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The Link between ADHD and Chemical Exposures

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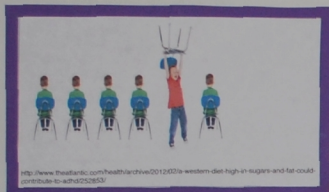
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What is ADHD?

- Attention Deficit Hyperactivity Disorder, commonly known as ADHD, is a disorder that causes attention deficit, hyperactivity, or impulsiveness (ADD&ADHD 2015).
- It is characterized as a neurodevelopmental disorder that must begin in childhood (ADD&ADHD 2015).
- There are three phenotypes of ADHD: inattentive, hyperactive-impulsive, and combined (ADD&ADHD 2015).

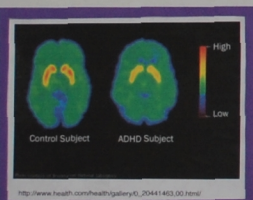


Signs and Symptoms of ADHD

- A person with the inattentive type of ADHD suffers from the following: lack of attention, making careless mistakes, not listening, being forgetful, avoiding tasks that involve effort, unable to understand and follow directions, being distracted, and/or losing things that are needed to complete tasks (ADD&ADHD 2015).
- A person suffering from the hyperactive-impulsive type of ADHD may fidget, squirm, get up often when seated, speak profusely, interrupt others in a conversation, have trouble playing quietly, and run/climb at inappropriate times (ADD&ADHD 2015).
- Most individuals suffering from ADHD have the combined type. He/she will exhibit a combination of the symptoms listed above. (ADD&ADHD 2015).

Signs and Symptoms of ADHD Continued...

- A child with ADHD usually has academic difficulties and problems with forming and maintaining relationships.
- When undiagnosed, 30%-70% of children continue to have these symptoms when they grow older. Adults with ADHD usually have trouble in their workplace and relationships (ADD&ADHD 2015).
- Signs of adults with ADHD include the inability to be on time, risky driving, distraction, outbursts, and hyper focus. Hyper focus happens when a person focuses intensely on tasks they deem interesting but struggle to pay attention to tasks that are boring. This is problematic when these tasks are necessary for everyday life (ADD&ADHD 2015).



ADHD Diagnosis

- Multiple tests are performed to determine if someone has ADHD.
- These tests range from interviews with parents and/or relatives, questionnaires/rating scales, and psychological tests.
- In the American Psychiatric Association's Diagnostic and Statistical Manual, there are criteria that define whether or not someone has this disorder. Psychologists and psychiatrists will use this manual to treat patients (ADD&ADHD 2015).
- If a person is determined to have ADHD, stimulants such as Adderall may be consumed to treat the symptoms. Psychotherapy can also help (ADD&ADHD 2015).

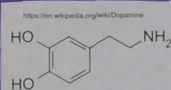
The Link Between

ADHD and

Chemical Exposures

Possible Causes of ADHD

- There are several possible causes for ADHD. Evidence suggests that this disorder is genetic meaning a child is more likely to inherit ADHD if one or more parents has it (ADD&ADHD 2015).
- The neural pathways and brain structure are slightly different in an individual with ADHD compared to someone without this disorder (ADD&ADHD 2015).
- Certain brain structures are smaller and neurotransmitters do not work the same in ADHD-affected individuals (ADD&ADHD 2015).
- One such neurotransmitter that may play a role is dopamine. Dopamine is an organic molecule that is made up of an amine attached to a catechol (a benzene with two hydroxyl side groups) via an ethyl chain (ADD&ADHD 2015).

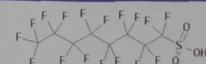
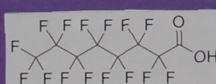


Possible Causes of ADHD Continued...

- Dopamine is an organic base that can be protonated in acidic environments but deprotonated in basic environments. Its protonated form is water soluble and very stable while its deprotonated form is less water soluble and more reactive (Mandal 2013).
- Dopamine is a neurotransmitter that controls the reward and pleasure centers of the brain. By regulating emotional responses, attention, and movement, it motivates humans to take actions to achieve rewards (Mandal 2013).
- Low levels of dopamine may be a major cause of ADHD. Other causes are environmental exposures to carcinogens such as PCBs and PFCs (Mandal 2013).

PFCs and ADHD

- Recent studies show that there is a positive correlation between PFCs and the presence of ADHD in children.
- Researchers at Boston University looked at the association of four PFCs and the parental report of ADHD. Data was obtained from a national examination survey with a sample size of 571 children (12-15 years of age). Levels of PFCs were measured in each child by drawing blood. Results showed that increased levels of PFCs found in the system increase the odds of a child having ADHD. (Hoffman 2010).
- Since PFCs are known carcinogens, this correlation is not surprising. Data suggests that PFCs may be potential developmental neurotoxicants (Hoffman 2010).

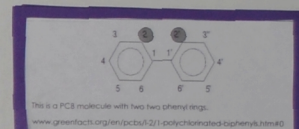


PCBs

- PCBs, also known as polychlorinated biphenyls, are man-made organic chemicals that did not exist until 1929.
- PCBs were widely used and the United States was the main manufacturer until its ban in 1979. Many products such as coolant liquids, carbon copy paper, and eat-in food containers contained PCBs during that time.
- PCBs were found to cause cancer in certain animals and are labeled as carcinogens. Their degradation depends on the number of chlorine atoms linked to the phenyl rings (Greenfacts 2015). The more chlorine atoms, the harder it is to degrade.
- Humans mainly consumed PCBs through consumption of contaminated poultry, fish, and meat although this has dramatically decreased after the ban.

PCBs Continued...

- A PCB molecule has two phenyl rings, which are six carbon atoms in a ring with hydrogen and chlorine atoms attached (Greenfacts 2015). These chlorine atoms may be present some or all of the 10 possible positions (Greenfacts 2015).
- The single bond between the two phenyl rings can rotate while the shape of the molecule is largely influenced by chlorine atom repulsion (Greenfacts 2015). The two rings will either be on the same plane or on different planes perpendicular to each other. PCB (planar) molecules with the two phenyl rings on the same plane tend to be more toxic to humans (Greenfacts 2015).
- PCBs have low water solubilities but high solubilities in solvents like oils, fats, and other organic solvents. They have low vapor pressure at room temperature. Thus, PCBs will bioaccumulate in the fatty tissues in organisms (Greenfacts 2015).



PCBs and ADHD

- Although not as toxic, non-planar PCB molecules, in high dosages, have been found to have a detrimental effect on the development of the nervous system and dopamine levels (Greenfacts 2015).
- A study conducted at the University of Illinois at Urbana-Champaign found that children and laboratory animals exposed to higher levels of PCBs displayed the same symptoms as children diagnosed with ADHD (Eubig 2010). Children that had higher levels of PCBs in their blood stream tended to respond too soon and earned less rewards much like children with ADHD (Eubig 2010).
- PCBs were found to decrease dopamine levels in the prefrontal cortex and the striatum (Eubig 2010).

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