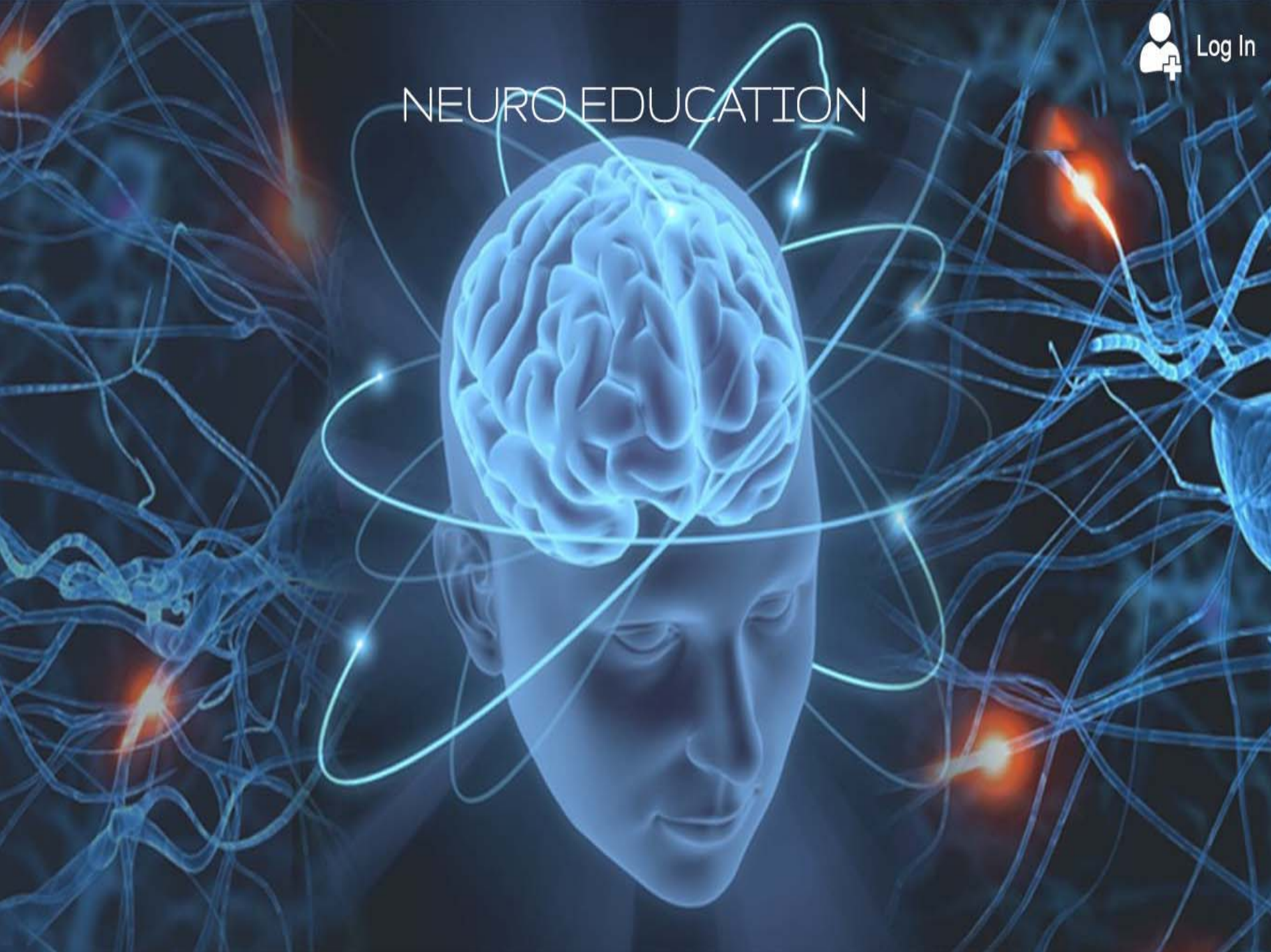




Log In

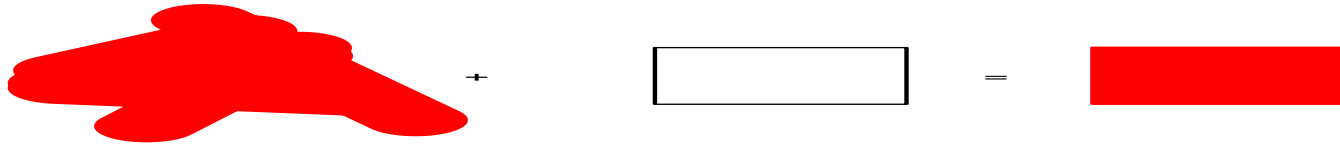
# NEURO EDUCATION



# Pribram's Holographic Theory and

## The Binding Problem in physiology

# The binding problem in psychophysiology



Separate and spatially distant neurons selectively respond to the color red and the shape of a rectangle.  
How is it that we see a red rectangle?

**Problem:** The question assumes that the firing of neurons is the only information that the brain has to construct a perception.

**Solution:** The brain has information in the form of wave patterns.

This memory research indicates that memory is stored / represented in the wave forms and the interactions. – the hologram

Pribram, K. H. (1999). Quantum holography:  
Is it relevant to brain function? *Information Sciences*,  
115(1–4), 97–102.

Pribram proposed  
the brain implements holonomic transformations that distribute  
episodic information over regions of the brain (and later  
"refocuses" them into a form in which we remember).  
Memory is a form of re-experiencing or re-constructing the initial  
sensory sensation.

Holonomic theory where Fourier-like transformations store  
information of the sensory modalities in the spectral (or  
frequency) domain. The sensory stimulus is spread out (or  
distributed) over a region of the brain.

The holographic idea is simply that each part contains some  
information of the whole. Or stated another way, the information  
(or features) are not localized, but distributed.



# Possible Role of Holography in understanding the results

“Holography is concerned with much more than pictorial three-dimensional imaging. .. Potential role in information storage, interferometry, microscopy and data processing.”

**Collier, R., Burckhardt, C. B., Lin, L.H. (1971). Optical Holography**

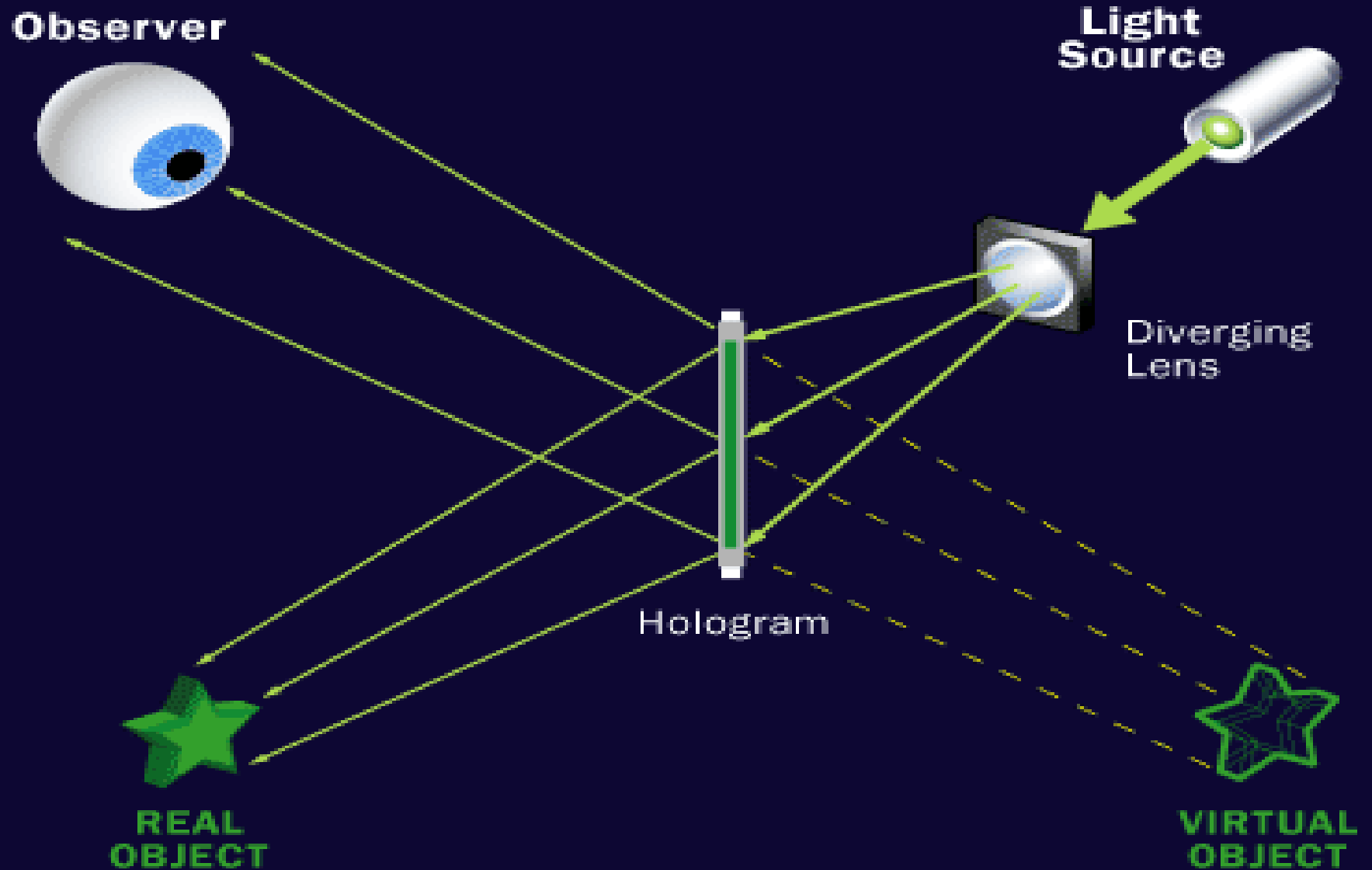
Interferometry uses the characteristics of electromagnetic waves to gather information about a sample.

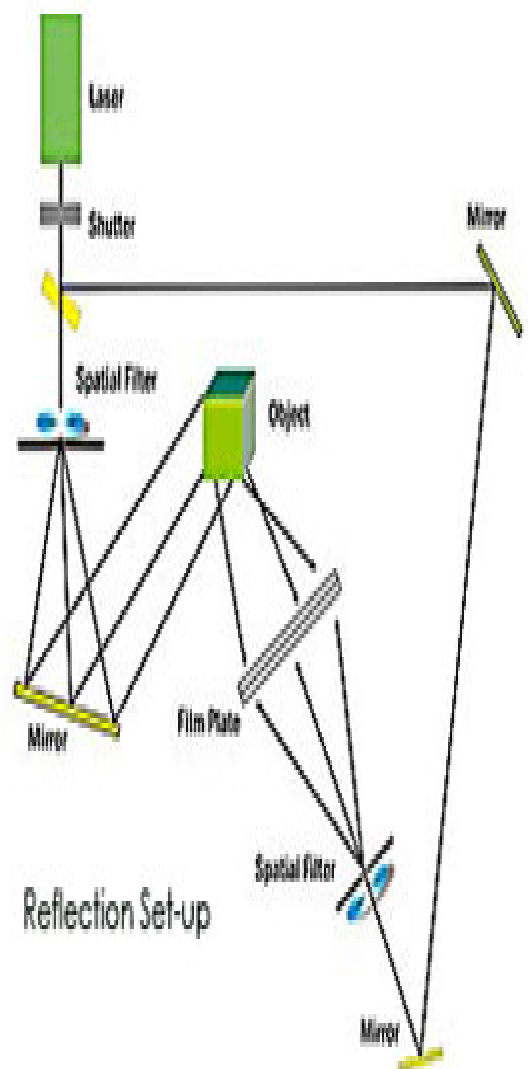
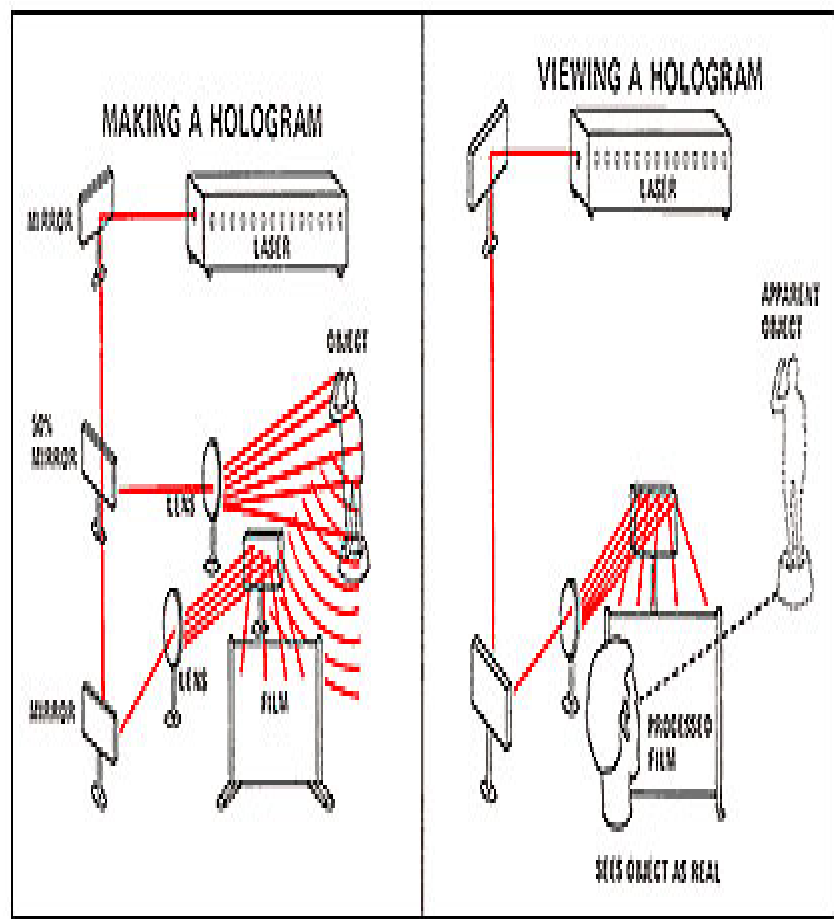
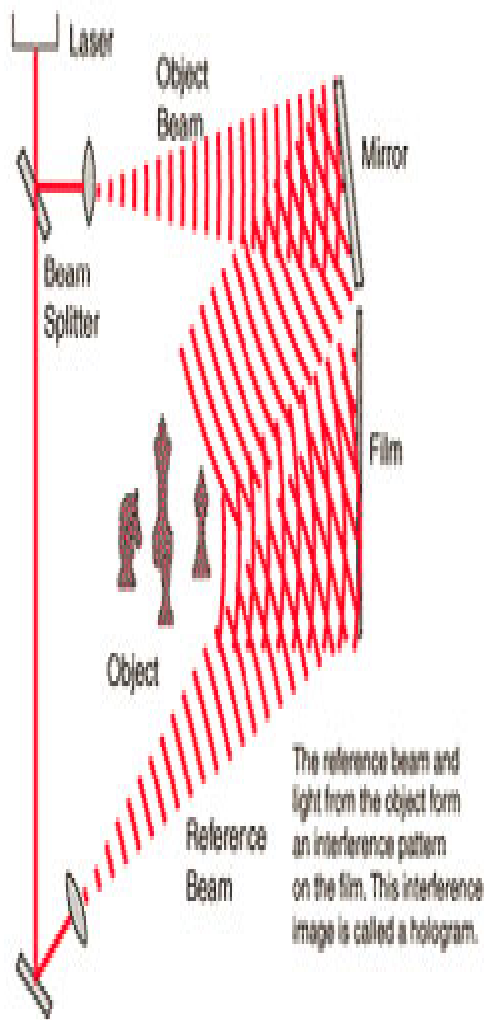
“The method of holography applies to all waves: to electron waves, Xrays, light waves, microwaves, acoustic waves, and seismic waves, providing the waves are coherent enough to form the required interference patterns.”

Interferometry is an important investigative technique in the fields of astronomy, fiber optics, engineering metrology, optical metrology, oceanography, seismology, spectroscopy (and its applications to chemistry), quantum mechanics, nuclear and particle physics, plasma physics, remote sensing, biomolecular interactions, surface profiling, microfluidics, mechanical stress/strain measurement, and velocimetry

“The hologram contains sufficient information about the phase and amplitude of the diffracted waves to permit their reconstruction.”

# How Holograms Work Illuminating





**Interferometry** uses the characteristics of electromagnetic waves to gather information about a sample.

“The method of holography applies to all waves: to electron waves, Xrays, light waves, microwaves, acoustic waves, and seismic waves, providing the waves are coherent enough to form the required interference patterns.”

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“The hologram contains sufficient information about the phase and amplitude of the diffracted waves to permit their reconstruction.”



# Auditory Memory

- 1) The problem of how to organize the information
- 2) Developmental Patterns
- 3) Correlates
- 4) Sex Differences

Conceptual Approach is based on **Coordinated Allocation Of Resource Model** (CAR) of brain functioning which states that:

Cognitive skills are

And employs resources of: based upon allocation of specific resources for specific skills, albeit overlapping in some situations

**1) Flashlight metaphor** – any location (10-20 system) sends out a “beam” to all other locations within a specific frequency

**2) Heuristic Processing units** – the brain can be organized into processing units

1) Frontal 2) Central 3) Posterior 4) Frontal – central

5) Left Hemisphere – Right Hemisphere

6) Quadrants – left frontal, right frontal; left posterior, right posterior

7) Frontal – Central posterior

## QEEG Variables

*CD=Coherence Delta; CT=Coherence Theta; CA=Coherence Alpha; CB1=Coherence Beta1; CB2=Coherence Beta2*

*PD=Phase Delta; PT=Phase Theta; PA=Phase Alpha; PB1=Phase Beta1; PB2=Phase Beta2*

*RPD=Relative Power Delta; RPT=Relative Power Theta; RPA=Relative Power Alpha; RPB1=Relative Power Beta1; RPB2=Relative Power Beta2*

*PKFD=Peak Frequency Delta; PKFT=Peak Frequency Theta; PKFA=Peak Frequency Alpha; PKFB1=Peak Frequency Beta1; PKFB2=Peak Frequency Beta2*

*MD=Magnivolts Delta; MT=Magnivolts Theta; MA=Magnivolts Alpha; MB1=Magnivolts Beta1; MB2=Magnivolts Beta2*

*PKAD=Peak Amplitude Delta; PKAT=Peak Amplitude Theta; PKAA=Peak Amplitude Alpha; PKAB1=Peak Amplitude Beta1; PKAB2=Peak Amplitude Beta2*

*The magnitude of a frequency is correlated with its peak amplitude  $\sim .98$ , thus the same variable*

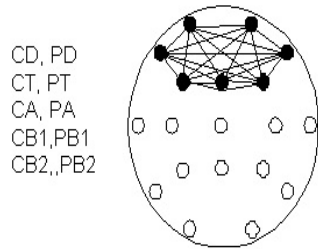
## Interrelationships between variables – total sample

