Connectivity guided EEG biofeedback as a treatment for Autistic disorders with and without seizures

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Diplomat, qEEG Certification Board
Presented at the 2011 Autism One Annual Meeting
Chicago, Illinois

Connectivity theory of Autism

Connectivity Theory of Autism: Use of Connectivity Measures in Assessing and Treating Autistic

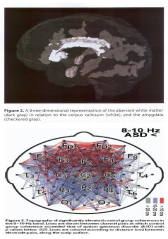
Authors:Coben, R.; Myers, T.Source:Journal of Neurotherapy, Volume 12, Issue 2-3, p.161-179 (2008)

Layperson Summary: Neurofeedback may be able to change the way neurons in the brain connect (neural networks) and improve the symptoms of autism. Many studies have noted that the brains of children with autism seem larger. The different structures in the brain also seem to be different in people with autism. Other studies have noted that people with autism tend to have lower levels of brain activity as measured by oxygen levels in the brain. This study describes the theory that suggests that autism is the result of poor neural networks in the brain. These networks can be seen and measured using electroencephalography (EEG).

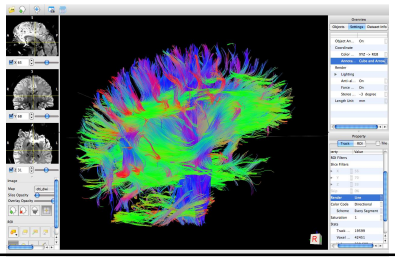
From: Healing Thresholds.com

Connectivity theory of Autism

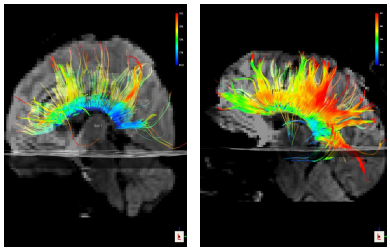
- **Epigenetic etiology leading to neural inflammation.**
- **Genetic findings on chromosomes 16, 11, and 7q31 MET receptor tyrosine kinase.**
- **Neural connectivity anomalies underlie the brain dysfunctions in autistic children.**
- **These neural connectivity disturbances lead to regional brain dysfunctions.**
- **Autistic children have overlapping neurophysiological dysfunctions.**



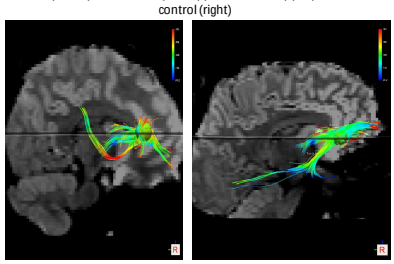
TrackVis fiber tracking of all neuronal pathways in a normal control (right sided view)



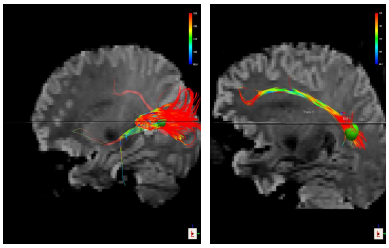
DTI of Corpus Callosum connectivity. Patient with Autism (left) and Normal control (right)



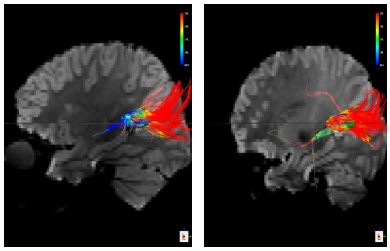
Inferior Frontal Gyrus connectivity. Patient (Case 1) with Autism (Mu suppression deficit) (left) and Normal control (right)



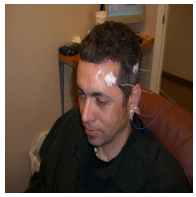
Superior temporal gyrus (Brodmann area 22/Wernicke's) connectivity. Patient 2 (Autism with left seizure foci and impaired speech) (left) and normal control (right)

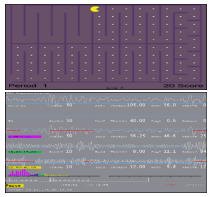


Superior temporal gyrus (Brodmann area 22/Wernicke's) connectivity. Patient 2 (Autism with left seizure foci and impaired speech) (right) and his brother with more severe symptomatology who is non-verbal (left)



What is Neurofeedback?





