

# IMAGES OF ATTENTION DEFICIT DISORDER

## ADD, Learning Disability Abstracts

The first evidence for the brain being understimulated was introduced with the use of more advanced electroencephalograms (EEG or brainwave studies) BY Joel Lubar from the University of Tennessee. He demonstrated that when ADD children and teenagers performed a concentration task there was an increased amount of slow brain wave activity in their frontal lobes, instead of the usual increase in fast brain wave activity that was seen in the majority of the control group.

In 1990, published PET data that supported the notion of brain underactivity in the prefrontal cortex, especially in response to an intellectual challenge. Data from my own work with brain SPECT imaging drew the same conclusions. At rest most ADD people have normal activity in their brain. When they perform a concentration task, however, they experience decreased activity in the prefrontal cortex, rather than the expected increased activity that is seen in a normal control group.

Tied to the decreased prefrontal cortex findings are the studies that indicate that ADD is has a large genetic contribution, involving dopamine availability in the brain. A significant amount of dopamine is produced in the basal ganglia (large, structures deep within the brain). Stimulant medications work by enhancing dopamine availability in this part of the brain. Studies have demonstrated that the basal ganglia is smaller in people with ADD. The basal ganglia have a significant number of nerve tracks that go through the limbic system to the prefrontal cortex. It appears that when there is not enough dopamine available in the basal ganglia then there is not enough 'fuel' to drive the frontal lobes when they need to activate with concentration.

Beside the genetic contribution to ADD, maternal alcohol or drug use, birth trauma, jaundice, brain infections and head trauma (sometimes even minor ones, especially to the left prefrontal cortex) can play a causative role.

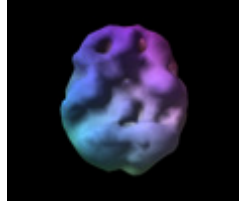
### **Subtypes of ADD**

It is essential to note that ADD is a developmental disorder diagnosed through clinical history over a prolonged period of time. Brain imaging is not necessary to make the diagnosis of ADD, although it may be helpful in certain complicated cases. Based on my brain imaging experience I have seen 5 clinical subtypes of ADD:

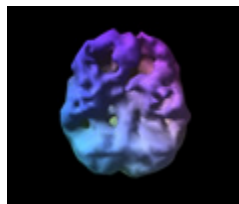
**1. AD/HD, combined type** with both symptoms of inattention and hyperactivity-impulsivity. Brain SPECT imaging typically shows decreased activity in the basal

ganglia and prefrontal cortex during a concentration task. This subtype of ADD typically responds best to psychostimulant medication.

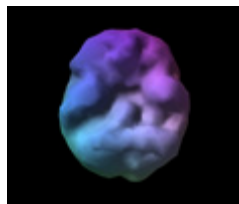
### **Rest, Concentration & Concentration with Medication**



undersurface view, rest  
mild decrease prefrontal area



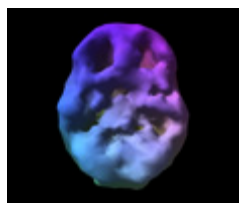
undersurface view, concentration  
marked decrease prefrontal cortex  
and left temporal lobe



undersurface view, w/Adderall  
overall marked improved activity

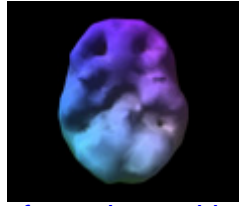
**2. AD/HD, primarily inattentive subtype** with symptoms of inattention and also chronic boredom, decreased motivation, internal preoccupation and low energy. Brain SPECT imaging typically shows decreased activity in the basal ganglia and dorsal lateral prefrontal cortex during a concentration task. This subtype of ADD also typically responds best to psychostimulant medication.