	RPD	RPT	RPA	RPB1	RPB2	PKAD	PKAT	PKAA	PKAB1	PKAB2
RPD	1.00	<b>0.55</b>	<b>-0.41</b>	<b>-0.47</b>	<b>-0.34</b>	<b>0.68</b>	<b>0.38</b>	-0.17	-0.17	-0.17
RPT	<b>0.55</b>	1.00	0.03	<b>-0.36</b>	<b>-0.49</b>	<b>0.41</b>	<b>0.70</b>	<b>0.23</b>	0.00	-0.22
RPA	<b>-0.41</b>	0.03	1.00	0.14	<b>-0.27</b>	<b>-0.26</b>	0.03	<b>0.64</b>	0.21	-0.19
RPB1	<b>-0.47</b>	<b>-0.36</b>	0.14	1.00	<b>0.52</b>	<b>-0.58</b>	<b>-0.50</b>	-0.21	0.20	0.01
RPB2	<b>-0.34</b>	<b>-0.49</b>	<b>-0.27</b>	<b>0.52</b>	1.00	<b>-0.43</b>	<b>-0.55</b>	<b>-0.43</b>	-0.15	<b>0.45</b>
MD	<b>0.67</b>	<b>0.46</b>	<b>-0.24</b>	<b>-0.58</b>	<b>-0.45</b>	<b>0.99</b>	<b>0.82</b>	<b>0.41</b>	<b>0.41</b>	<b>0.37</b>
MT	<b>0.39</b>	<b>0.70</b>	0.03	<b>-0.51</b>	<b>-0.55</b>	<b>0.78</b>	<b>1.00</b>	<b>0.66</b>	<b>0.53</b>	<b>0.33</b>
MA	-0.19	0.18	<b>0.64</b>	-0.19	<b>-0.43</b>	<b>0.36</b>	<b>0.63</b>	<b>0.99</b>	<b>0.73</b>	<b>0.34</b>
MB1	-0.17	0.00	0.15	0.16	-0.09	<b>0.42</b>	<b>0.56</b>	<b>0.70</b>	<b>0.98</b>	<b>0.68</b>
MB2	-0.18	<b>-0.25</b>	-0.22	0.00	<b>0.50</b>	<b>0.34</b>	<b>0.27</b>	<b>0.28</b>	<b>0.52</b>	<b>0.99</b>
PKFD	<b>-0.41</b>	<b>0.26</b>	<b>0.31</b>	0.20	-0.06	<b>-0.34</b>	0.14	0.21	0.13	-0.08
PKFT	<b>-0.44</b>	0.00	<b>0.60</b>	0.02	-0.15	-0.11	0.15	<b>0.53</b>	0.16	0.03
PKFA	<b>-0.33</b>	<b>-0.58</b>	0.04	<b>0.51</b>	<b>0.34</b>	<b>-0.38</b>	<b>-0.53</b>	-0.20	0.19	0.05
PKFB1	-0.06	<b>-0.22</b>	<b>-0.32</b>	0.10	<b>0.50</b>	-0.07	-0.19	-0.23	-0.19	<b>0.31</b>
PKFB2	-0.19	<b>-0.34</b>	-0.08	-0.05	<b>0.39</b>	-0.17	<b>-0.30</b>	-0.18	-0.19	0.19

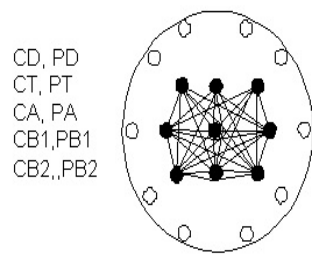
Comment: note high relationship between the peak amplitude of a variable and the magnitude of that variable

# Examples of Processing Units and Flashlights

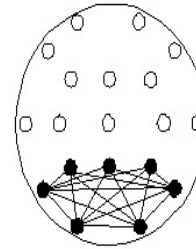
Frontal Processing Unit (FPU)



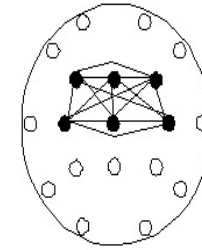
Central Processing Unit (CPU)



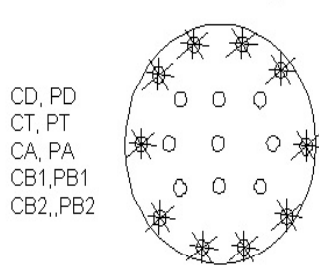
Posterior Processing Unit (PPU)



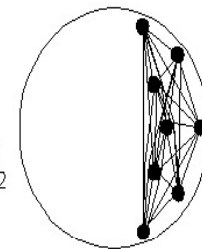
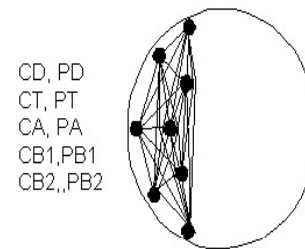
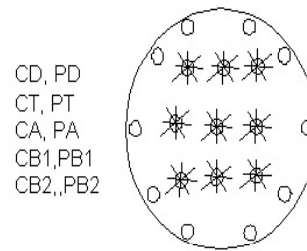
Frontal CPU (fCPU)



Lateral Flashlights

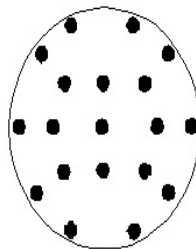


Internal Flashlights



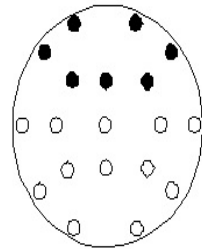
All

RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



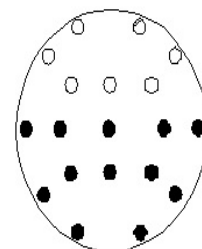
Frontal

RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2

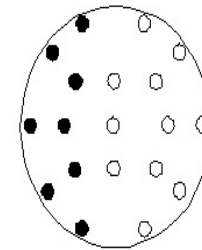


Central / Posterior

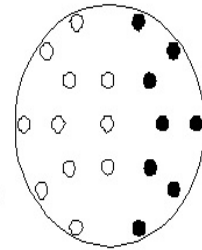
RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



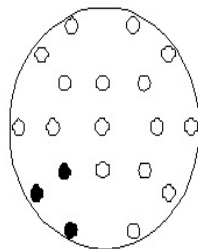
RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



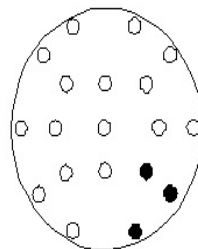
RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



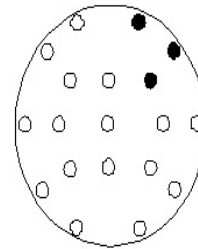
RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



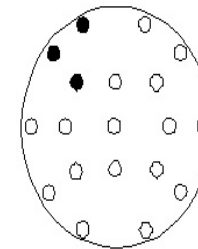
RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2



RPD, MD  
RPT, MT  
RPA, MA  
RPB1, MB1  
RPB2, MB2  
PKFA, PKFB1  
PKFB2





# Reading Silently task

There are several different ways of organizing the results and analyzing the data. All are valid.

1) Individual correlations

2) By location (i.e. T3, T5, etc.) Flashlight metaphor

3) By location & frequency

4) By processing modules  
(frontal, central, posterior)

5) By age groups

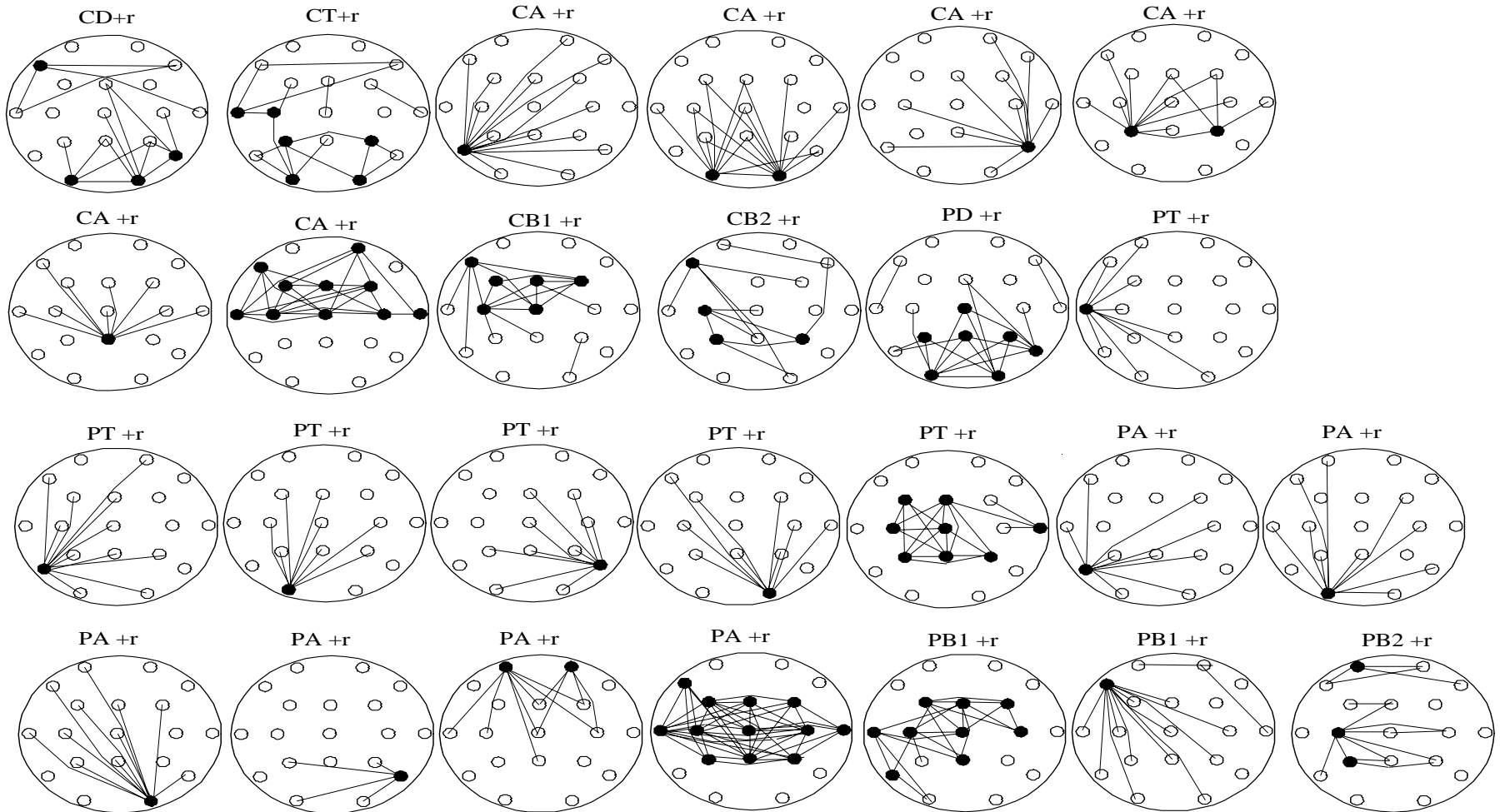
We will look at them all

# The Variable Problem – How do we look at it

## 1) By individual connection and frequency

All children & All adults N=268 - Reading Condition

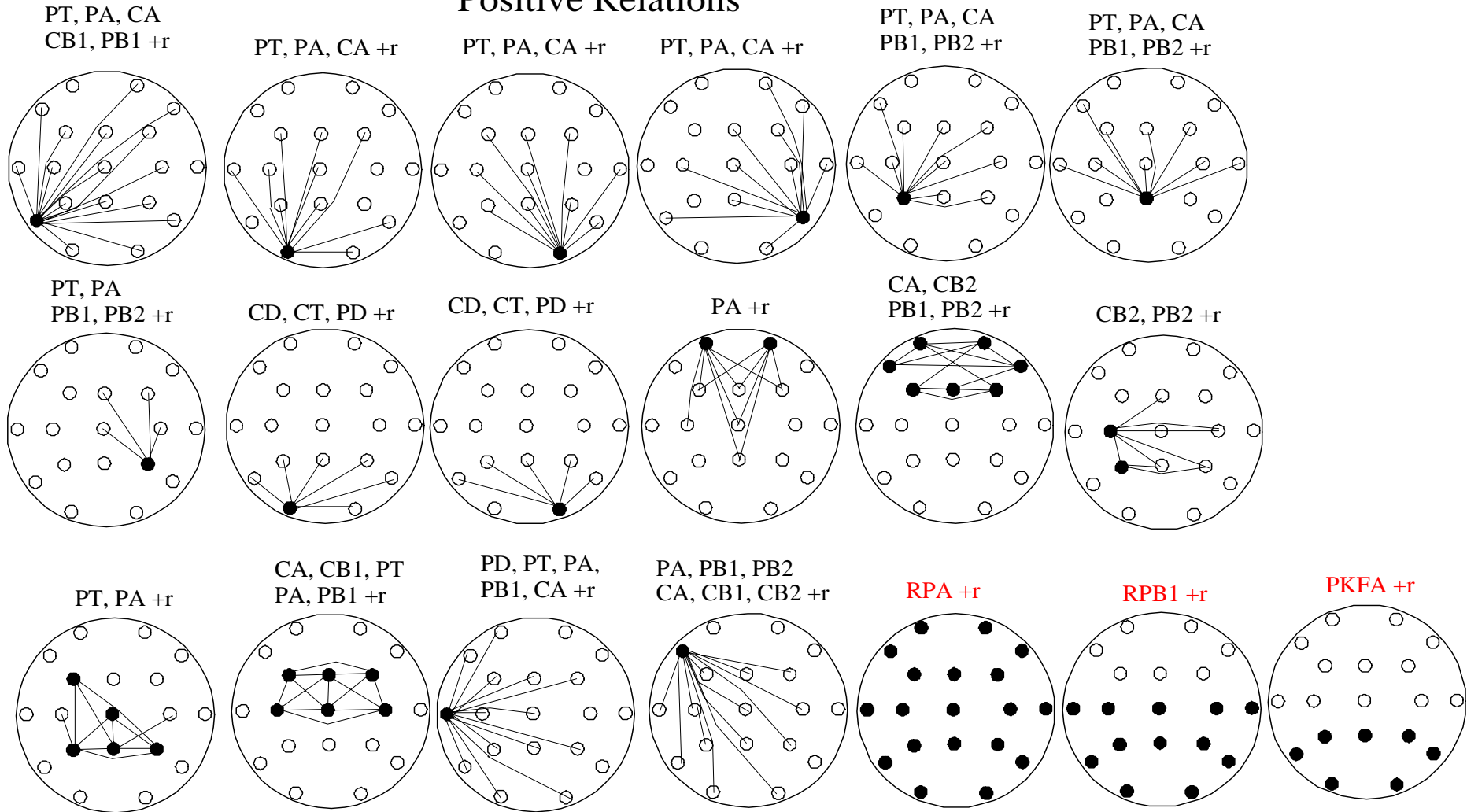
Positive Relations



# 2) & 3) By location & frequency– positive – flashlight metaphor

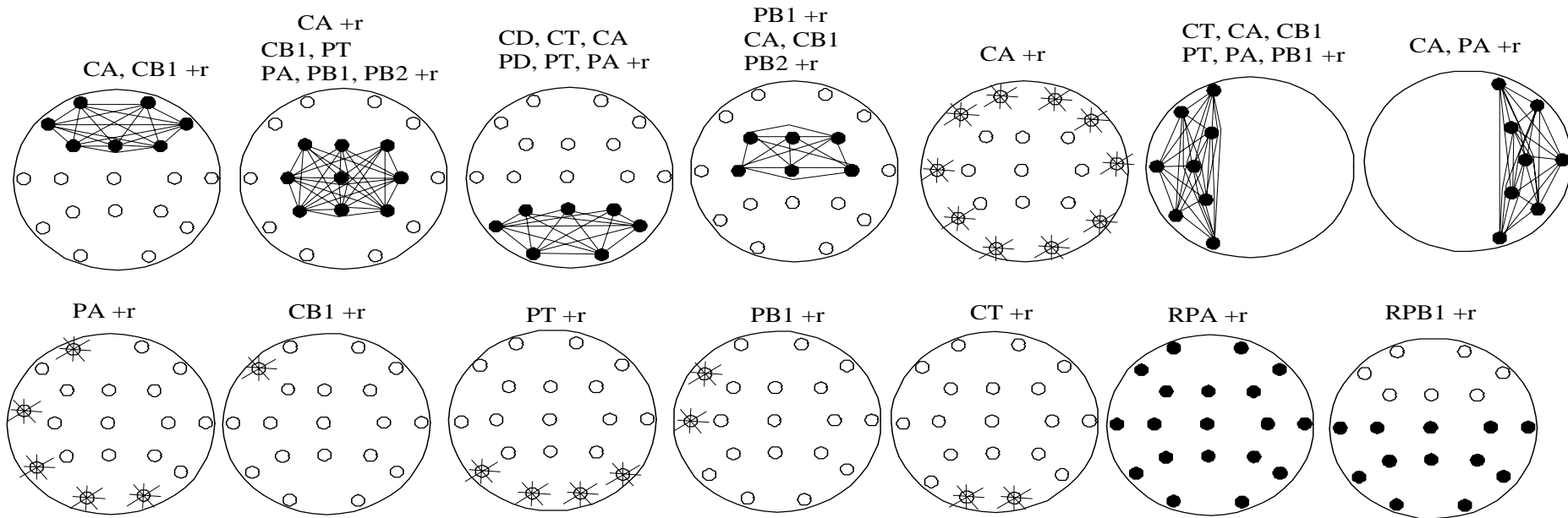
## Reading Memory Input

### Positive Relations

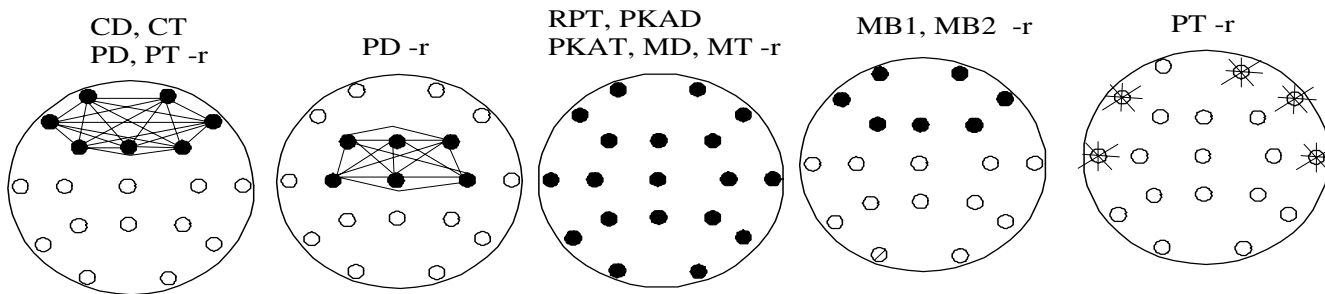


# 4) Employing Flashlight and Processing Unit Ideas

## Positive Relations



## Negative Relations



**Table 1 – Participant Characteristics – Normal Group**

<b>Sample Size</b>	<b>Age Mean (SD) and Range</b>	<b>Male</b>	<b>Female</b>
<b>Group A - 36</b>	112 (22.4) / 9.3 Yrs. Range: 68-142 Mos. <b>5.7 Yrs. – 11.8 Yrs.</b>	20	16
<b>Group B - 34</b>	177 (22.2) / 14.75 Yrs. Range: 145-227 Mos. <b>12.1 Yrs. – 18.9 Yrs.</b>	21	13
<b>Group C - 68</b>	501.8 (176) – 41.8 Range: 249-857 Mos. <b>20.75 Yrs. – 71.4 Yrs.</b>	30	38



John Smith /lived on an old dirty barge/ in New York harbor/. One day he left the boat/ to go shopping/ for some milk,/ potatoes/ and hamburger/. He entered an alley/ to save time/, but as he began to exit the alley/ a tall, large man/ came over to him/ and demanded his money/. John gave the man/ the \$10 that he had/, as he was afraid/. The man left/. John continued to the store/ in the hope of getting credit/. He found a \$20 bill/ on the ground/ near a fire hydrant/ as he approached the store/. N=24 Score =

Date:

**Developmental patterns during listening task for 6-12 year old**  
**Red star indicates variable correlated with memory during encoding**  
**Note - increases mostly involve lower frequencies**