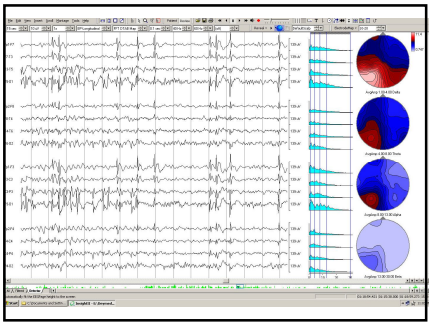
Human EEG biofeedback was first attempted in the 1960s by Joe Kamiya at the University of Chicago. Early investigations focused on operant conditioning of alpha brain waves primarily to facilitate deep relaxation and meditation.

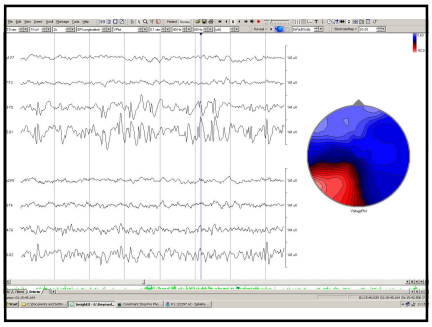
SMR/beta biofeedback developed from operant conditioning of cats' EEG. Barry Sterman of UCLA serendipitiously discovered that when cats were exposed to toxic chemicals that usually induce epileptic seizures, those who had been trained in the middle to high frequency range (12-20 Hz) from a previous unrelated experiment had greater latency to seizure onset, and a higher threshold for seizure onset, than untrained cats. These results were replicated in monkeys and humans. The results with humans were subsequently replicated in some twelve research centers, comprising some twenty studies. After several years of treating patients with intractable seizures with SMR biofeedback, it was noted that the hyperactive children not only had decreased seizure activity, but their behavior improved as well.

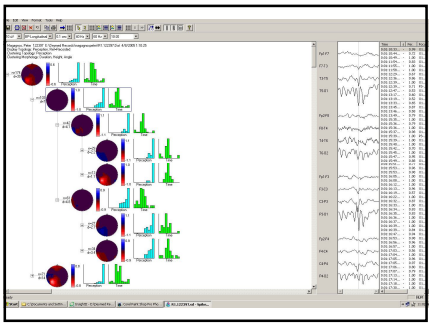
In the mid 70's, Joel Lubar at the University of Tennessee examined the effect of neurofeedback on hyperactivity absent any seizure history.

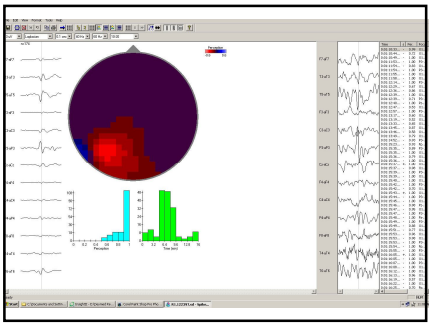
EEG biofeedback – Case 1

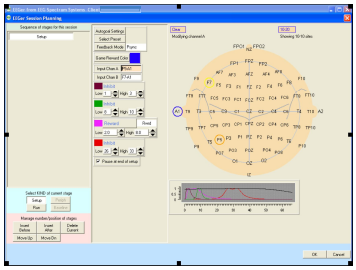
- 7 year old by diagnosed with PDD at the age of 5
- Born 36 weeks gestation due to gestational diabetes with high liver enzymes
- Walked at 2 years and spoke in utternaces by 3 years
- Difficulties with focusing, sitting still, temper outbursts, socialization, head banging, repetitive behaviors
- FSIQ = 80; Verbal IQ 75; Performance IQ = 90
- Impairments in receptive language, motor sequencing, visual-perceptual analysis.
- Unable to read or identify letters