### **Before & After Treatment with Ritalin & Adderall**

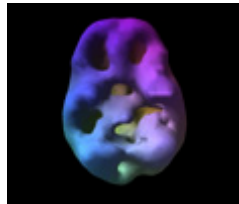


undersurface view, NO MEDS  
poor prefrontal and

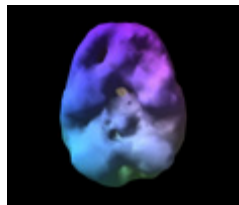
temporal lobe activity



undersurface view, with Adderall  
marked overall improvement

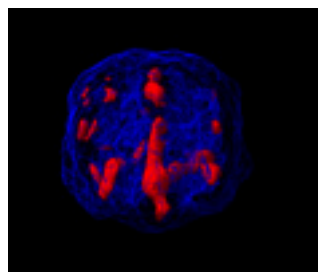


undersurface view, NO MEDS  
overall severe decreased activity

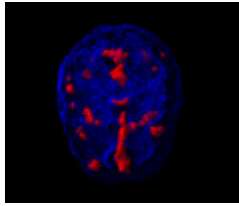


undersurface view, w/Ritalin  
overall marked improved activity

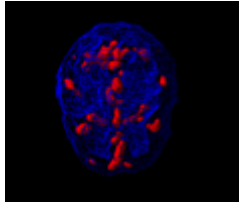
**3. Overfocused ADD**, with symptoms of trouble shifting attention, cognitive inflexibility, difficulty with transitions, excessive worrying, and oppositional and argumentative behavior. There are often also symptoms of inattention and hyperactivity-impulsivity. Brain SPECT imaging typically shows increased activity in the anterior cingulate gyrus and decreased prefrontal cortex activity. This subtype typically responds best to medications that enhance both serotonin and dopamine availability in the brain, such as venlafaxine or a combination of an SSRI (such as fluoxetine or sertraline) and a psychostimulant.



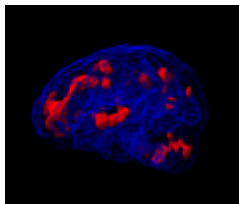
front on active view  
increased cingulate activity



active top down view  
increased cingulate activity

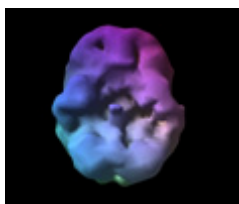


top down active view  
increased cingulate activity

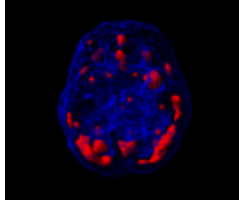


active side view  
increased cingulate activity

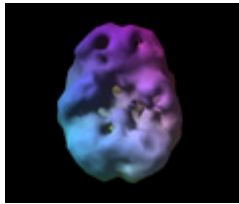
**4. Temporal lobe ADD**, with symptoms of inattention and/or hyperactivity-impulsivity and mood instability, aggression, mild paranoia, anxiety with little provocation, atypical headaches or abdominal pain, visual or auditory illusions, and learning problems (especially reading and auditory processing). Brain SPECT imaging typically shows decreased or increased activity in the temporal lobes with decreased prefrontal cortex activity. Aggression tends to be more common with left temporal lobe abnormalities. This subtype typically responds best to anticonvulsant medications (such as gabapentin, divalproate, or carbamazepine and a psychostimulant).



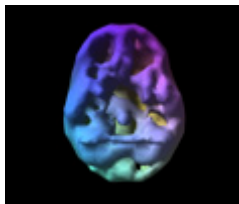
undersurface view  
decreased left temporal lobe activity



underside active view  
increased left temporal lobe activity

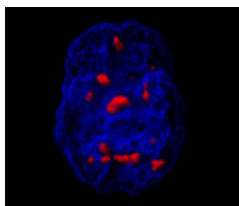


undersurface view  
marked decreased left  
temporal lobe activity

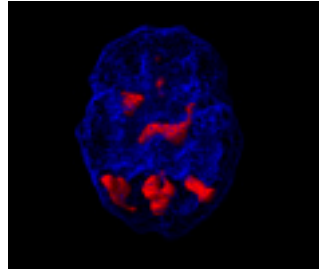


undersurface view  
marked decreased temporal  
and prefrontal cortex bilaterally

