Delayed Maturation in Brain Electrical Activity Partially Explains the Association Between Early Environmental Deprivation and Symptoms of Attention-Deficit/Hyperactivity Disorder.

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Background

- Deprivation in institutional settings
  - psychosocial, linguistic, and sensory

- A wide-range of developmental abnormalities are highly associated with institutionalization
  - e.g., physical, mental, cognitive, language, social and emotional development

- Are elevations in psychiatric problems among institutionalized children attributable to atypical patterns of brain development resulting from institutional deprivation?
Methods & Materials: Sample

- Bucharest Early Intervention Project (BEIP)
  - A longitudinal study on institutionalized vs. community children in Romania

- Groups (age matched 6-30 m/o):
  - 136 institutionalized children randomly assigned into:
    - Foster care intervention: 69 (→ 41)
    - Institutional care: 67 (→ 57)
  - 72 community children (→ 60)
Methods & Materials: General Procedure

Comprehensive assessments:
- At initial entry, 30 and 42 m/o
- Health, cognitive ability, and brain functioning
- EEG measurements

Psychiatric disorders assessment:
- At 54 m/o
- Preschool Age Psychiatric Assessment (PAPA)
  - Structured caregiver interview
  - Symptoms of ADHD, anxiety disorders, major depression, and oppositional defiant disorder (ODD)
- Diagnoses based on DSM-IV
Methods & Materials: EEG

- Resting EEG collected at initial entry
  - At least 9 m/o

- Standard experimental protocol for infants and toddlers:
  - Frequency bands of interest
    - Theta (3-5 Hz), alpha (6-9 Hz), and beta (10-18 Hz)
  - Relative power (RP)
    - Proportion of power at a given electrode site relative to total power at that same electrode site

- 10 sec
  - Colored balls in spinning bingo wheel

- 10 sec
  - Wheel stopped
  - Changed balls

- 9 times
Methods & Materials: Statistical Analysis

- Standard Tests of Statistical Mediation

- Evidence for Mediation:
  1. Association between the exposure and outcome of interest
     - Institutionalization & Psychopathology
  2. Association between the exposure and the putative mediator
     - Institutionalization & Brain Development
  3. Association between the mediator and the outcome
     - Brain Development & Psychopathology
  4. The degree of attenuation in the association between the exposure and outcome in a model that includes the mediator
     - Mediation Models
Methods & Materials: Statistical Analysis (Cont.)

Mediation Models
Results

- **Institutionalization & Psychopathology**
  - Children who were institutionalized had a greater number of symptoms than community children in ADHD, anxiety, depression, and ODD.
  - Lower levels of anxiety and depression in fostered children than non-fostered group, but no difference of symptoms in ADHD and ODD.
Results (Cont.)

Institutionalization & Brain Development

- Significantly increased theta (in frontal, temporal and occipital regions) and decreased alpha (in frontal and occipital regions) relative power in institutionalized children than their community counterparts

- No group difference in beta relative power
Results (Cont.)

- **Brain Development & Psychopathology**
  - Increased theta relative power in the temporal region and decreased alpha relative power in the frontal region significantly predicted the hyperactivity symptoms.
  - Increased theta relative power in the frontal, temporal, and parietal regions and decreased alpha relative power in the frontal and parietal regions significantly predicted the hyperactivity and impulsivity symptoms.
  - Beta relative power is not associated with either hyperactivity or impulsivity.
  - Generally, no other psychiatric symptoms are associated with the EEG relative power across all frequency bands.
Results (Cont.)

Mediation Models

Exposure  
Outcome  
Mediator

-19.2%  
-17.3%  
0.81  
0.67

Institutional Deprivation  
Birth Weight Head Circumference  
Alpha Relative Power Frontal  
Theta Relative Power Temporal
Take-Home Message

- Children reared in institutions evidenced greater symptoms of ADHD, anxiety, depression, and ODD.
- Decreased alpha and increased theta relative power suggested a delay in cortical maturation among institutionalized children, predicting symptoms of hyperactivity and impulsivity.
- EEG power was not associated with other psychopathological symptoms.
- Results suggesting deprivation in social and environmental conditions may perturb early patterns of neurodevelopment and manifest as psychiatric problems later in life.