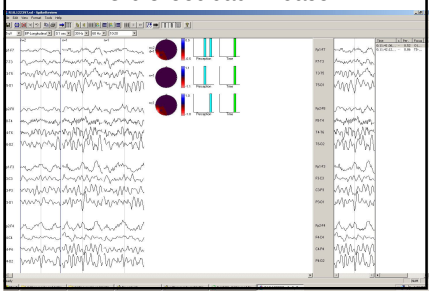




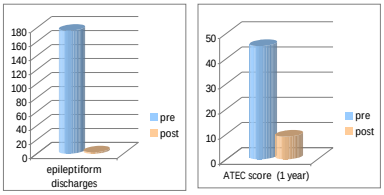




EEG biofeedback – Case 1



EEG biofeedback – Case 1



Neuropsychological measures all within normal limits, except receptive language rated as mildly impaired. Went from being alexic to now reading within one year of his age.

Efficacy of Connectivity Guided Neurofeedback for Autistic Spectrum Disorder: Controlled Analysis of 75 cases With a 1- to 2-year Follow-up

I'm not misbehaving

I have Autism

Please be understanding

Robert Coben, PhD

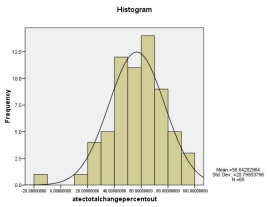
Presented at the 16th Annual ISNR Conference
San Antonio, Texas
August 30th, 2008

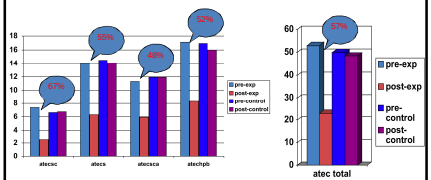
Sample

- 110 subjects on the autistic spectrum, 85 in the experimental and 25 the control group.
- Age: mean = 9.72, sd = 3.1, range = 4 – 20.
- Medication: 77% none, 14% 1, 7% 2, 1% 3.
- IQ: mean = 93, sd = 15.3, range = 50 – 130.
- ATEC: mean = 50, sd = 13.4, range = 35 – 110.
- Sessions: mean = 74.2, sd = 22.4, range = 40 – 170.
- No sign diff for age, gender, hand, race, meds, iq, atec.

ANOVA

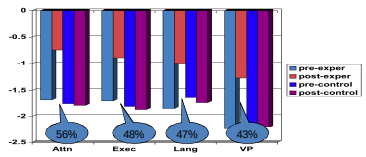
		Sum of Squares	df	Mean Square	F	Sig.	
atecscchange	Between Groups	555.078	1	555.078	49.806	.000	3.7219e-010
	Within Groups	980.745	88	11.145			
	Total	1535.822	89				
atecschange	Between Groups	1078.657	1	1078.657	78.754	.000	7.4479e-014
	Within Groups	1205.298	88	13.697			
	Total	2283.956	89				
atecscachange	Between Groups	626.876	1	626.876	41.595	.000	5.8738e-009
	Within Groups	1326.246	88	15.071			
	Total	1953.122	89				
atechpbchange	Between Groups	1519.036	1	1519.036	40.566	.000	8.4097e-009
	Within Groups	3295.286	88	37.446			
	Total	4814.322	89				
atectotalchange	Between Groups	14242.801	1	14242.801	117.213	.000	7.3570e-018
	Within Groups	10693.022	88	121.512			
	Total	24935.822	89				





ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	
Attnchange	Between Groups	18.802	1	18.802	54.038	.000	7.1610e-011
	Within Groups	32.706	94	.348			
	Total	51.507	95				
Execchange	Between Groups	13.963	1	13.963	15.647	.000	0.00015
	Within Groups	81.206	91	.892			
	Total	95.169	92				
Langchange	Between Groups	9.933	1	9.933	31.241	.000	1.2653e-006
	Within Groups	14.307	45	.318			
	Total	24.240	46				
VPchange	Between Groups	22.677	1	22.677	53.599	.000	1.6074e-010
	Within Groups	34.269	81	.423			
	Total	56.946	82				



Multiple Comparisons

Dependent Variable: atectotalchangepercentout
Tukey HSD

(I) fsiqlevel	(J) fsiqlevel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
low fsiq	average fsiq	-2.8411	3.4454	.319	-.0452466	.3025880
	high fsiq	-6.5987*	3.8597	.766	-.4323901	.0491190
average fsiq	low fsiq	2.8411	3.4454	.319	-.0302588	.4524657
	high fsiq	-3.7576	3.7297	.836	-.4912798	.3602225
high fsiq	low fsiq	6.5987	3.8597	.766	-.0491119	.3239012
	average fsiq	3.7576	3.7297	.836	-.3602222	.9127977

Multiple Comparisons

Dependent Variable: atectotalchangepercentout
Tukey HSD

(I) atectotalfc	(J) atectotalfc	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
low atectotalfc	average atectotalfc	-3.9439	4.4282	.995	-.275453	.3154415
	high atectotalfc	-3.4648	7.3798	.870	-.162586	.577525
average atectotalfc	low atectotalfc	3.9439	4.4282	.995	-.315442	.545306
	high atectotalfc	.4791	6.1490	.875	-.243619	.1780751
high atectotalfc	low atectotalfc	3.4648	7.3798	.870	-.457752	.625857
	average atectotalfc	-.4791	6.1490	.875	-.678075	.1438192

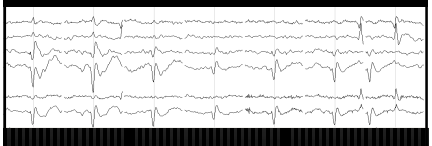
Groups divided into quartiles based on IQ and ATEC.

IQ 50 – 83 / 84 – 103 / 104 – 130

ATEC 35 – 50 / 51 – 64 / 65 – 105

Compared this estimates of level of functioning to ATEC change scores. No significant differences.

Intensity of Epileptiform Discharges and Neural Organization in Autistic Children: Impact on Neurofeedback Training



Robert Coben, PhD
William J. Hudspeth, PhD

Presented at the 2010 AAPB Annual Meeting, San Diego, CA

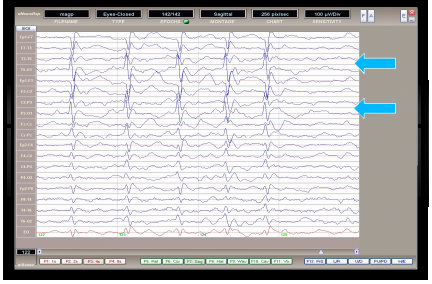
Seizures in ASD

- ✓ Prevalence of at least 20% (Canitano, 2007)
- ✓ As high as 46% (Hughes & Melyn, 2005)
- ✓ Average prevalence of 36%
- ✓ Associated with increasing cognitive/intellectual disability
- ✓ May be more likely in girls with ASD
- ✓ Paroxysmal discharges occur at even higher rates in ASD
- ✓ Spikes appear to reflect underlying intracranial foci, morphological brain abnormalities, and/or metabolic disturbances

