Brain imaging and connectivity An adjunct to screening

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National Institute on Alcohol Abuse and Alcoholism

CIFASD is supported by NIAAA



Invisible.

1996





Dr. Pi-Nian Chang

University of MN FAS Clinic (1978-2010); succeeded by Dr. Chris Boys



















A rare "visible" case of prenatal alcohol damage in the brain



Typical Development



Fetal Alcohol Syndrome

Diffusion Tensor Imaging (DTI): Beginning to literally make the "invisible" visible

Anatomical images





FASD is a "foundational" injury











A simple two-region connectivity experiment





Typical right-left communication



Atypical right-left communication

Brains are typically built to maximum efficiency



A foundational injury (prenatal alcohol) disturbs the balance



A more complex 92-region, <u>whole-</u> <u>brain</u> model









Activity from 92 regions

Fancy network math

Individual rating

Psychometric approach (identifying "abnormal" network connectivity)



- Atypical clustering was 2.4 times more common in the alcohol-exposed children
- Atypical local connectivity
 2.7 times more common in the alcohol exposed children

Figure 1. Distribution for clustering across all participants; showing a 1 standard deviation cutoff

Diagnostic categorization based on dysmorphology (N=126 CIFASD participants)



Image courtesy of Ken Jones

Diagnostic categorization based on dysmorphology (N=126 CIFASD participants)





What can we do about the children in diagnostic limbo??

Image courtesy of MOFAS

Characterizing individual functional connectivity



Histogram Histogram Jano + fisit2 Dia Day + 0.030400 N+143 Histogram Histogram Masn + fisit2 Dia Day + 0.030400 N+143

Mean Clustering Coefficient (cost = 0.30)

n (% within network measure)	PAE (n = 37)	Control (n = 18)	Chi-square, sig.
Characteristic Path Length (CPL)			
ТурісаІ	28 (63.6%)	16 (36.4%)	
Atypically high	9 (81.8%)	2 (18.2%)	x ² =1.32, p=.307
Mean Clustering Coefficient (MCC)			
ТурісаІ	25 (58.1%)	18 (41.9%)	
Atypically high	<mark>12 (100%)</mark>	<mark>0 (0%)</mark>	x ² =7.47, p=.005
Global Efficiency (GLOB)			
ТурісаІ	30 (62.5%)	18 (37.5%)	
Atypically low	<mark>7 (100%)</mark>	<mark>0 (0%)</mark>	x ² =3.90, p=.051
Local Efficiency (LOC)			
Typical	25 (58.1%)	18 (41.9%)	
Atypically high	<mark>12 (100%)</mark>	<mark>0 (0%)</mark>	x ² =7.47, p=.004

Returning to those in diagnostic limbo...

4 out of 10 of these have a measureable neurodevelopmental "signal" that is <u>highly specific</u> to prenatal alcohol exposure





What have we learned?

- 1. Alcohol impacts network efficiency (the foundation of information processing)
- Brain measures (incl. network status) can serve as "biomarkers" for neurodevelopmental injury
- 3. Combined with other metrics (dysmorphology), these tools may identify previously "invisible" cases of FASD

What's next?



"Everybody's getting together after work to do some more work-- you in?"

Next steps

- Establish thresholds for levels of "atypical" neurodevelopment
- Use these "biomarkers" for neurodevelopmental injury to re-assess our diagnostic methods