**Positive Relations**

RPB1, PKFA +r

RPA +r

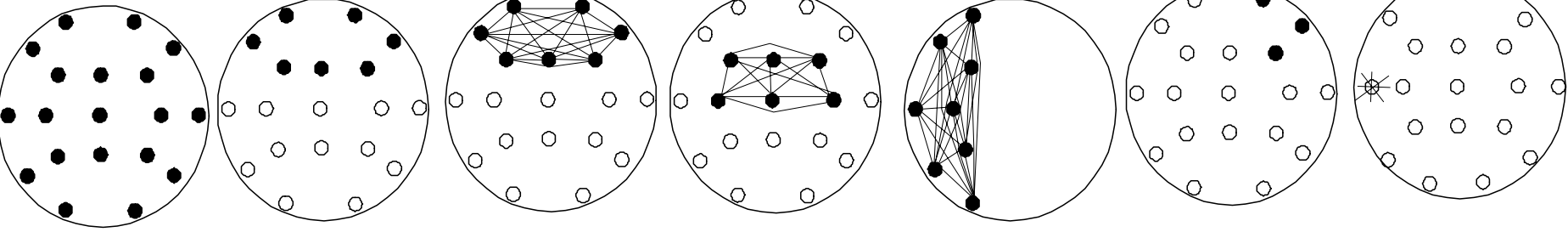
PA +r

PA +r

CT, PT +r

PKFD +r

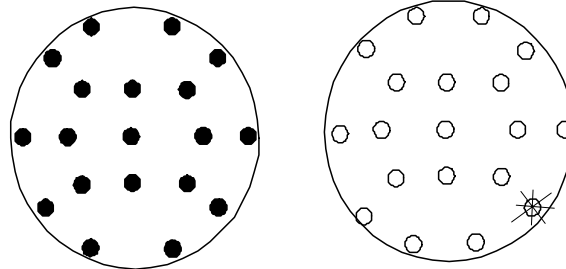
PT +r



**Negative Relations**

PKAD, MD, RPD -r

PA -r



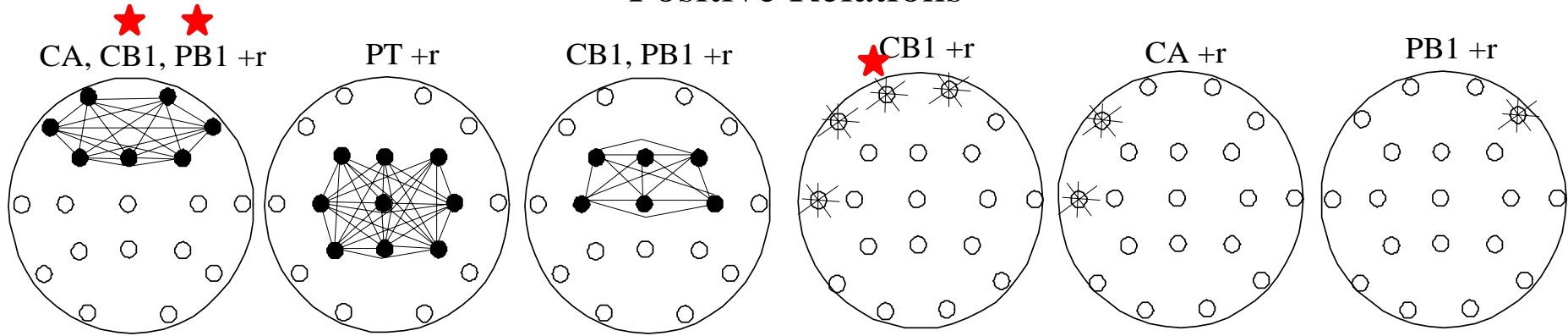
*CT=Coherence Theta; PT=Phase Theta; PA=Phase Alpha; RPD=Relative Power Delta;  
 RPB1=Relative Power Beta1; MD=Magnivolts Delta; PKFA=Peak Frequency Alpha; PKAD=Peak  
 Amplitude Delta; PKFD=Peak Frequency Delta*

## Developmental patterns in the 12-20 year old sample

Red star indicates variable correlated with memory during encoding

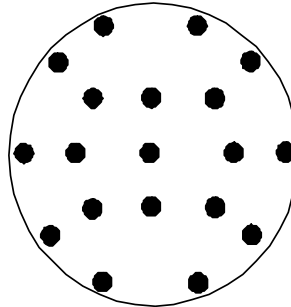
Note – increases now in the beta1 frequency

### Positive Relations



### Negative Relations

PKAD, MD, RPD -r

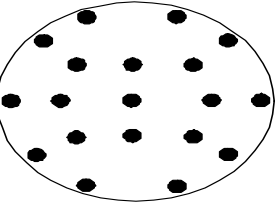


CA=Coherence Alpha; CB1=Coherence Beta1; PT=Phase Theta; PB1=Phase Beta1;  
RPD=Relative Power Delta; MD=Magnivolts Delta; PKAD=Peak Amplitude Delta

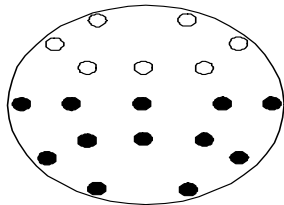
# Developmental data for the age 21-71 – Note – increases now in beta2 frequency

## Positive Relations

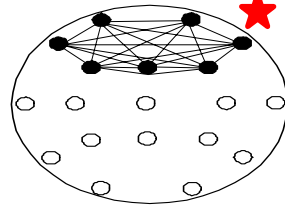
RPB1, RPB2 +r



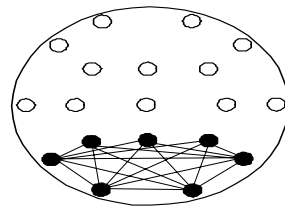
PKFB1 +r



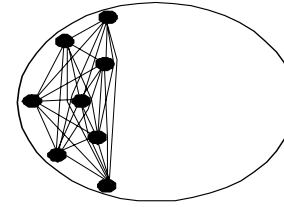
CT, CB1, PB1, PB2 +r



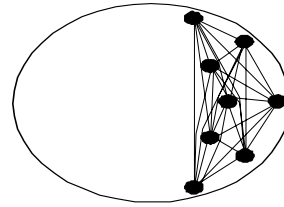
PB1 +r



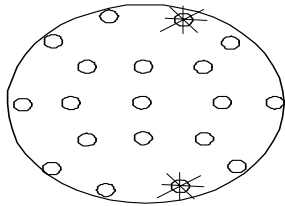
CD, CB1, CB2  
PD, PT, PB1, PB2 +r



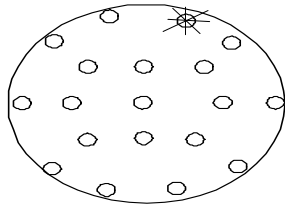
CB2 +r



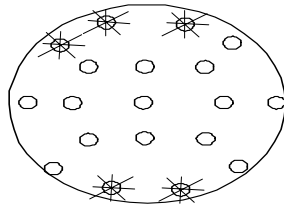
CD +r



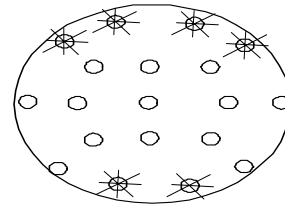
CT +r



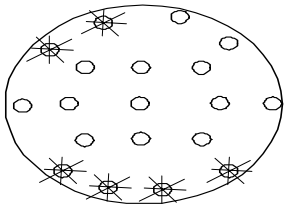
CB1 +r



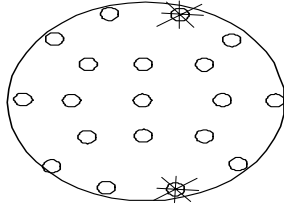
CB2 +r



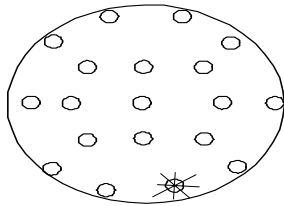
PD +r



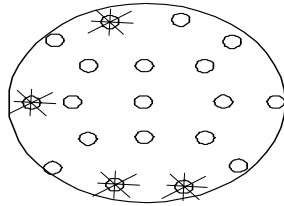
PT +r



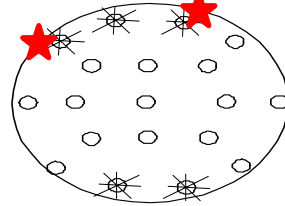
PA +r



PB1 +r

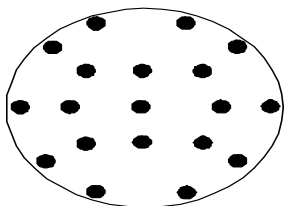


PB2 +r

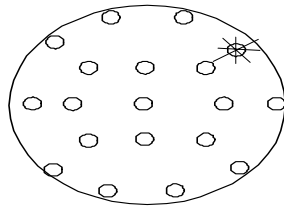


## Negative Relations

RPA, PKFA  
MA, RPT -r



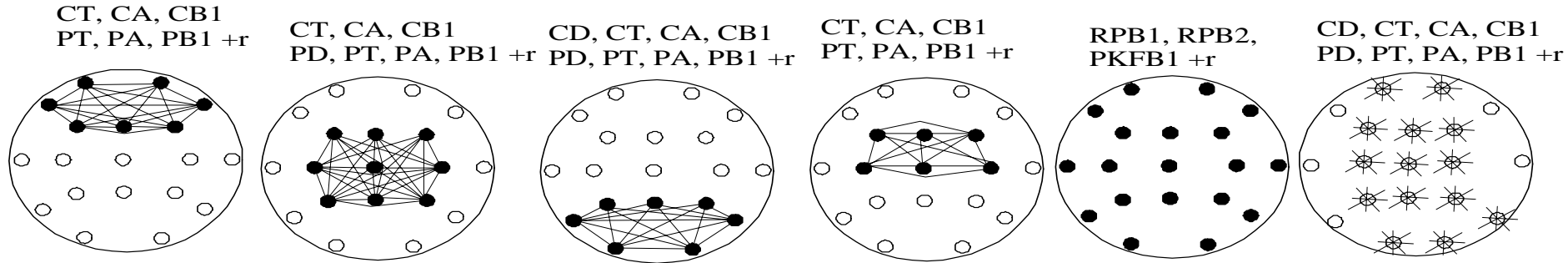
CA -r



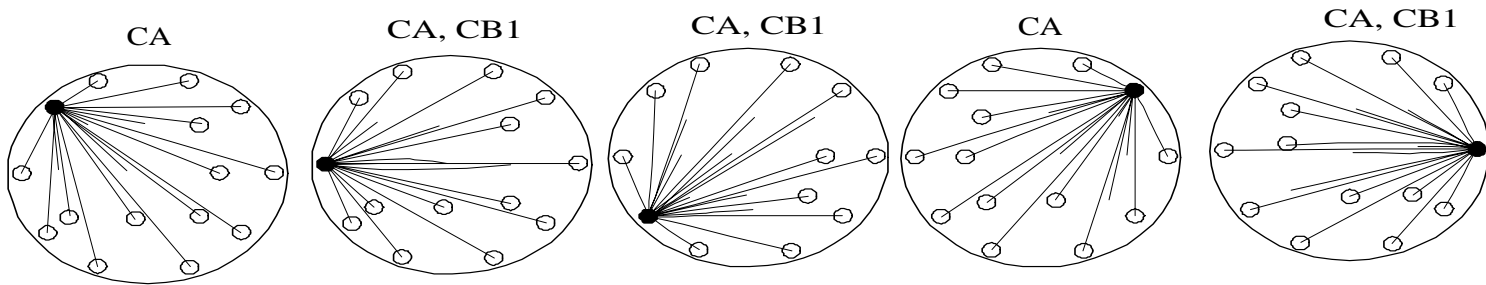
CD=Coherence Delta; CT=Coherence Theta; CB1=Coherence Beta1; CB2=Coherence Beta2; PD=Phase Delta; PT=Phase Theta; PA=Phase Alpha; PB1=Phase Beta1; PB2=Phase Beta2; RPT=Relative Power Theta; RPA; Relative Power Alpha; RPB1=Relative Power Beta1; RPB2=Relative Power Beta2; MA=Magnivolts Alpha; PKFA=Peak Frequency Alpha; PKFB1=Peak Frequency Beta1

Developmental Patterns N=140 alpha@.01  
 All normal children and adults

Positive Relations

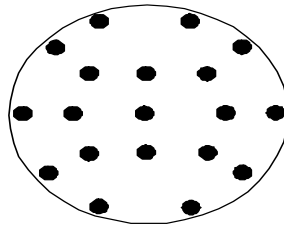


EXCEPT



Negative Relations

MD, MT, MA, RPD, RPT  
 PKAD, PKAT, PKAA -r

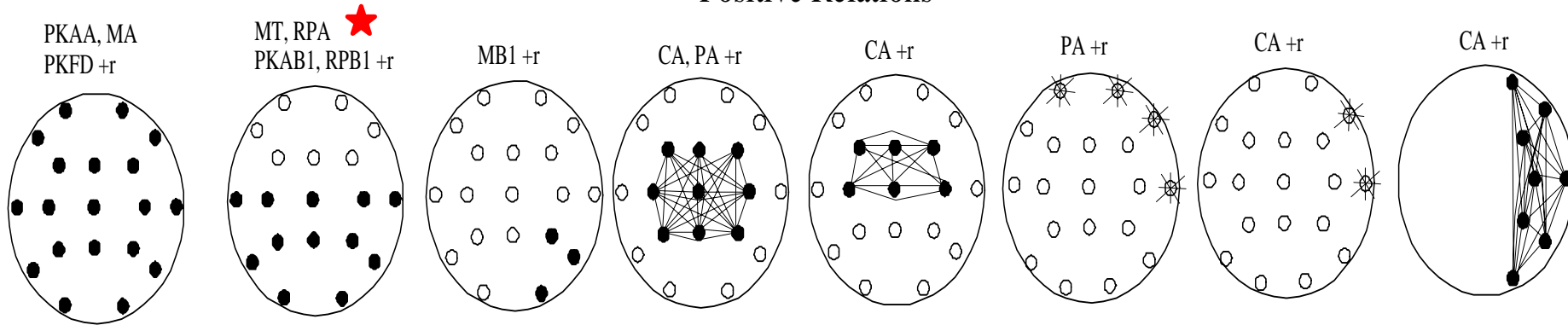


**Comment: No significant developmental increases in coherence / phase beta2 (32-64 Hz)  
 – yes there is in the 21-71 age group??**

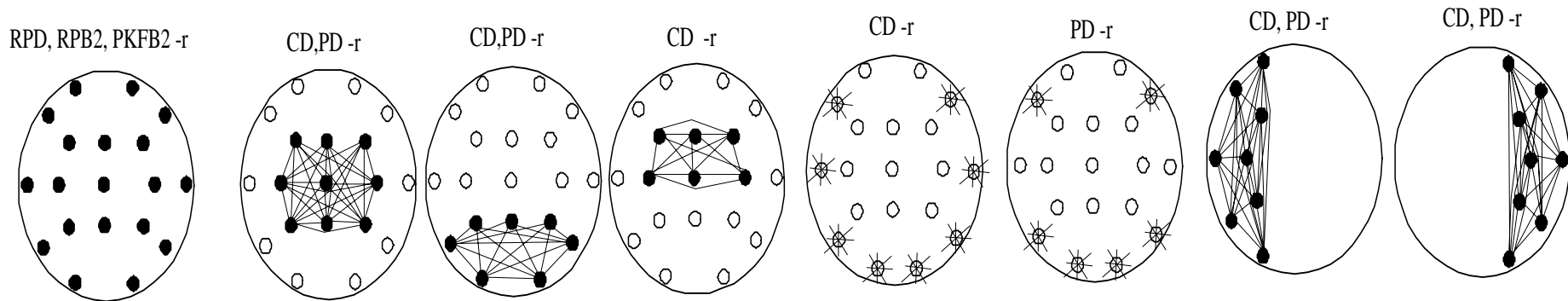


# Relations between QEEG variables and performance during encoding task 6-12 yr old

## Positive Relations



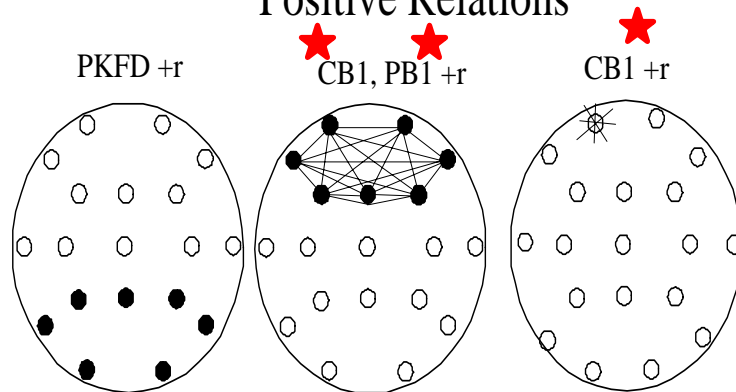
## Negative Relations



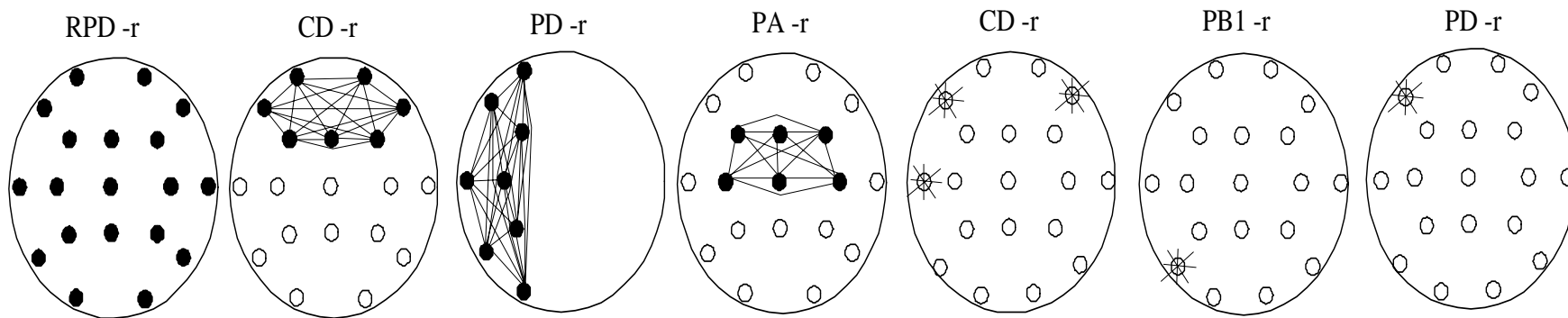
*CD=Coherence Delta; CA=Coherence Alpha; PD=Phase Delta; PA=Phase Alpha; RPD=Relative Power Delta; RPA; Relative Power Alpha; RPB1=Relative Power Beta1; RPB2=Relative Power Beta2; MT=Magnivolts Theta; MA=Magnivolts Alpha; MB1=Magnivolts Beta1; PKFD=Peak Frequency Delta; PKFB2=Peak Frequency Beta2; PKAB1=Peak Amplitude Beta1*