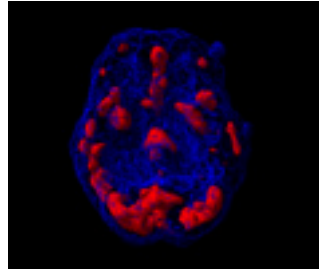
**5. Limbic ADD**, with symptoms of inattention and/or hyperactivity-impulsivity and negativity, depression, sleep problems, low energy, low self-esteem, social isolation, decreased motivation and irritability. Brain SPECT imaging typically shows increased central limbic system activity and decreased prefrontal cortex activity. This subtype typically responds best to stimulating antidepressants such as buprion or imipramine, or venlafaxine if obsessive symptoms are present.



underside active view  
increased limbic activity

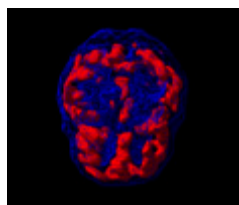


underside active view  
increased limbic activity

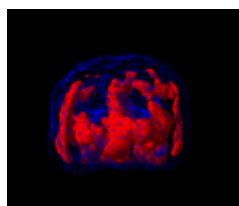


underside active view  
marked increased limbic, basal ganglia and cingulate activity

**6. Ring of Fire ADD** - many of the children and teenagers who present with symptoms of ADD have the "ring of fire" pattern on SPECT. They often do not respond to psychostimulant medication and in many cases are made worse by them. They tend to improve with either anticonvulsant medications, like Depakote or Neurontin, or the new, novel antipsychotic medications such as Risperdal or Zyprexa. The symptoms of this pattern tend to be severe oppositional behavior, distractibility, irritability and temper problems and mood swings. We think it may represent an early bipolar pattern.

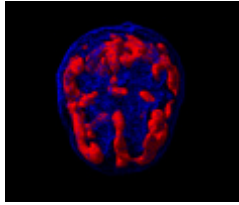


top down active view  
increased activity in the cingulate,  
lateral parietal, frontal and temporal lobes



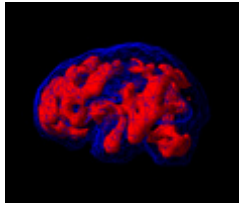
active front on view  
increased activity in the cingulate,

lateral parietal, frontal and temporal lobes



top down active view

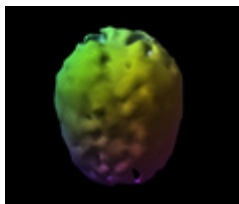
increased activity in the cingulate,  
lateral parietal, frontal and temporal lobes



left side active view

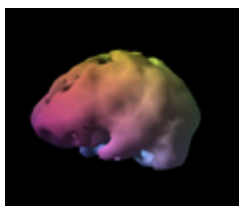
increased activity in the cingulate,  
lateral parietal, frontal and temporal lobes

**7. Trauma Induced ADD**, especially to the left dorsolateral prefrontal cortex. The symptoms come on or intensify in the year after a head injury. The ADD symptoms may respond to psychostimulant medication. If irritability results secondary to psychostimulant medication the addition of a low dose anticonvulsant may be helpful.



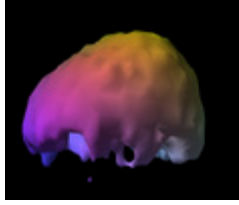
top down surface view

marked decreased left front  
prefrontal and occipital lobes



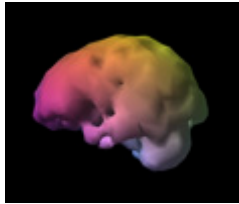
side surface view

marked decreased left prefrontal  
and anterior temporal region



side surface view

decreased left prefrontal cortex



side surface view

decreased left prefrontal and  
temporal lobe activity