Attentional Dysfunction in Psychiatric Disorder

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Virtually all major psychiatric disorders are characterized by disturbances in attention or concentration.

- **Attention-Deficit/Hyperactivity Disorder**
- **Complex Post-Traumatic Stress Disorder -- Secondary to Childhood Trauma**
Attention-Deficit/Hyperactivity Disorder

- ADHD is recognized world-wide as one of the most common neuropsychiatric disorders of childhood. It has been estimated to affect between 2% and 9% of school-age children -- with most recent studies indicating a prevalence of approximately 6%.

- ADHD accounts for 30% - 50% of child referrals to mental health services.
Hyperactivity
Inattention
Impulsivity
Hyperactivity
A. Either (1) or (2):

(1) Six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

(2) Six (or more) of the following symptoms of hyperactivity - impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
Diagnostic Criteria - DSM IV

Inattention - 6 or more

1. Often fails to attend to details
2. Often has difficulty sustaining attention
3. Often does not seem to listen
4. Often fails to finish tasks
5. Often has difficulty organizing tasks
6. Often avoids sustained mental effort
7. Often loses things necessary for tasks
8. Is often distracted by extraneous stimuli
9. Is often forgetful
Diagnostic Criteria - DSM IV

Hyperactivity & Impulsivity - 6 or more

1. Often fidgets with hands or feet
2. Leaves seat in classroom when expected to stay seated
3. Often runs about or climbs excessively
4. Often has difficulty playing quietly
5. Often “on the go” or “driven by a motor”
6. Often talks excessively
7. Often blurts out answers
8. Often has difficulty awaiting turn
9. Often interrupts or intrudes
McLean Motion and Attention Test (MMAT)
INFRARED MOTION ANALYSIS
MOVEMENT PATTERNS

Session 1
head →

Session 2

Session 3

0 40 cm

Normal 9y/o Boy

ADHD 10y/o Boy
Effects of Methylphenidate

Placebo
0.2 mg/kg bid

0.4 mg/kg bid

0.75 mg/kg bid
Computerized vigilance tasks using a GO/NO-GO strategy have been used as laboratory tests to provide composite measures of attention. However, attention is not a static parameter, but a dynamic and fluctuant process. Throughout the course of a 15 minute test there can be many shifts in attention and mental state.
Better insight into the nature of the attention disturbance in ADHD, and understanding of the effects of drugs on the disorder may arise from the assessment of attention as a dynamic temporal process.
MMAT: Fluctuations in Attention

Subj.  Pre-MPH  Post-MPH

- On task
- Impulsive
- Distracted
- Random
Imaging studies have identified key brain regions implicated in the pathophysiology of ADHD.
These include the striatum (caudate and putamen), prefrontal cortex, and most recently the cerebellar vermis.
Initial findings of brain-based differences between individuals with ADHD and healthy controls were established using measures of basal blood flow or metabolism.
T2-Relaxometry

T2 intensity decay curve from single pixel in the putamen
T2-relaxometry provides a non-invasive indirect measure of resting relative cerebral blood volume.
T2-Relaxometry

Left Putamen

T2 Relaxation Time (msec)

ADHD

Normal
Logistic Regression Analysis: Using Left-Putamen and Right Dorsolateral Prefrontal Cortex Distinguishes 11/11 ADHD from 6/6 controls.
Relationship Between Activity and T2-Relaxation Time

T2-RT (putamen+vermis-dorsolat PFC)

Activity (temporal scaling exponent)

\[ y = 0.081352 + 0.86659x \]

\[ R = 0.93091 \]
Complex PTSD

Developmental Trauma Disorder
Physical, sexual, and psychological trauma in childhood may lead to psychiatric difficulties that show up in childhood, adolescence, or adulthood.
We have proposed that early childhood maltreatment acts as a severe stressor, that produces a cascade of physiological and neurohumoral responses which leads to enduring alterations in the patterns of brain development, and that alterations in brain function set the stage for the emergence of psychiatric disorders.
Hypothesis

Common consequences relating to the effects of stress, fear, anxiety, humiliation, etc. on the developing brain

Sexual Abuse
Physical Abuse
Witness Domestic Violence
Verbal Abuse
Hypothesis

Sexual Abuse
Physical Abuse
Witness Domestic Violence
Verbal Abuse
Hypothesis

Unique effects relating to sensory systems activated, and ways in which specific events are processed.

- Sexual Abuse
- Physical Abuse
- Witness Domestic Violence
- Verbal Abuse
Example of Unique Effects Related to Type of Abuse
Study consisted of 23 females (mean age, 19.1 ± 1.1 years) with repeated episodes of childhood sexual abuse (CSA) but no exposure to other forms of trauma, and to 14 female controls (mean age, 20.1 ± 1.3 years) with complete MRI scans.
Effects of Childhood Sexual Abuse

CSA was associated with 14.1% reduction in gray matter volume of left primary and secondary visual cortex.
Results confirmed using cortical surface-based segmentation and parcellation analyses (FreeSurfer)
Verbal Abuse

*!#$^&@
Study consisted of 17 females (18-22 years) with high degree of exposure to parental verbal aggression, but no history of sexual or significant physical abuse. There were 17 female controls of comparable age and SES.
Effects of Childhood Verbal Abuse

Exposure to high levels of parental verbal abuse was associated with 11.3% reduction in GMV of right superior temporal gyrus.
Effects of Childhood Verbal Abuse

Exposure to high levels of parental verbal abuse was associated with significant thinning of a portion of the right superior temporal gyrus (FreeSurfer).
Sensitive Periods
Hippocampal volume reduced 13.2% in subjects who experienced abuse at age 4 (n=7).
Corpus Callosum - Rostral Body

Abused at index age vs abused at other ages

CC area reduced 22.4% in subjects who experienced abuse at age 10 (n=5).
Prefrontal Cortex

Abused at index age vs abused at other ages

PFC GMV reduced 5.8% in subjects who experienced abuse at age 14 (n=4).
Composite Path Analysis

Hippocampal Volume

-0.69 (p<10^-7)

Density Abuse 3-5 years

0.41 (p<0.005)

Area Rostral Body Corpus Callosum

0.25 (p<0.05)

Density Abuse 6-8 years

0.58 (p<0.0001)

Density Abuse 9-10 years

0.44 (p<0.005)

Density Abuse 11-13 years

0.44 (p<0.005)

Density Abuse 14-16 years

-0.48 (p<0.005)

Frontal Cortex Gray Matter Vol.