## Relations between QEEG variables and performance during encoding task age 12-19

### Positive Relations



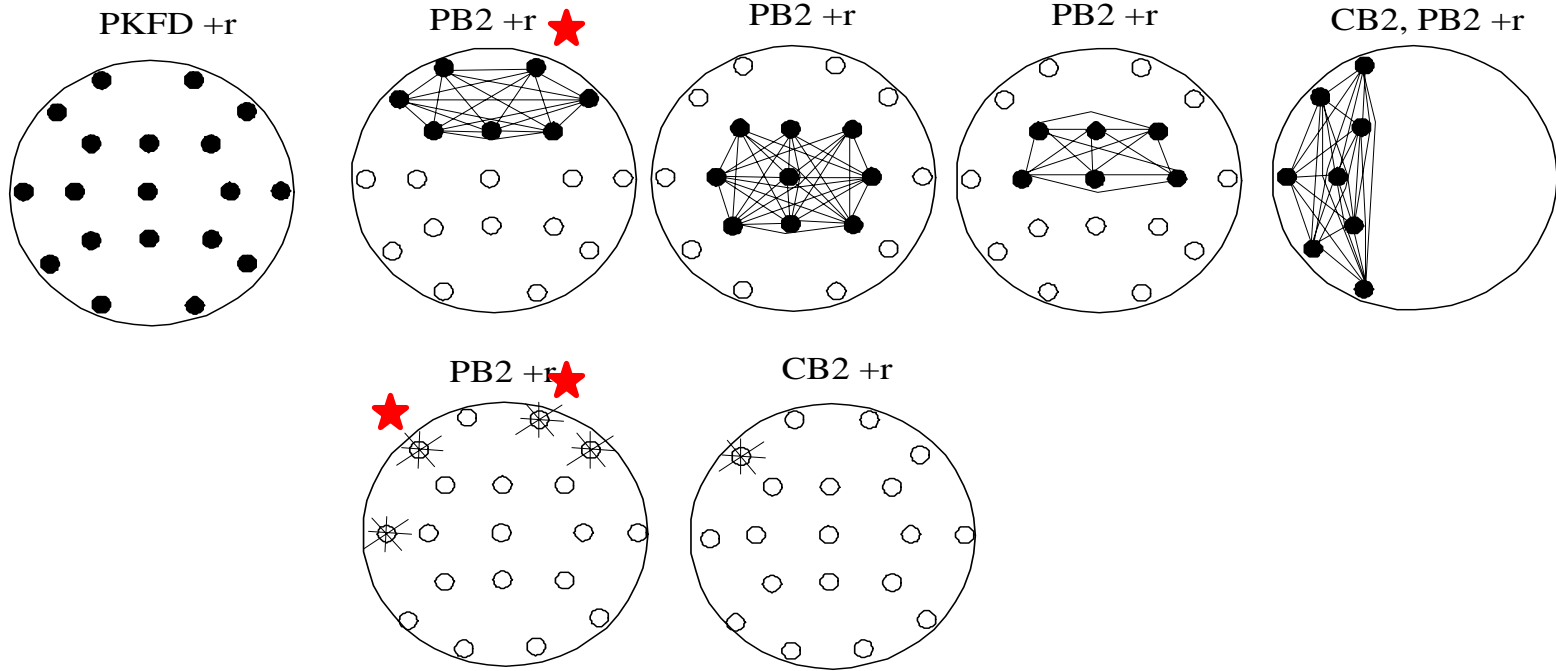
### Negative Relations



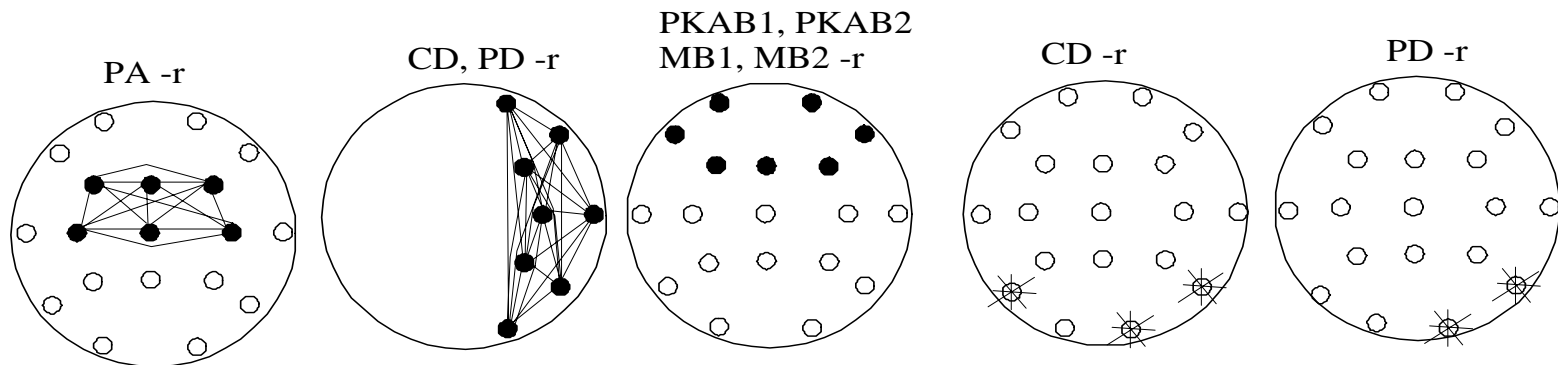
*CD=Coherence Delta; PD=Phase Delta; PA=Phase Alpha; CB1=Coherence Beta1; PB1=Phase Beta1;  
PKFD=Peak Frequency Delta; RPD=Relative Power Delta*

# Relations between QEEG variables and performance during encoding task age 21-71

## Positive Relations



## Negative Relations

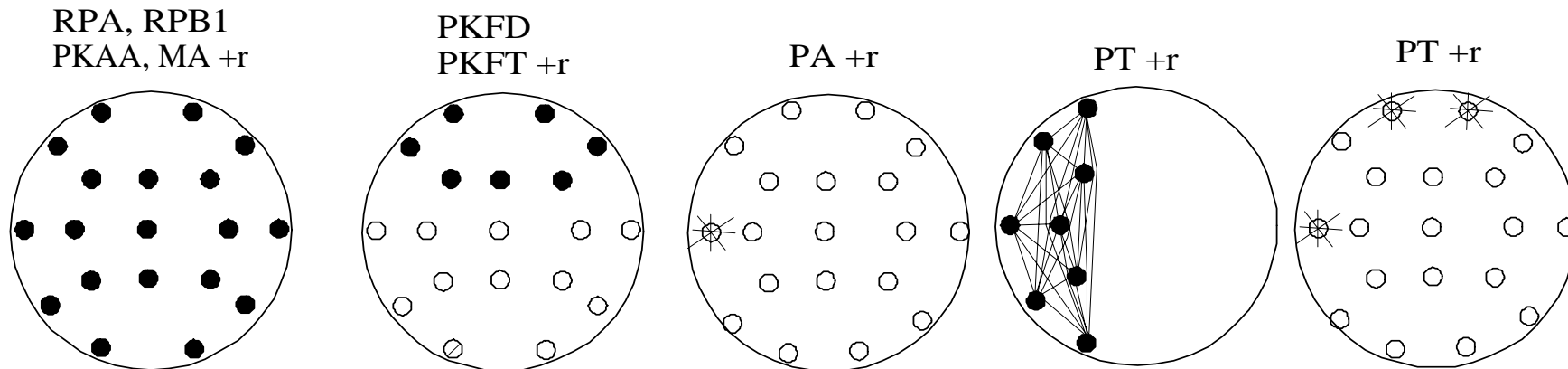


CD=Coherence Delta; CB2=Coherence Beta2; PD=Phase Delta; PB2=Phase Beta2; MB1=Magnivolts Beta1; MB2=Magnivolts Beta2; PKFD=Peak Frequency Delta; PKAB1=Peak Amplitude Beta1; PKAB2=Peak Amplitude Beta2

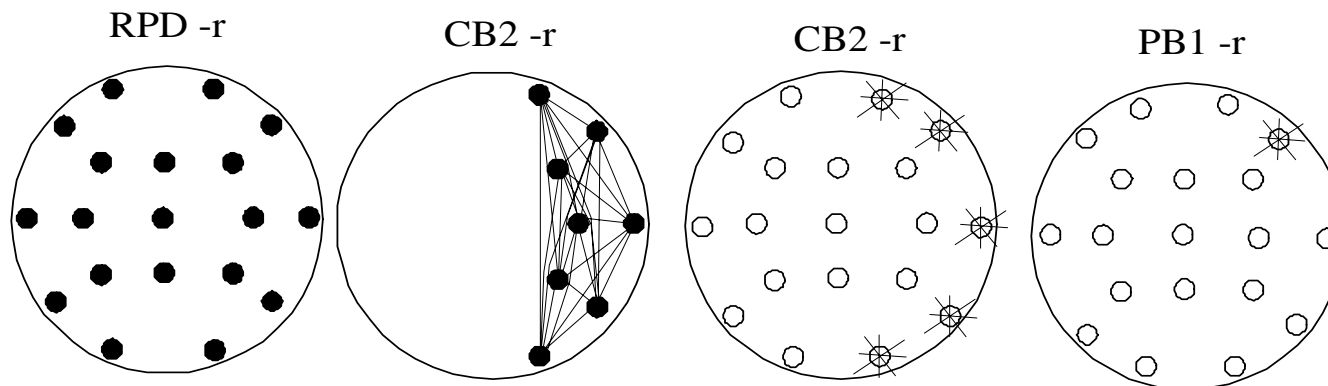
# Relations between QEEG variables and performance during immediate recall task 6-12 yr old

Note – use of phase theta and phase alpha

## Positive Relations



## Negative Relations



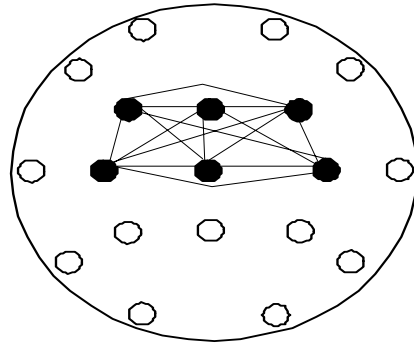
CB2=Coherence Beta2; PT=Phase Theta; PA=Phase Alpha; PB1=Phase Beta1; RPD=Relative Power Delta; RPA; Relative Power Alpha; RPB1=Relative Power Beta1; MA=Magnivolts Alpha; PKFD=Peak Frequency Delta; PKFT=Peak Frequency Theta; PKAA=Peak Amplitude Alpha

# Relations between QEEG variables and performance during immediate recall task ages 12-19

Note – Use of phase alpha

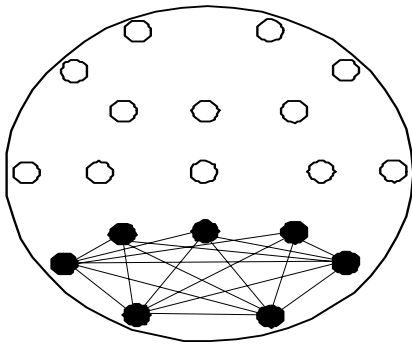
## Positive Relations

PA +r

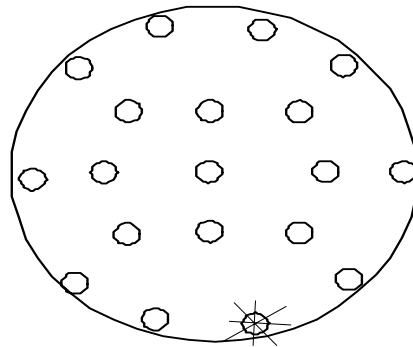


## Negative Relations

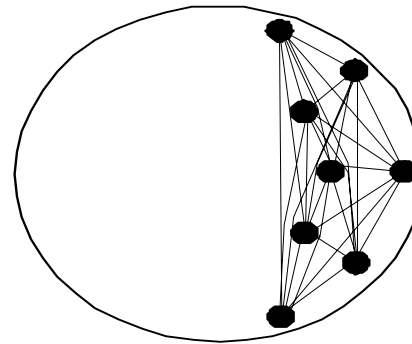
CA -r



CA -r



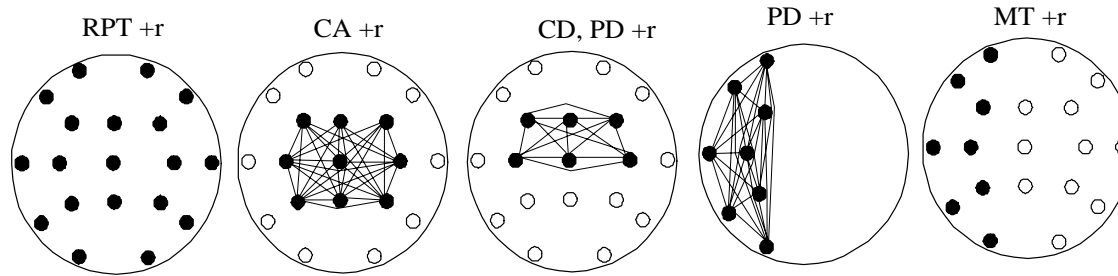
CA -r



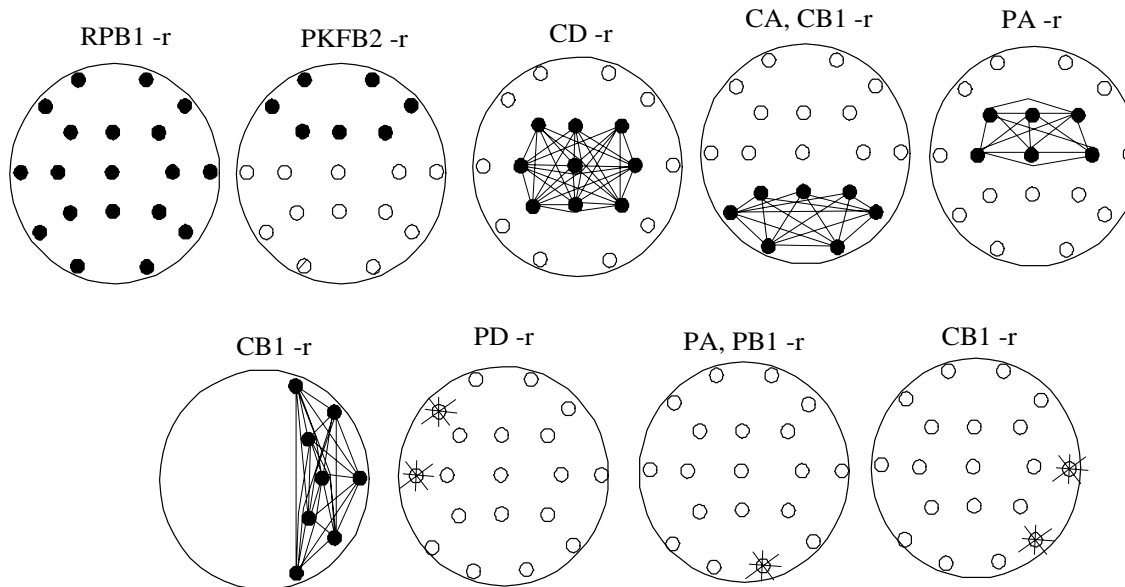
CA=Coherence Alpha; PA=Phase Alpha

# Relations between QEEG variables and performance during immediate recall task ages 21-71

## Positive Relations



## Negative Relations

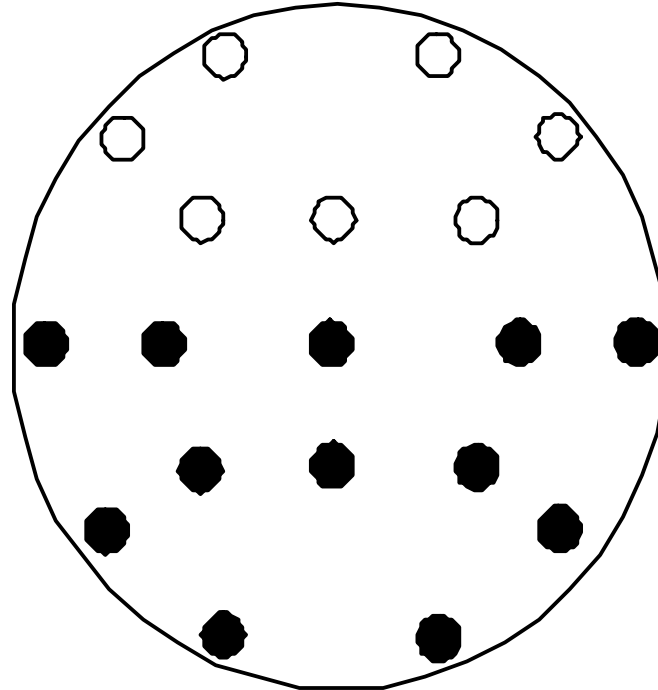


*CD=Coherence Delta; CA=Coherence Alpha; CB1=Coherence Beta1; PD=Phase Delta; PA=Phase Alpha; PB1=Phase Beta1; RPT=Relative Power Theta; RPB1=Relative Power Beta1; MT=Magnivolts Theta; PKFB2=Peak Frequency Beta2*

Relations between QEEG variables and performance during delayed recall task 6-12 yr. old

# Positive Relation

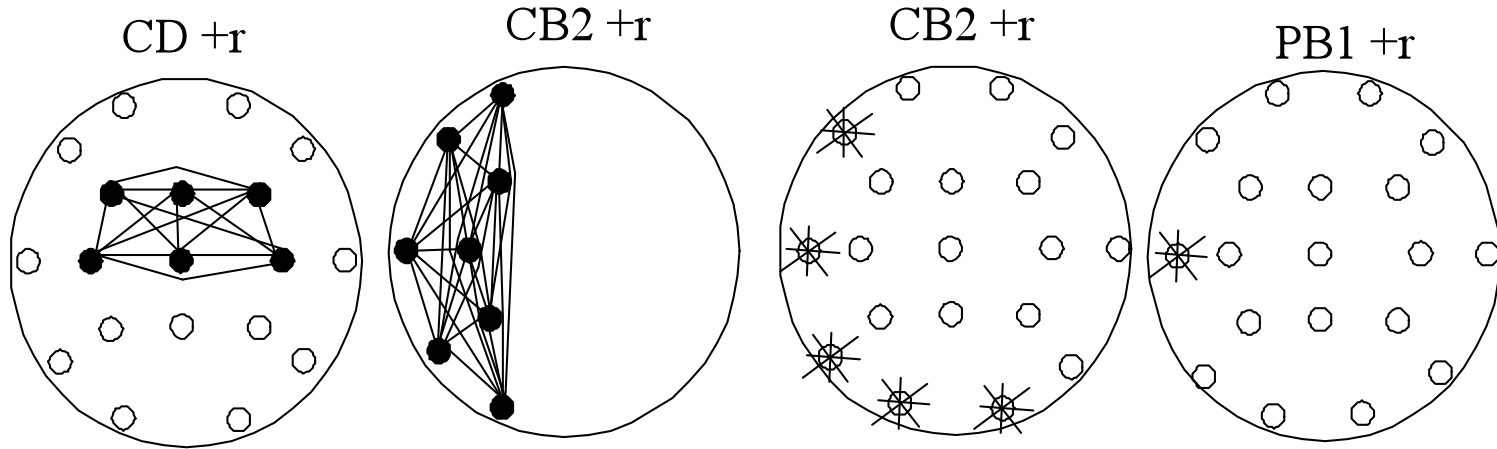
PKFA +r



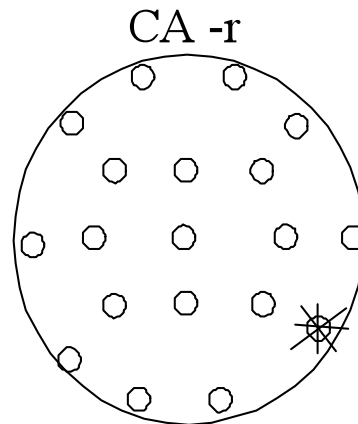
*PKFA=Peak Frequency Alpha*

**Relations between QEEG variables and performance during delayed recall task – ages 12-19  
alpha @ .10**

**Positive Relations**



**Negative Relations**



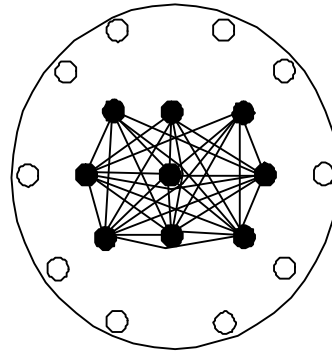
*CD=Coherence Delta; CA=Coherence Alpha; CB2=Coherence Beta2; PB1=Phase Beta1*



