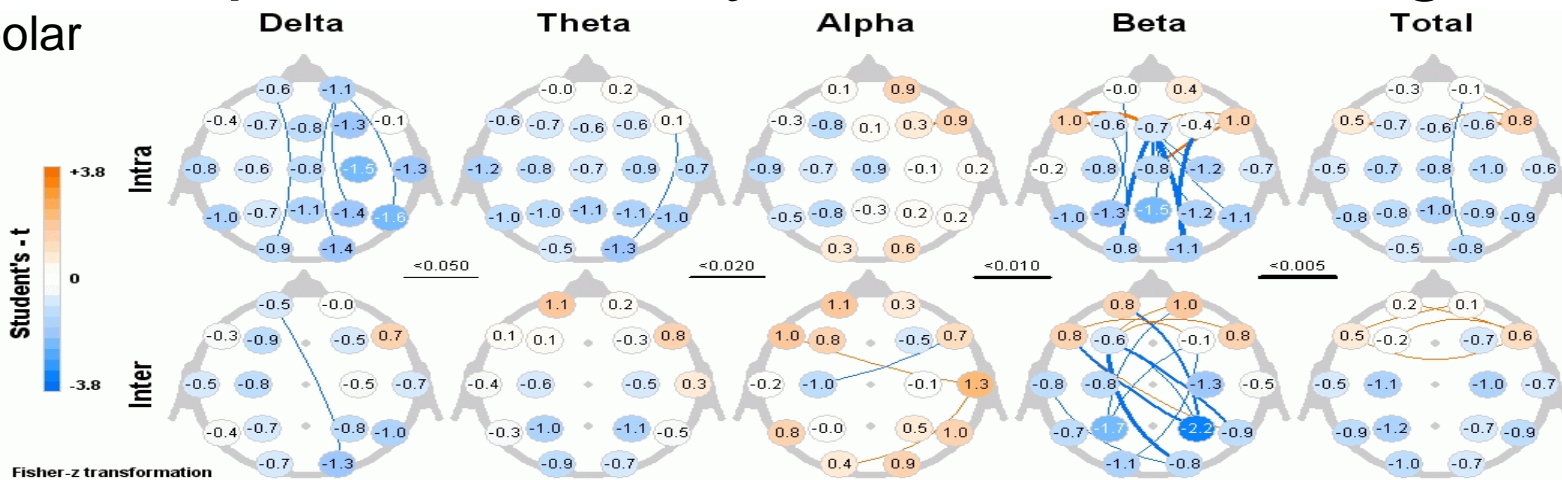
Bipolar/Interhemispheric

Coherence



Part 2: Neurofeedback Outcome Study: Comparative Analyses: QEEG changes

Bipolar



Coherence