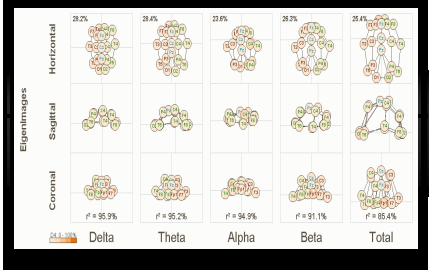
Regression in ASD

- 20 – 30% of all autistic children have a regression in speech or behavior early in life (Canitano, 2007)
- More severe symptomatology, speech and behavior
- The EEG is abnormal in a greater proportion of autistic children that regress
- Is regression associated with seizure disorders in ASD?
- Mixed findings: some show seizures to be related to regression and others do not
- No other factor has been found to be related to regression
- EEG's are recommended in the evaluation of autistic disorders

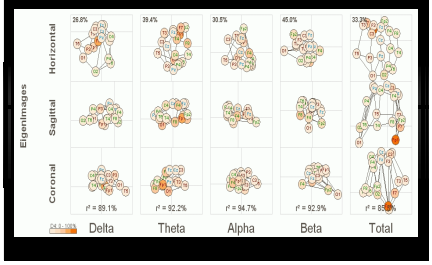
Raw EEG Waveforms (Longitudinal)



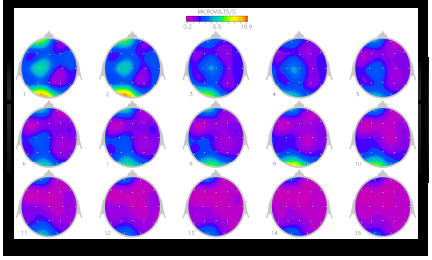
Normal EC Neuroelectric Eigenimage



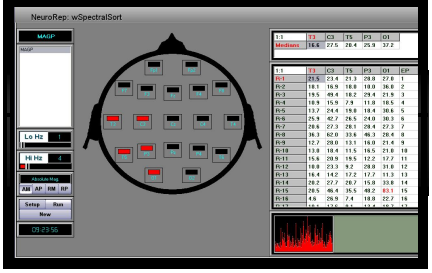
Epileptiform EC Neuroelectric Eigenimage



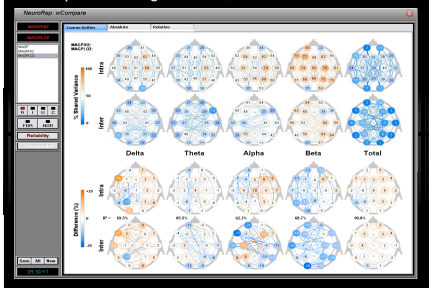
Weighted Average Distribution of Absolute Magnitude



Spectral Sort: 1 – 4 c/s, Lower Left Quadrant

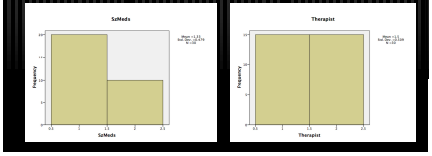


Compare: Average Hi + Lo, Difference Hi - Lo

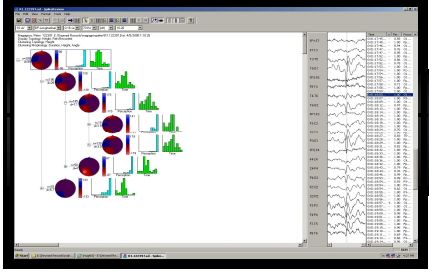


Methodology and Sample

- Patients diagnosed with autism surveyed over a period from 1/1/2009 – 1/1/2010.
- Of ~~100+~~ children, 30 were randomly selected diagnosed with both autism spectrum disorder and seizure/spike patterns.
- Age: mean = 8.74, sd = 3, range = 4 – 15
- Gender: 25 male, 5 female
- Handedness: 24 right (80%), 1 left, 5 mixed



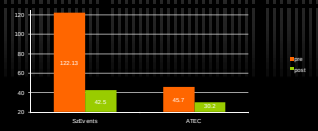
Dependent Variables: Persyst Insight2 Spike Review events/Autism Treatment Evaluation Checklist scores