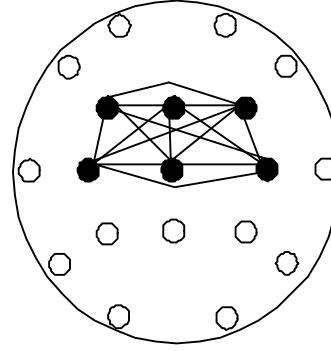
## Relations between QEEG variables and performance during delayed recall task – ages 21-71

### Positive Relations

CB1, PB1 +r

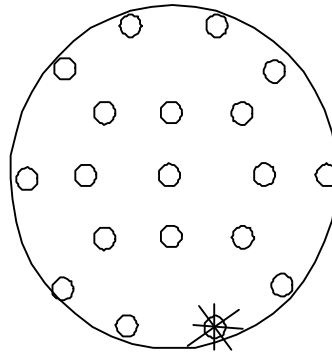


PA, PB1 +r



### Negative Relations

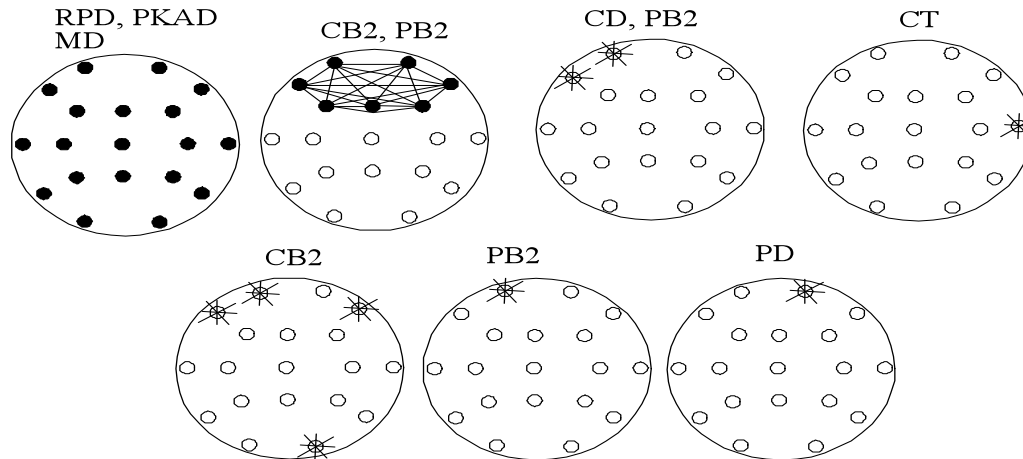
PA -r



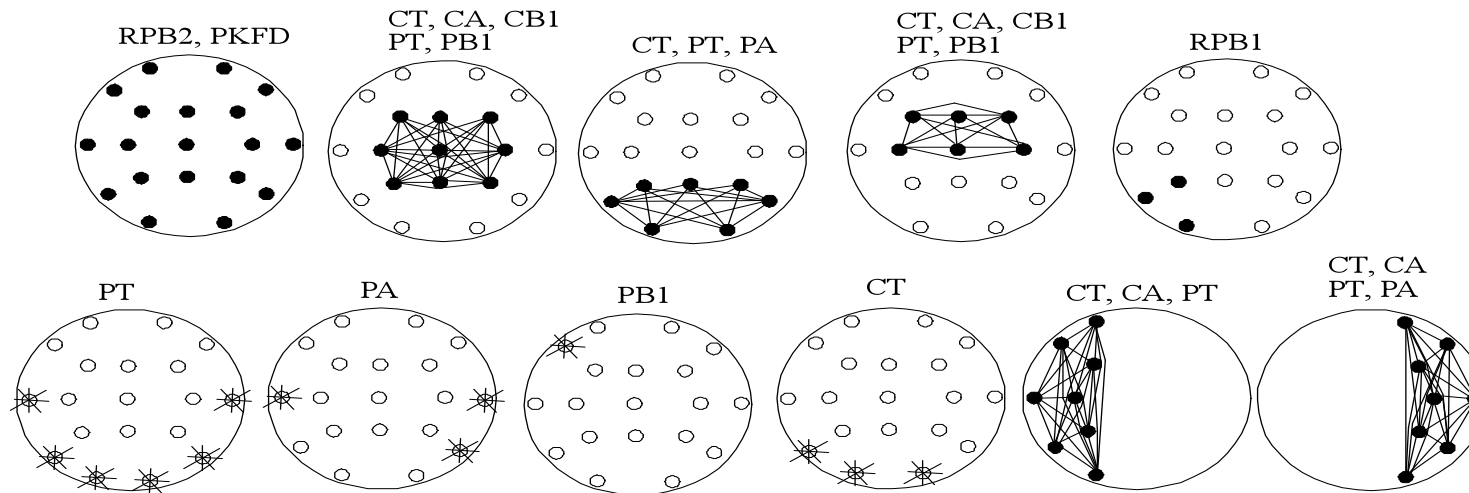
*CB1=Coherence Beta1; PA=Phase Alpha; PB1=Phase Beta1*

## Sex differences in response style during listening

Male > Female



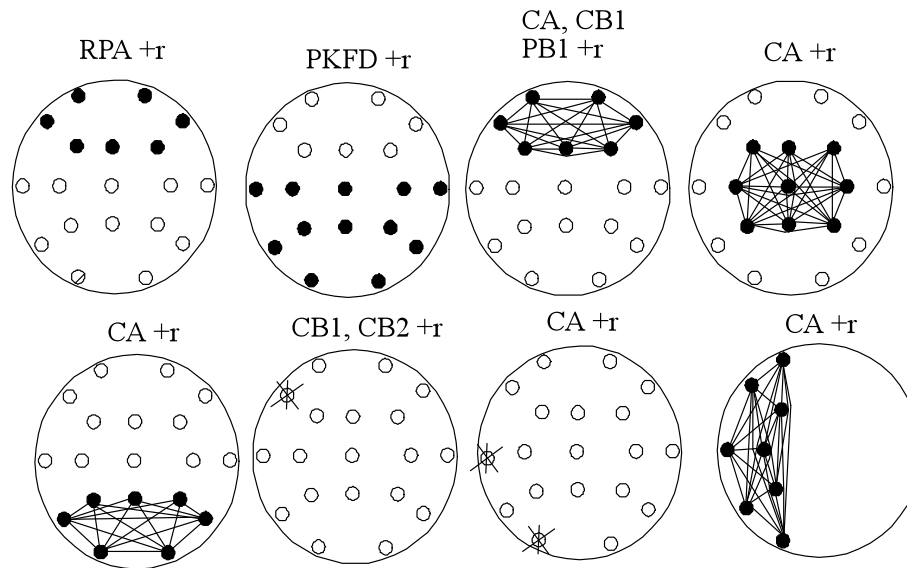
Female > Male



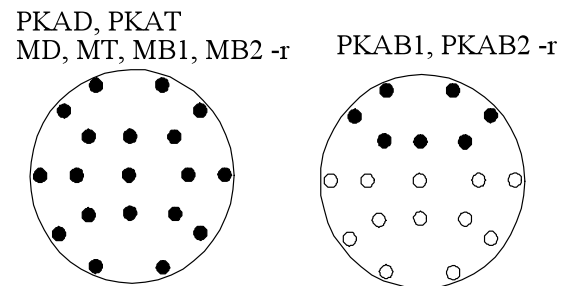
*CD=Coherence Delta; CT=Coherence Theta; CA=Coherence Alpha; CB1=Coherence Beta1; CB2=Coherence Beta2; PD=Phase Delta; PT=Phase Theta; PA=Phase Alpha; PB1=Phase Beta1; PB2=Phase Beta2; RPD=Relative Power Delta; RPB1=Relative Power Beta1; RPB2=Relative Power Beta2*

# Sex differences in correlates of performance during listening task

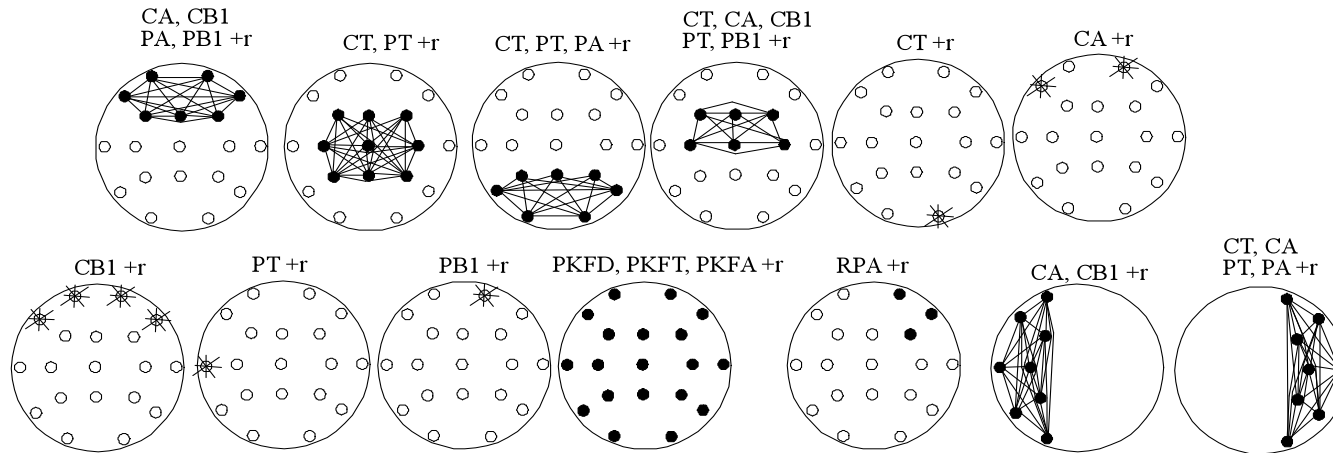
## POSITIVE RELATIONS - FEMALES



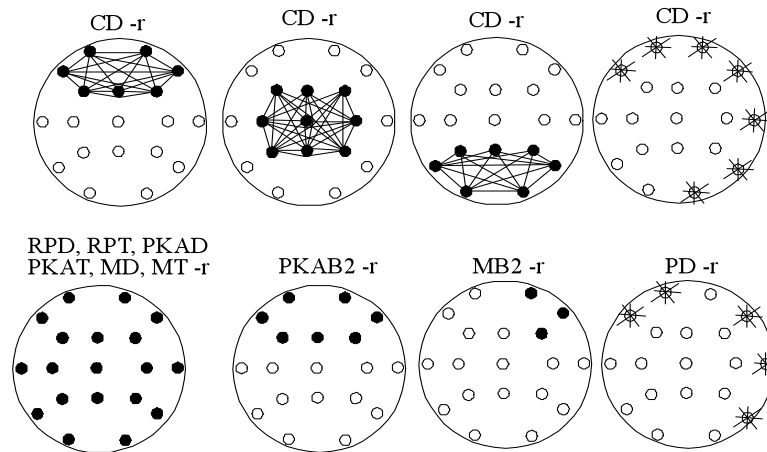
## NEGATIVE RELATIONS - FEMALES



### Positive Relations - Males



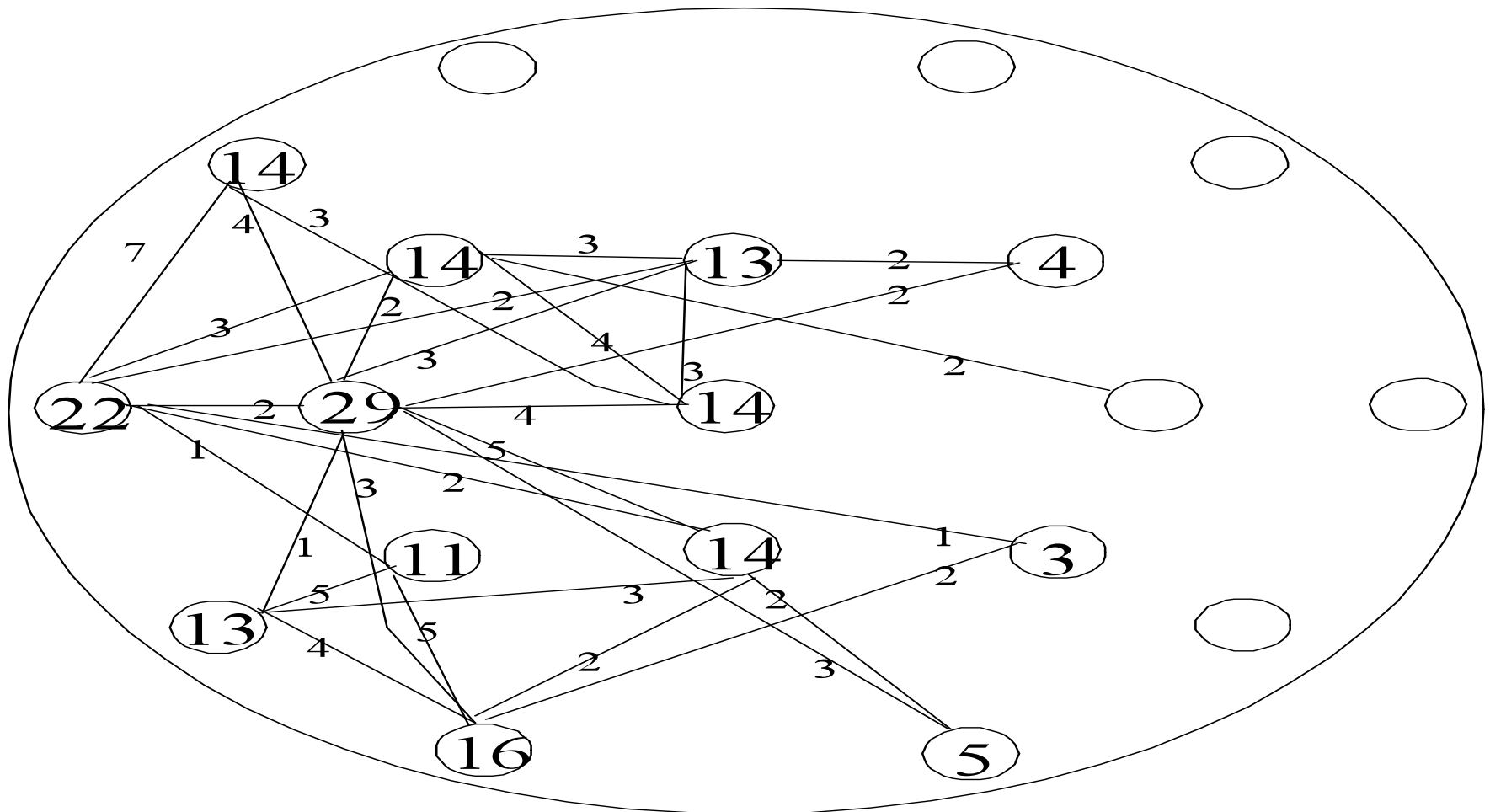
### Negative Relations - Males



*CD=Coherence Delta; CT=Coherence Theta; CA=Coherence Alpha; CB1=Coherence Beta1; PD=Phase Delta; PT=Phase Theta; PA=Phase Alpha; PB1=Phase Beta1; RPA; Relative Power Alpha; MD=Magnivolts Delta; MT=Magnivolts Theta; MB1=Magnivolts Beta1; MB2=Magnivolts Beta2; PKFD=Peak Frequency Delta; PKFT=Peak Frequency Theta; PKFA=Peak Frequency Alpha; PKAD=Peak Amplitude Delta; PKAT=Peak Amplitude Theta*

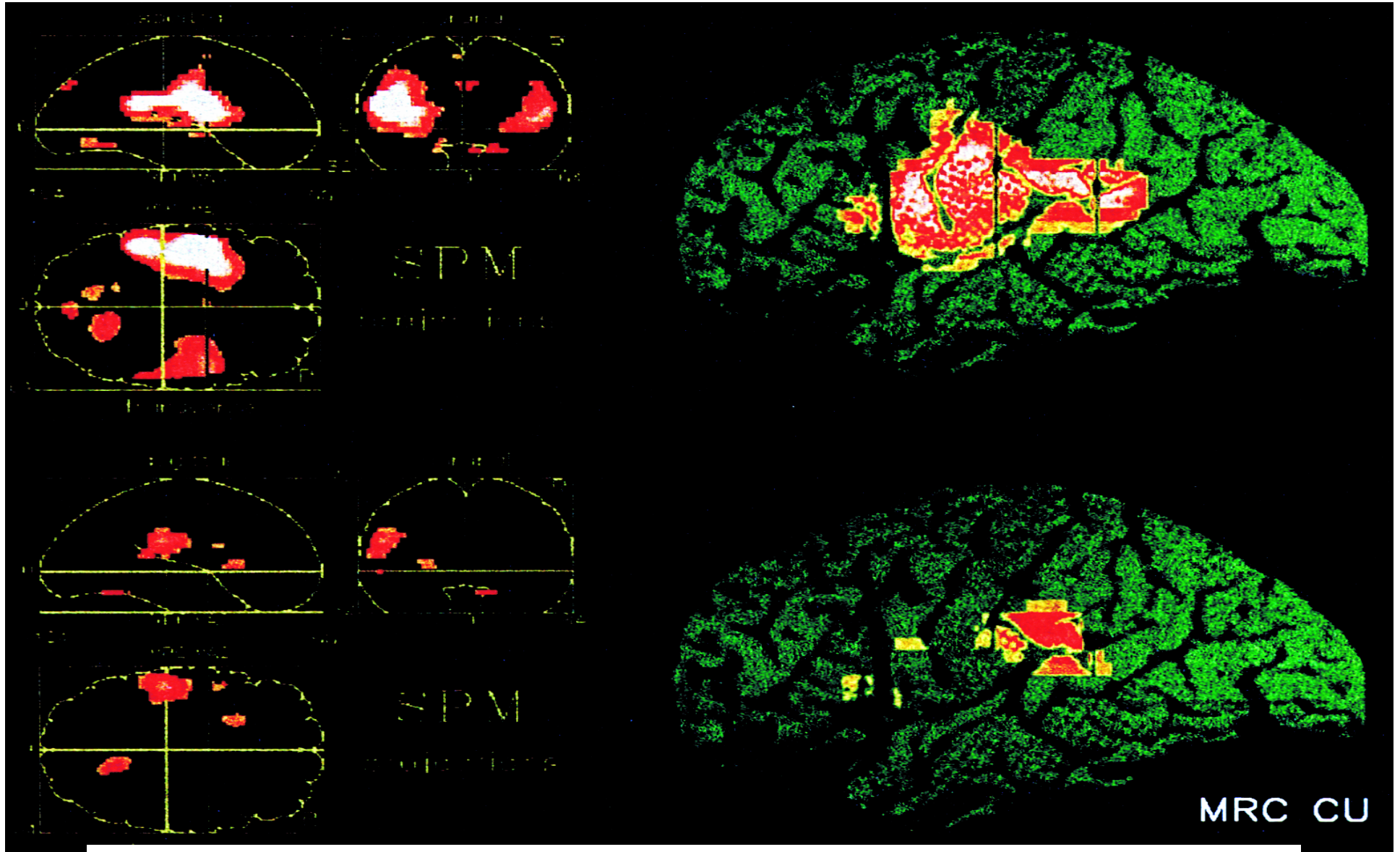
Listening – Normal Adult

Coherence & Phase Sig.  
Relations by location  
Alpha set @ .01



# Is Developmental Dyslexia a disconnection Syndrome? Evidence from Pet Scanning

Paulesu, E., Frith, U., Snowling, M., Gallagher, A., Morton, J., Frackowiak, R.S.J., Frith, C.D., 1996, Brain, 119, 143-157



Phonological Short term Memory Task N=5 Adult Dyslexics vs Normals (5)

## Relations of Interest for F4 phase alpha relations

Auditory Memory

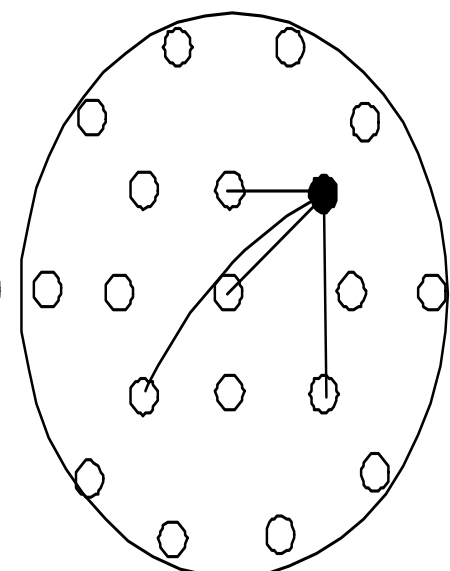
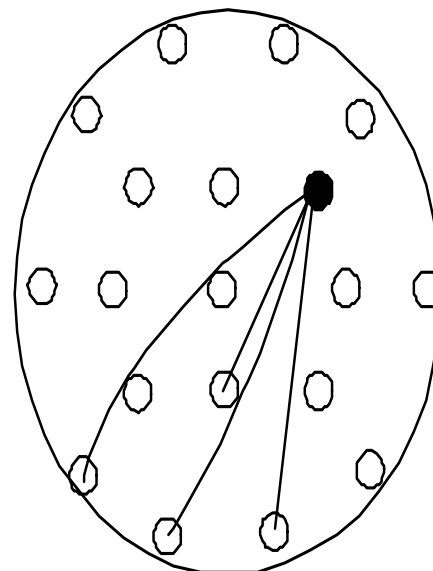
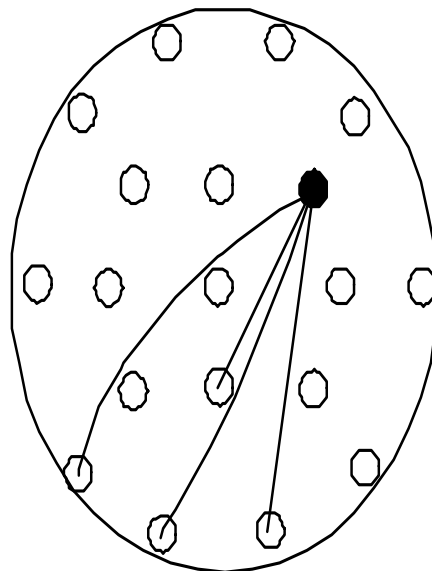
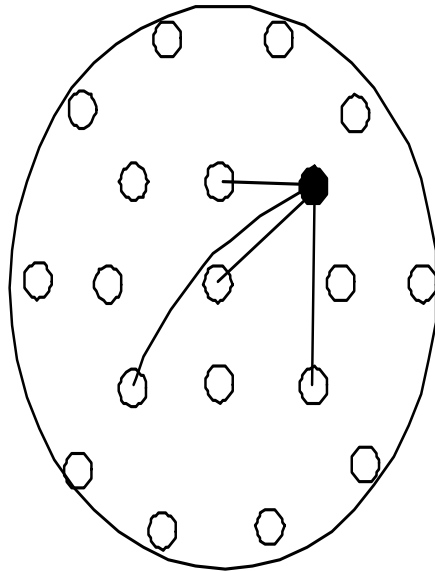
Reading Memory

Positive

Negative

Positive

Negative



Correlations between F4 phase values and memory scores for auditory memory during encoding task

Listen	F4T5PA	F4O1PA	F4O2PA	F4PZPA	F4FZPA	F4CZPA	F4P3PA	F4P4PA
N=344 AllCN	-.47	-.20	-.27	-.37	.56	.56	.39	.36
N=155 AllN	-.51	-.27	-.33	-.44	.57	.57	.37	.29
N=59 NC	-.46	-.41	-.40	-.42	.49	.51	(.25)	(.14)
N=95 NCAA	<b>-.61</b>	-.25	-.33	-.59	<b>.67</b>	<b>.65</b>	<b>.43</b>	<b>.37</b>
N=64 CC	(-.16)	(-.07)	-.32	(-.17)	(.07)	(-.02)	(.01)	(.20)
N=125 CAA	-.23	(-.02)	(-.04)	(-.12)	.39	.40	.29	.34
Avg. (for sig)	<b>-.46</b>	<b>-.28</b>	<b>-.33</b>	<b>-.46</b>	<b>.54</b>	<b>.54</b>	<b>.37</b>	<b>.34</b>

*AllNC= all non-clinical and clinical: AllN= all non-clinical: NCC=non-clinical children under the age of 14: NCAA=non-clinical adolescents and adults: CC= clinical children: CAA=clinical adolescents and adults*



## Correlations between F4 phase values and memory scores for auditory memory during immediate task

Immed. Recall	F4T5PA	F4O1PA	F4O2PA	F4PZPA	F4FZPA	F4CZPA	F4P3PA	F4P4PA
N=341 AllCN	-.46	-.28	-.32	-.37	.49	.48	.30	.29
N=155 AllN	-.51	-.27	-.33	-.44	.57	.57	.37	.29
N=57 NC	-.37	-.39	-.36	-.42	.35	.34	(.12)	(.06)
N=88 NAA	-.68	-.35	-.41	-.69	.71	.67	.46	.38
N=67 CC	(.01)	-.31	-.32	(.00)	(-.11)	(-.17)	-.29	-.31
N=127 CAA	-.27	(-.13)	(-.17)	(-.15)	.31	.31	(.17)	.22
Avg. (for sig)	-.46	-.32	-.35	-.48	.49	.47	.21	.17

*AllNC= all non-clinical and clinical: AllN= all non-clinical: NC=non-clinical children under the age of 14: NAA=non-clinical adolescents and adults: CC= clinical children: CAA=clinical adolescents and adults*

## Correlations between F4 phase values and memory scores for auditory memory during delayed recall task

Delay Recall	F4T5PA	F4O1PA	F4O2PA	F4PZPA	F4FZPA	F4CZPA	F4P3PA	F4P4PA
N=343 AllNC	-.28	-.16	-.22	-.22	.34	.34	.23	.20
N=147 AllN	-.35	-.27	-.33	-.29	.36	.37	.20	(.12)
N=57 NC	-.38	-.38	-.40	-.37	.39	.42	(.12)	(.06)
N=89 NAA	-.38	-.28	-.34	-.35	.38	.37	.23	(.14)
N=66 CC	(.07)	(-.16)	(-.12)	(-.08)	(-.12)	(-.17)	(-.08)	(-.27)
N=129 CAA	(-.09)	(-.03)	(-.03)	(.17)	(.17)	.17	(.13)	.17
Avg. (for sig)	-.35	-.27	-.32	-.31	.37	.33	.22	.19

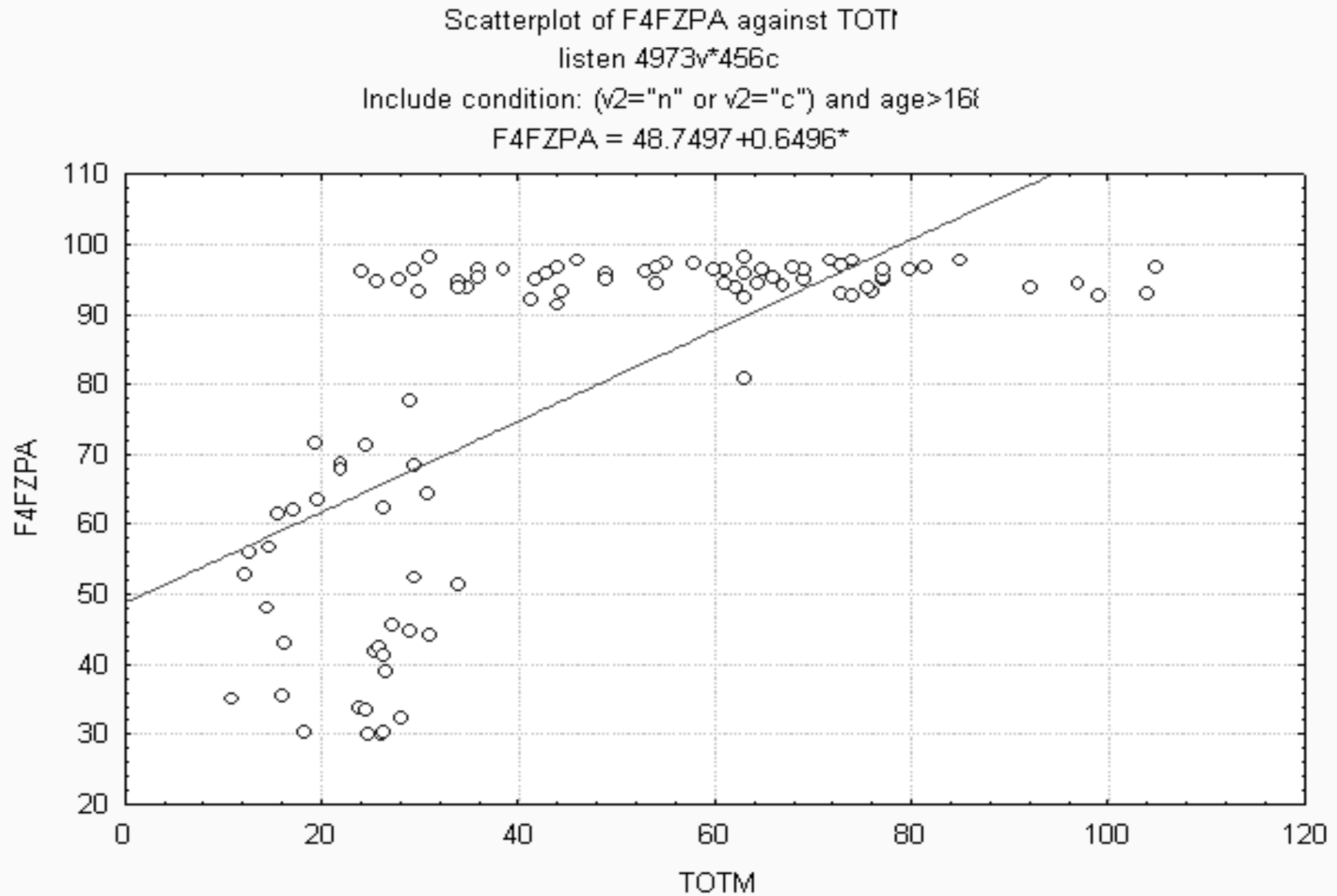
*AllNC= all non-clinical and clinical: AllN= all non-clinical: NC=non-clinical children under the age of 14: NAA=non-clinical adolescents and adults: CC= clinical children: CAA=clinical adolescents and adults*

## Correlations between F4 phase values and memory scores for reading memory during encoding

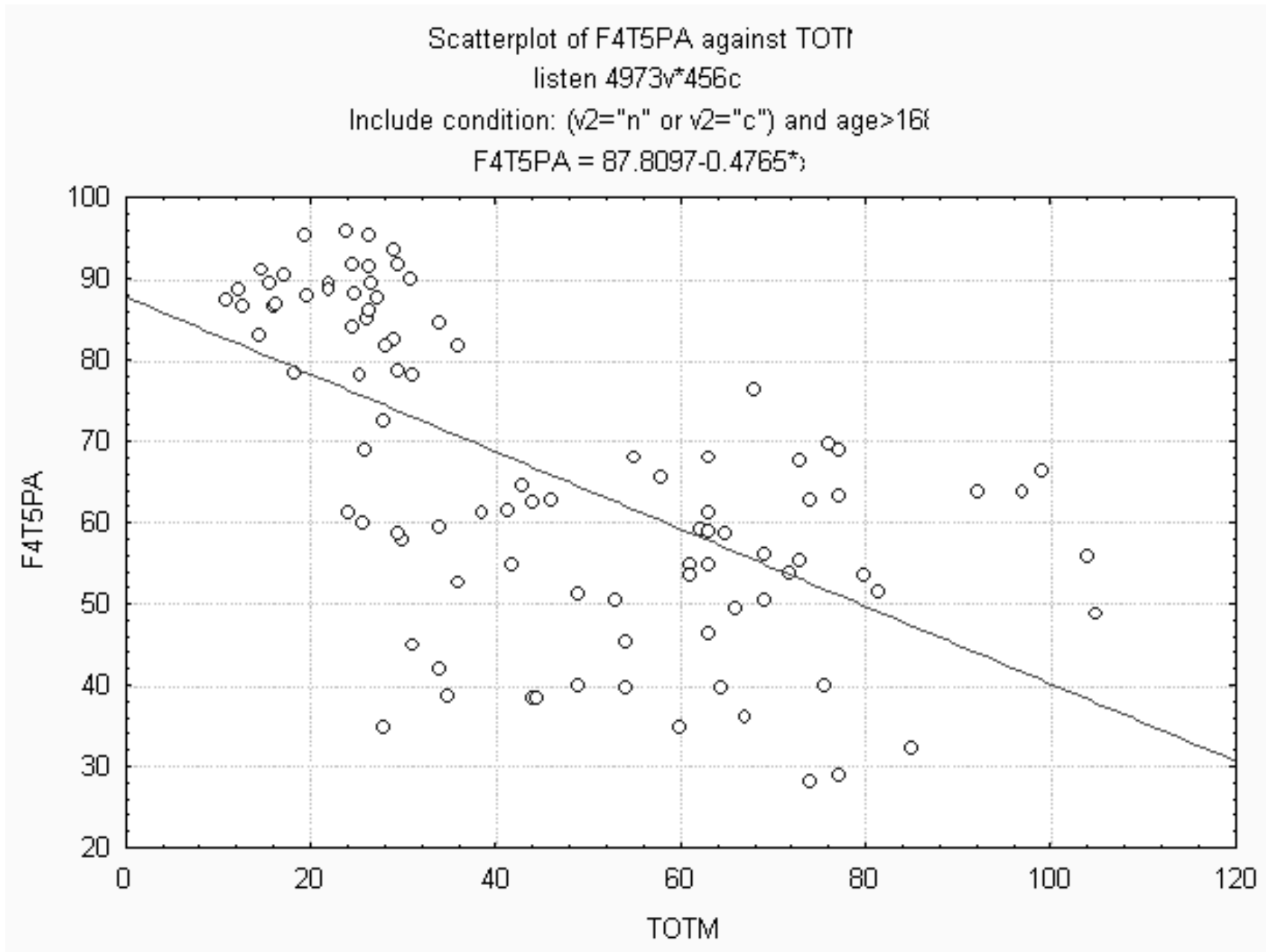
Reading	F4T5PA	F4O1PA	F4O2PA	F4PZPA	F4FZPA	F4CZPA	F4P3PA	F4P4PA
N=308 AllNC	.20	.14	.16	.21	-.11	(-.09)	(-.05)	(-.08)
N=136 AllN	(.06)	(.10)	(.14)	(.13)	(.06)	(.05)	(.04)	(.12)
N=53 NC	(-.25)	(-.10)	(-.12)	(-.22)	.33	(.25)	(.24)	(.14)
N=83 NAA	.37	.25	.23	.40	-.38	-.33	(-.14)	(-.19)
N=63 CC	.27	(-.14)	(.09)	(.20)	-.28	-.30	(-.27)	(-.24)
N=109 CAA	.26	(.14)	(.15)	.26	-.29	-.28	(-.19)	-.21
Avg. for sig.	<b>.28</b>	<b>.20</b>	<b>.20</b>	<b>.29</b>	<b>-.15</b>	<b>-.30</b>	<b>0.00</b>	<b>-.21</b>

*AllNC= all non-clinical and clinical: AllN= all non-clinical: NC=non-clinical children under the age of 14:  
NAA=non-clinical adolescents and adults: CC= clinical children: CAA=clinical adolescents and adults*

## Scatterplot of positive relations between F4FZPA and Memory



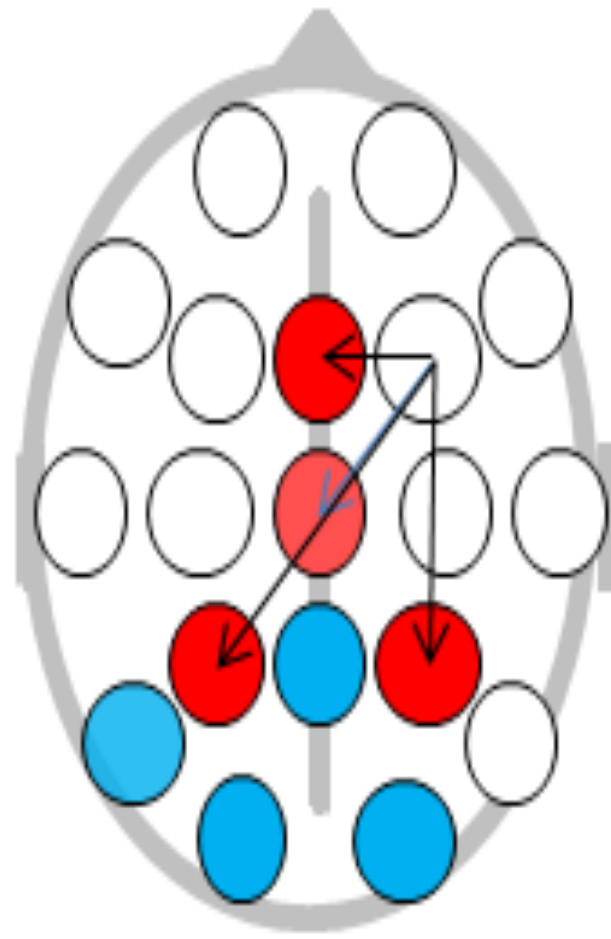
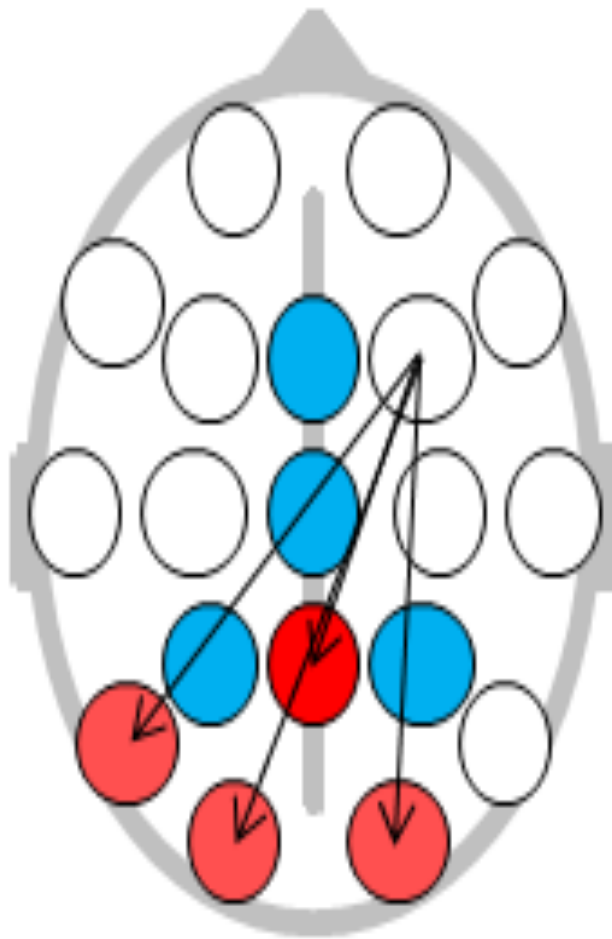
## Scatterplot of negative relations between F4T5PA and Memory