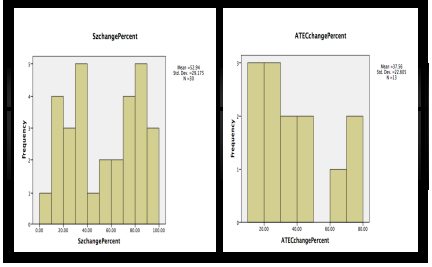
Results

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PreSzEvents - PostSzEvents	3.334	29	.002
Pair 2	PreATEC - PostATEC	5.745	12	.000



Results



Results

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SzchangePercent	Between Groups	1307.610	1	1307.610	1.566	.221
	Within Groups	23376.519	28	834.876		
	Total	24684.129	29			
ATECchangePercent	Between Groups	910.791	1	910.791	1.919	.193
	Within Groups	5220.841	11	474.622		
	Total	6131.632	12			

Interesting Part: Therapist variables and medications do not influence the results significantly.

NF reduces seizure events on or off of meds.
NF reduces seizure events beyond that of meds.
Patients that receive NF and meds maintain diminished seizure events when meds are removed.

Enduring effects of NF for ASD

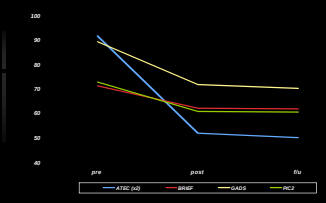
- 20 patients with ASD seen for connectivity guided NF for at least 40 sessions and seen for follow-up assessment.
- Age: mean = 9.53, sd = 3.53, range = 5 – 20.
- Gender: 16 male, 4 female.
- Handedness: 16 right, 1 left, 3 mixed.
- Race: 100% Caucasian.
- Medications: 16 none, 1 1 med, 2 2 meds, 1 4 meds.
- NF Sessions: mean = 64.5, sd = 23.1.
- Follow-up period: mean = 10.1, sd = 4.8, range = 5 – 22 months.

Results

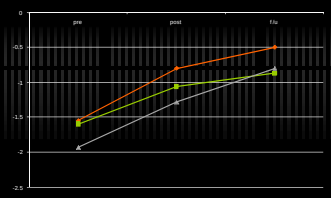
Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	ATEC1 - ATEC2	11.302	19	.000
Pair 2	ATEC2 - ATEC3	.709	19	.487
Pair 3	BRIEF1 - BRIEF2	5.370	19	.000
Pair 4	BRIEF2 - BRIEF3	.193	19	.849
Pair 5	GADS1 - GADS2	8.332	19	.000
Pair 6	GADS2 - GADS3	.877	19	.392
Pair 7	PIC21 - PIC22	6.320	19	.000
Pair 8	PIC22 - PIC23	.326	19	.748
Pair 9	NPatexpre - NPatexpost	-5.897	19	.000
Pair 10	NPatexpost - NPatexfu	-3.021	19	.007
Pair 11	NPlangpre - NPlangpost	-2.235	10	.049
Pair 12	NPlangpost - NPlangfu	-2.347	10	.041
Pair 13	NPvppre - NPvppost	-5.308	18	.000
Pair 14	NPvppost - NPvpfu	-3.568	18	.002

Results



Results



EEG Biofeedback or Neurofeedback

- 98% of children with ASD improve with a full course of treatment.
- 91% lessen their symptoms by 30% or more.
- 0% worsen their condition or have long-lasting side effects.
- Average reduction in symptoms of 60 – 70%.
- Significant improvements in neuropsychological, language, social, and behavioral functions.
- Helps children at varied levels of functioning and intelligence levels (> IQ = 50) equally.
- Helps reduce seizures/paroxysmal events in ASD with or without medication.
- Effects of treatment appear to be long-lasting and promote future developmental gains.