F4PA correlates during listening and reading = Red high positive correlates  
Blue – High negative correlates

Reading

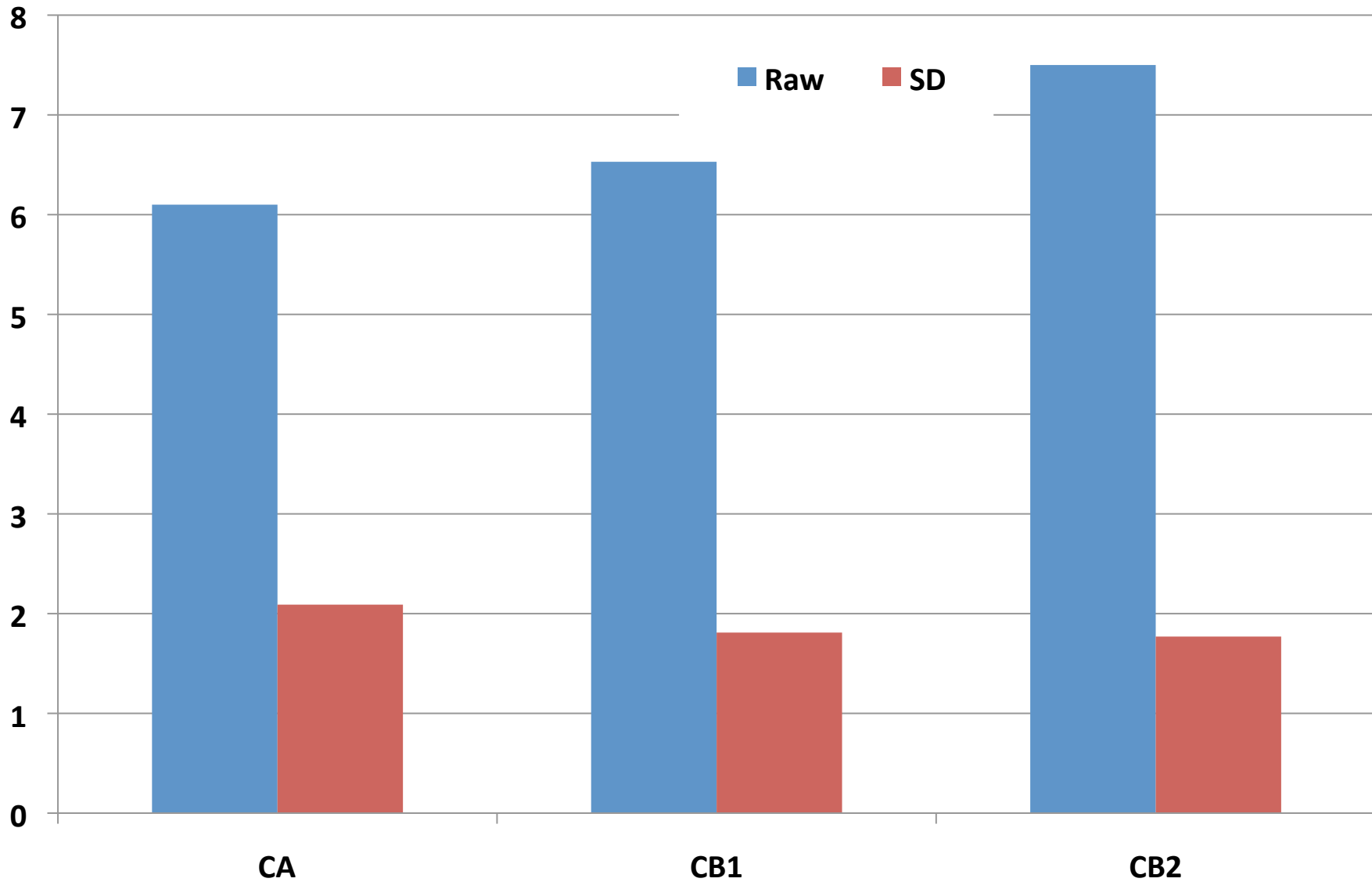
Listening



## Effects of Interventions

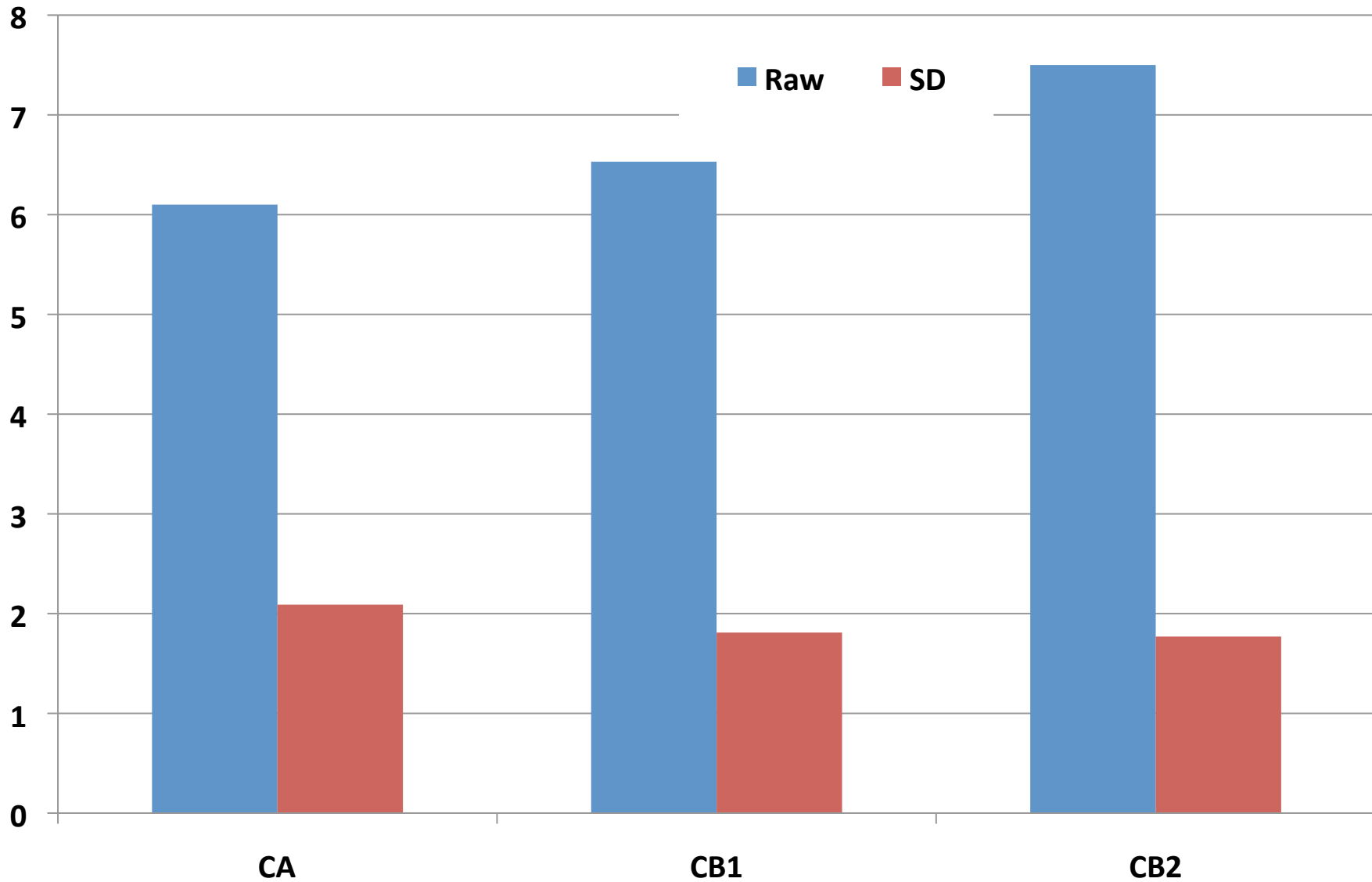
Intervention principle involve CAR model and addressing deficit connection patterns which are correlated with performance in normative group, as well as arousal variables such as relative power alpha, beta1, etc.

# Average Changes across all groups in coherence values

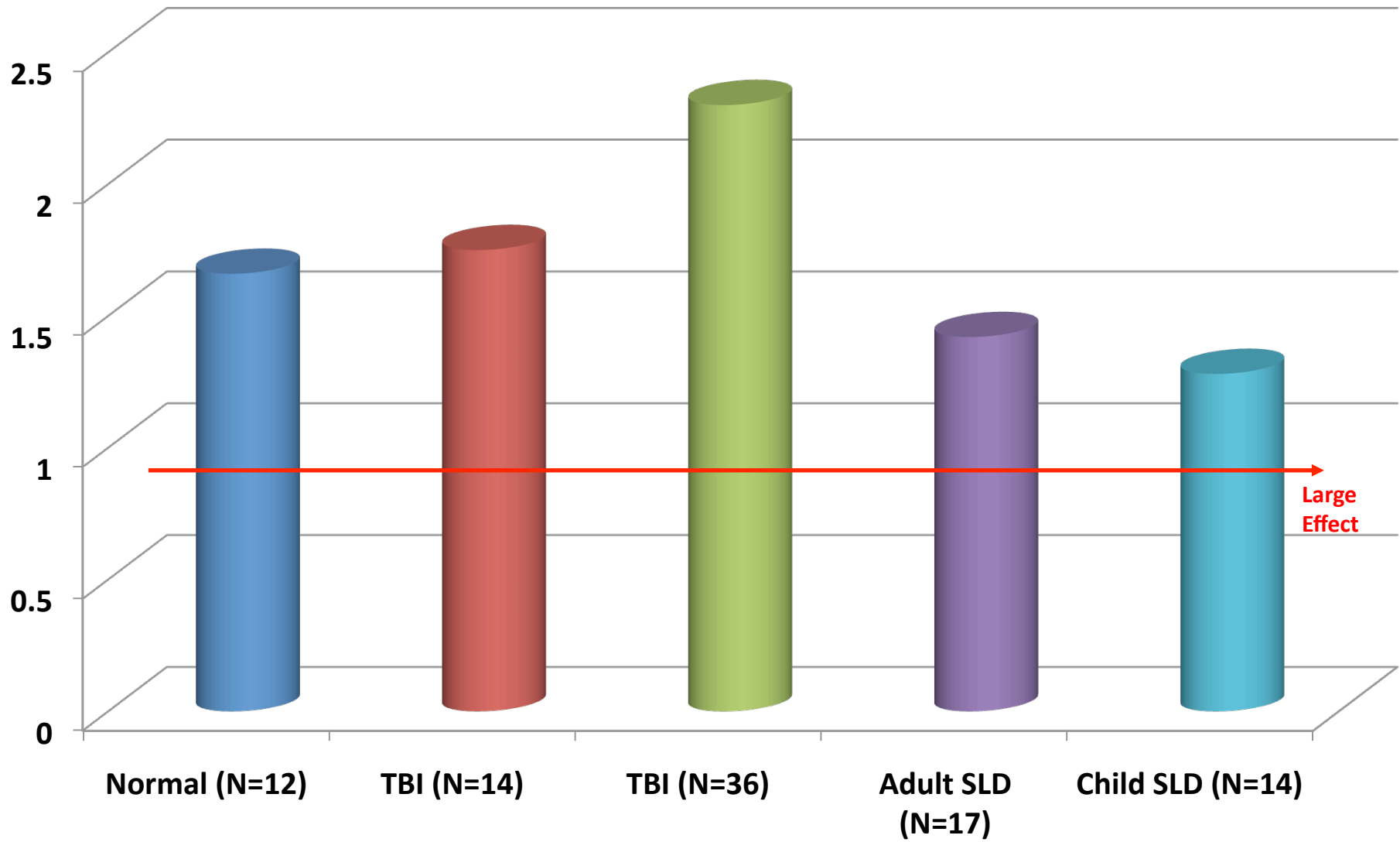




# Average Changes across all groups in coherence values



**Auditory Memory – Standard Deviation (SD) Effect –  
middle green column represents data across 3 studies**

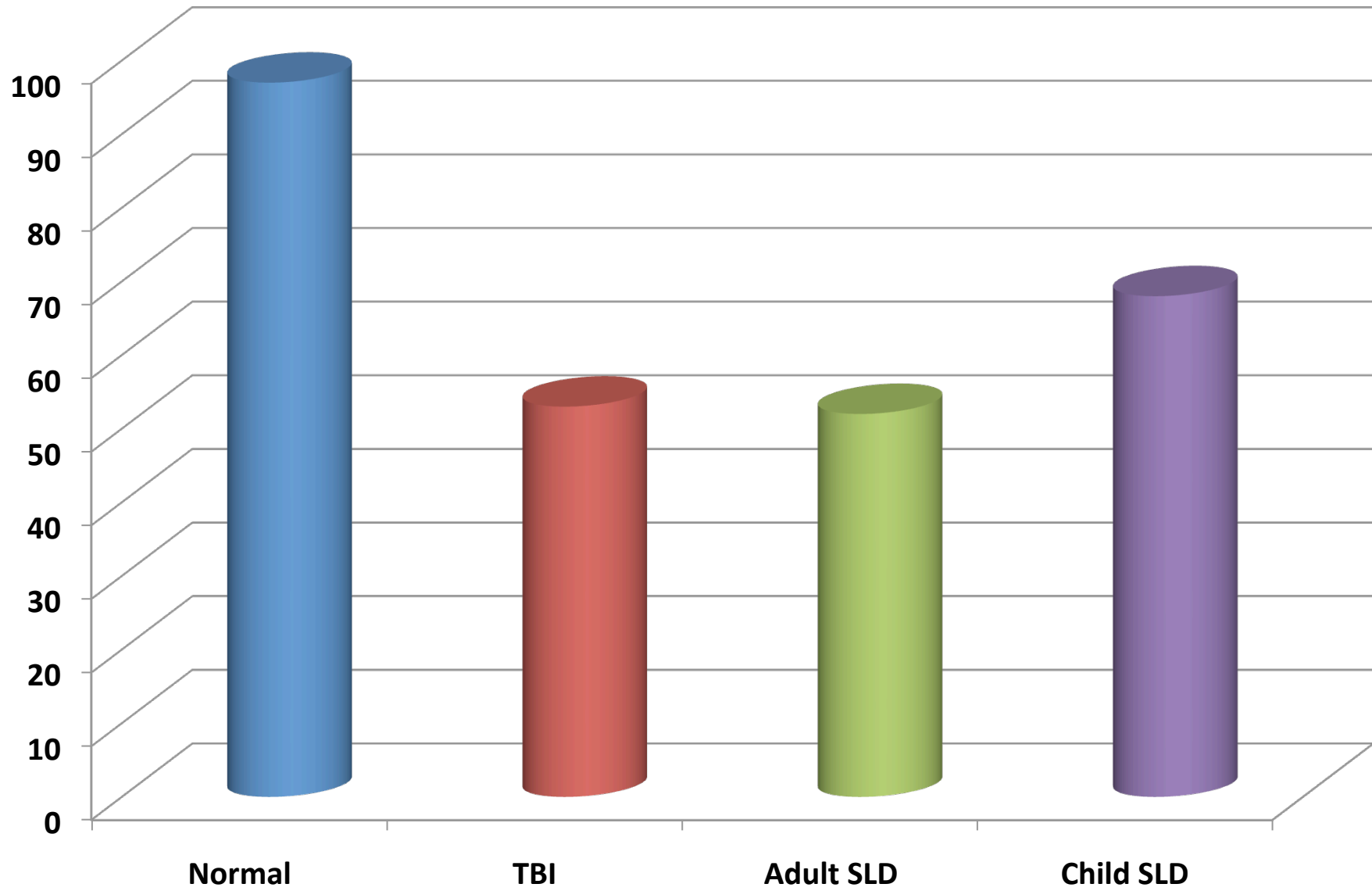


TBI=Traumatic Brain Injury Adult

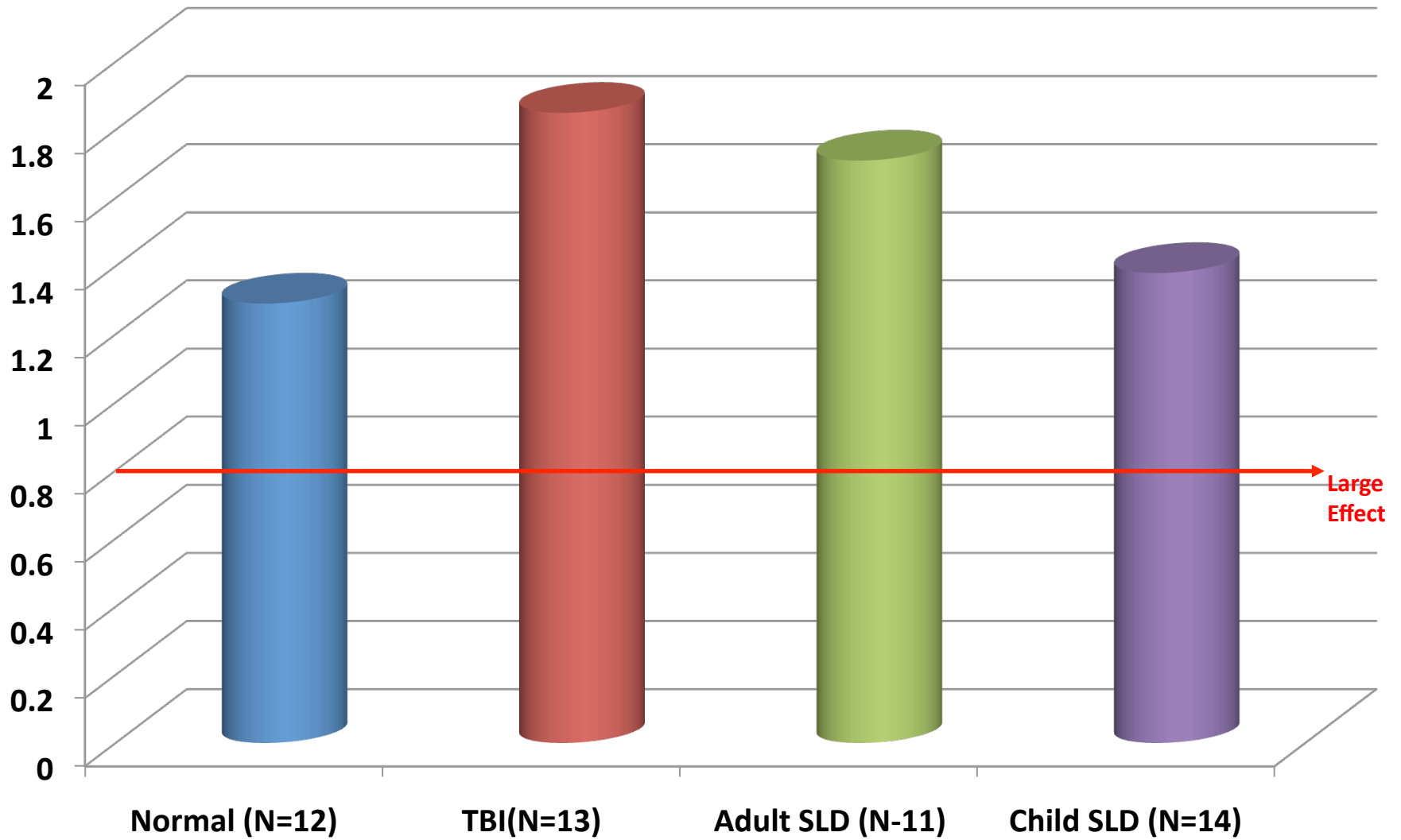
Adult SLD=Adult Specific Learning Disability

Child SLD=Child Specific Learning Disability

# % Better than normal-“cured”



# SD Effect Size - Reading

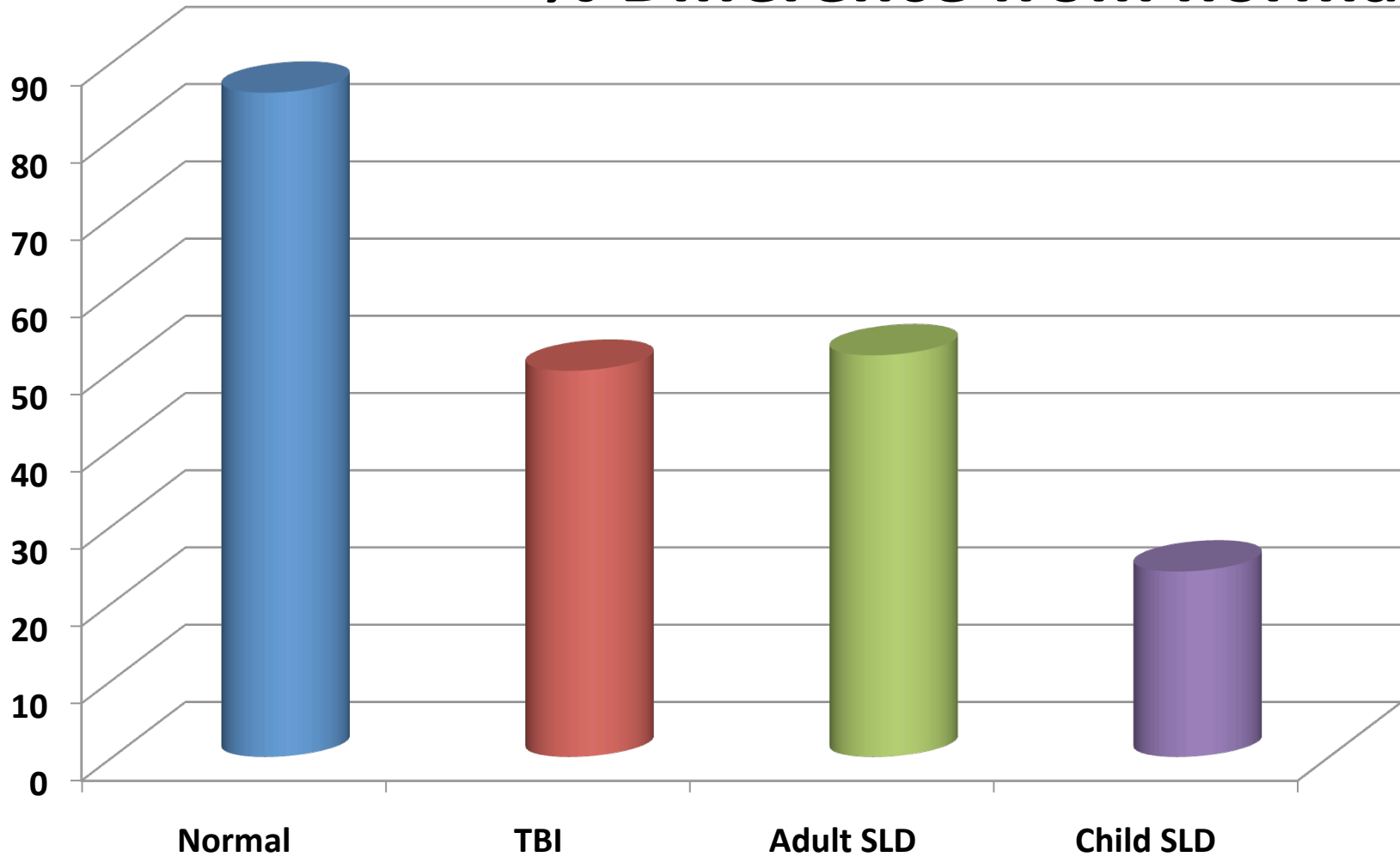


TBI=Traumatic Brain Injury Adult

Adult SLD=Adult Specific Learning Disability

Child SLD=Child Specific Learning Disability

# % Difference from normal

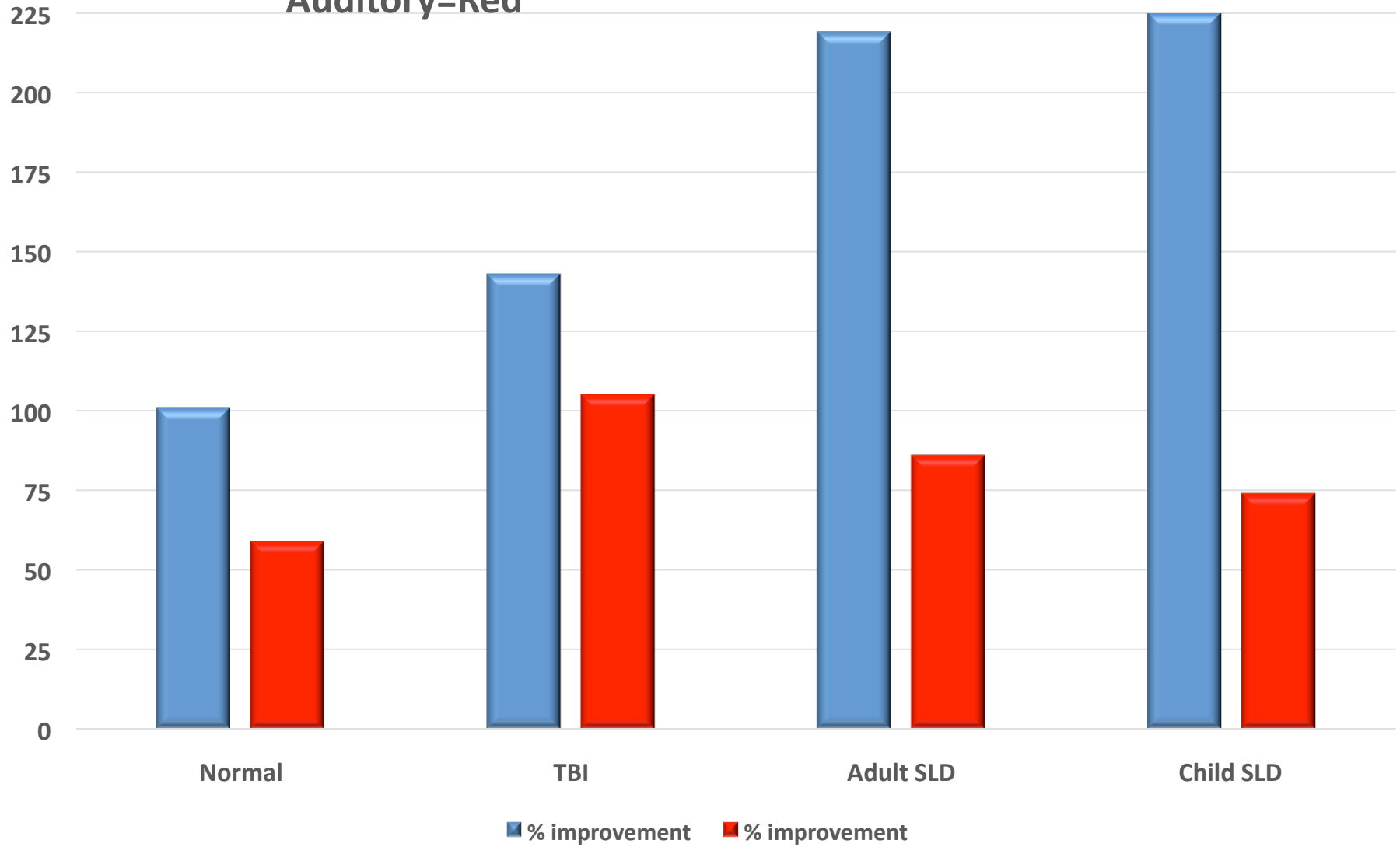


TBI=Traumatic Brain Injury Adult

SLD=Adult Specific Learning Disability  
Specific Learning Disability

Child SLD=Child

**% Improvement**  
**Reading = Blue**  
**Auditory=Red**



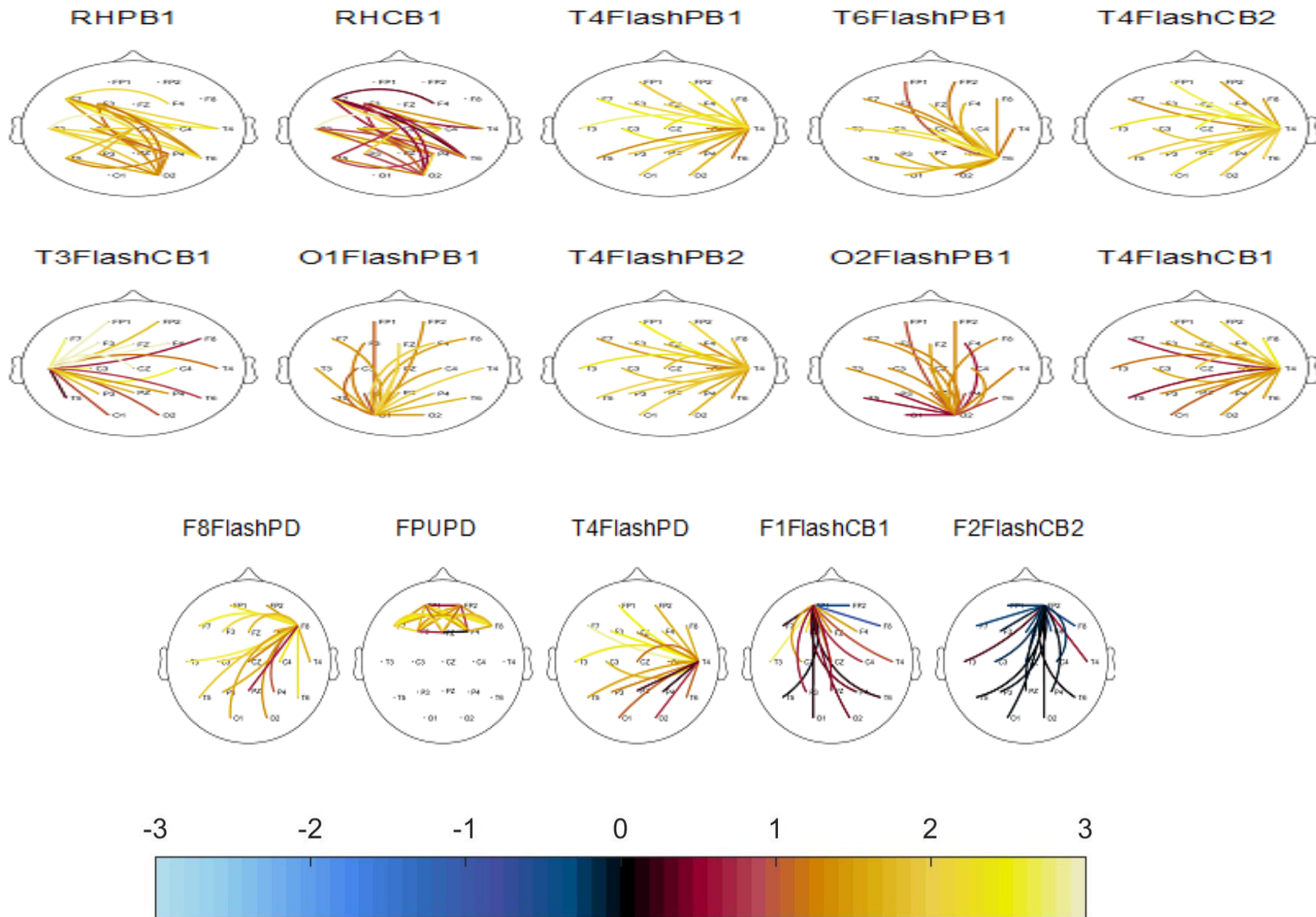
**Value of Car Model in determination of  
intervention protocols  
And new “diagnostic” mapping of  
dysfunction**

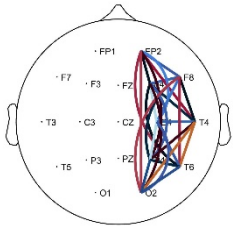
T3 Problem extends to 32-64 Hz range – also note frontal lobe problem  
 Memory in severely impaired range – usefulness of method to determine where the problem is

Beta2	F1	F2	F7	F8	F3	F4	T3	T4	C3	C4	T5	T6	P3	P4	O1	O2	FZ	CZ	
F2	<b>-1.65</b>			<b>frontal cpu -1.01</b>			fCPU	0.48	CPU	0.68	PPU	0.49							
F7	<b>-1.30</b>	<b>-1.31</b>																	
F8	<b>-0.89</b>	<b>-1.59</b>	<b>-0.55</b>																
F3	<b>-1.63</b>	<b>-1.14</b>	<b>0.39</b>	<b>-0.26</b>															
F4	<b>-1.39</b>	<b>-2.45</b>	<b>-0.43</b>	<b>-0.82</b>	<b>-0.20</b>														
T3	-0.34	-0.60	0.21	<b>-0.51</b>	<b>-0.88</b>	<b>-1.06</b>													
T4	0.54	0.17	0.89	-0.12	1.36	0.55	<b>-0.26</b>												
C3	-0.83	-0.56	0.25	-0.13	0.07	-0.37	<b>-1.38</b>	0.71											
C4	-0.33	-1.06	0.66	-0.60	1.50	-0.24	<b>-1.08</b>	0.70	0.89										
T5	0.03	-0.02	0.36	0.18	0.97	0.18	<b>-1.35</b>	0.64	1.58	0.69									
T6	0.27	0.00	0.75	-0.14	1.45	0.75	<b>-1.00</b>	0.72	0.70	1.39	-0.01								
P3	-0.18	-0.14	0.28	0.01	0.85	0.20	<b>-1.54</b>	0.78	0.50	0.67	0.55	-0.21							
P4	0.20	-0.07	0.76	-0.13	1.57	0.39	<b>-1.31</b>	0.72	1.03	0.77	0.38	-0.05	0.62						
O1	0.08	0.15	0.55	0.32	1.44	0.79	<b>-1.45</b>	1.13	1.24	1.26	-0.14	0.06	0.66	0.92					
O2	0.29	0.16	0.88	0.15	1.80	0.90	<b>-1.20</b>	0.96	1.50	1.30	0.36	-0.22	0.97	0.58	0.52				
FZ	-1.03	-1.58	0.32	-0.59	1.28	-0.92	<b>-0.82</b>	1.18	0.54	0.92	0.92	1.37	0.93	1.20	1.25	1.39			
CZ	-0.26	-0.72	0.64	-0.31	1.54	-0.26	<b>-1.27</b>	0.94	1.13	0.84	1.11	0.88	0.93	0.89	1.22	1.28	0.43		
PZ	-0.02	-0.11	0.59	-0.06	1.49	0.37	<b>-1.48</b>	0.88	1.33	0.79	0.45	0.14	0.83	0.26	0.84	0.67	0.85	0.49	
tot ave	-0.47	-0.70	0.22	-0.34	0.59	-0.22	<b>-0.96</b>	0.72	0.45	0.54	0.38	0.41	0.37	0.48	0.60	0.68	0.43	0.53	0.44

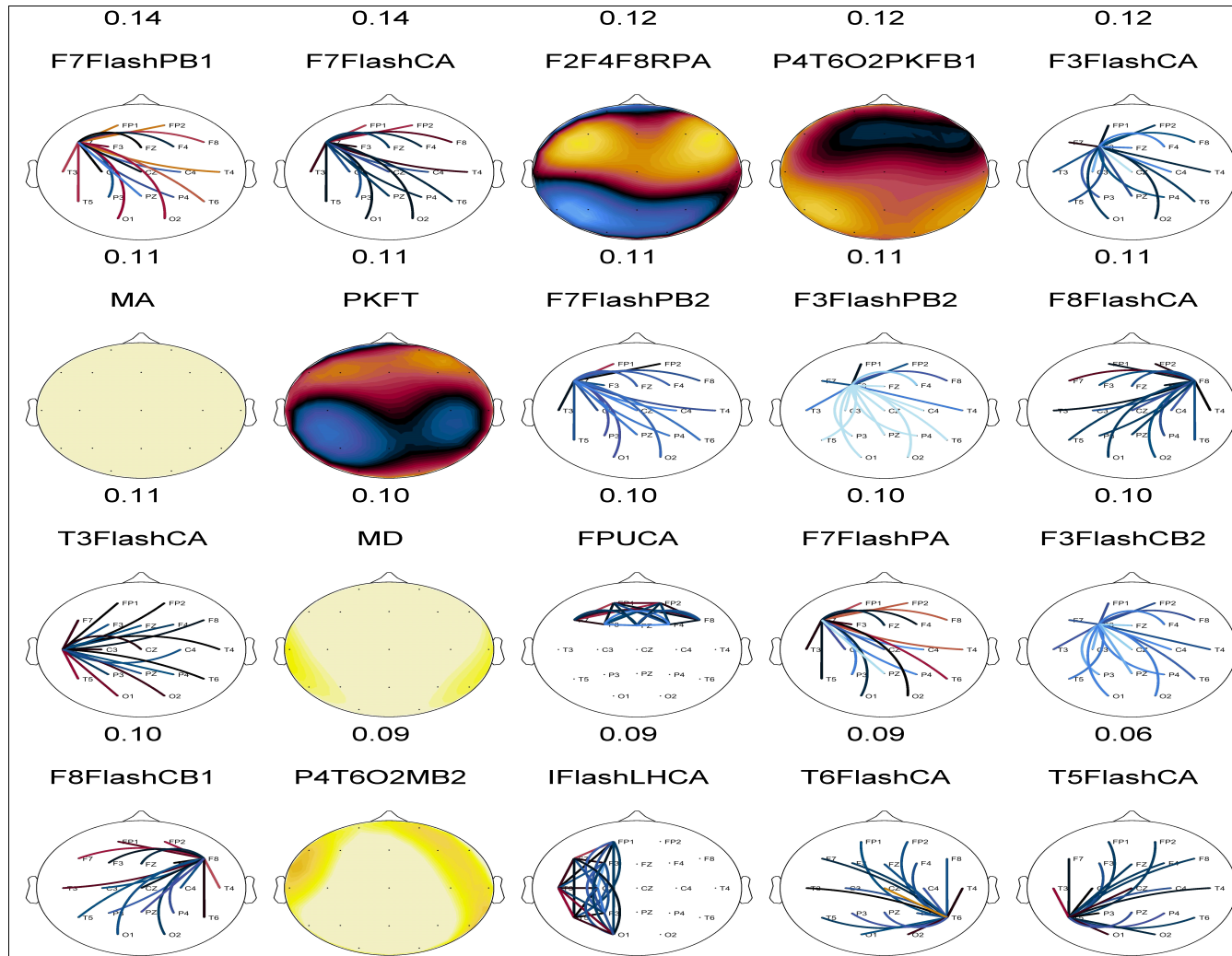


**New Approach - Report presents data in figure format as well as Standard Deviation Values**





## New Approach - Report presents data in figure format as well as Standard Deviation Values



Standard  
Deviations  
SD

