Research Article

Cognitive Science Perspective on Attention Deficit: Causes, Impacts, and Interventions

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ARTICLE INFO	ABSTRACT
	Cognitive Science (CS) is the study of the human mind and brain. The brain is a physical entity one can touch it and feel it and it has a physical shape. Mind is a logical entity, a mental process, one cannot touch it and feel it. The mind and brain are different but are dependent on each other. CS is essential for understanding human behaviour and addressing neurological issues like attention deficit hyperactivity disorder (ADHD), epilepsy, learning disorders etc. This research focuses on attention. At present, at best of our knowledge there lacks standard definition on understanding attention. Understanding the core component of attention is very important and critical because attention deficit impacts negatively in people's lives. One may face academic difficulties, poor organizational skills, social difficulties, low self-esteem, behavioural problems, etc. There lacks the research on the relationship between attention, cognitive neuroscience and psychology. This study aims to clarify attention, attention deficit, its types, and causes. It also explores how ADHD impacts children and adults differently including variations across genders. Understanding CS and Attention is vital because it helps to simplify our day-to-day tasks and improve the quality of life. **Keywords:** ADHD, Neuroscience, Psychology, attention deficit, Cognitive science.

INTRODUCTION

CS is an interdisciplinary approach that studies the human mind and brain. It helps to know how the mind works, how it performs cognitive processes, and how to analyze a person's behavior. In CS, researchers from psychology, linguistics, artificial intelligence, robotics, anthropology, and neuroscience work together for optimal solutions. Every field consists of a different set of tools and interpretations. Cognitive scientists refer to the mind as an information-processing center.

Computers are also information processing centers. A computer takes information with the help of input devices such as a mouse or keyboard. This information is stored on the computer with the help of a hard drive. Similarly, humans perform various tasks. The input is in the form of our senses and is stored in our memories as thoughts. These thoughts can act as outputs, such as language or behavior [1].

CS and Attention Deficit Hyperactivity Disorder (ADHD):

The study of attention is a combination of fields like psychology and neuroscience which are the field of CS. Attention is understanding how the brain focuses on certain stimuli and ignores others. Psychology has provided the foundational theories for attention. Few British psychologists have performed experiments like Broadbent's filter theory which concentrated on hearing. How can a person process the relevant sound when there are multiple sounds? This raised two fundamental questions – what is the difference between the selected sound (relevant sound) and the

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ignored sound? What do people know about the ignored sound? The answers for selected sounds are based on physical differences like the direction of the sound it is coming from, sudden changes in the volumes of the sound or changes in the pitch like low to high. And people know only some information about the ignored sound. Even though they can hear the sound they do not process the deeper meaning of the sound. Other experiments are Treisman's Attenuation Theory argues that ignored sound is not completely left but the information is weakened, and Feature Integration Theory which focuses on how attention combines features like colour, and shape to perceive objects.

Later the study by Ducan on how the neurons in the brain of the monkey behave when performing different attention-related stimuli. This helped to understand how the brain processes the selected sound and the ignored sound. In addition, Ducan also studied psychological data from his human participants. Advances in to study of the attention in the brain by ERPs and functional imaging. ERPs are brainwave patterns recorded from the scalp to study attention. When a person is integrated into a stimulus ERPs show voltage fluctuations that occur in the brain while processing the information. Research proved that the attention increases brain's response to relevant sound in areas like the occipital cortex which helps in visual processing. PET (Positron Emission Tomography) helps to track the flow of blood to different brain regions and fMRI (Functional Magnetic Resonance Imaging) is used to measure the brain's activity by identifying the level of blood oxygenation and gives clear information about where the brain activity occurs [2][3].

The increasing interaction between psychology and neuroscience has enhanced our understanding of attention. Psychological theories help to understand how attention works and neuroscience helps to validate these theories by linking them to actual brain activities [2].
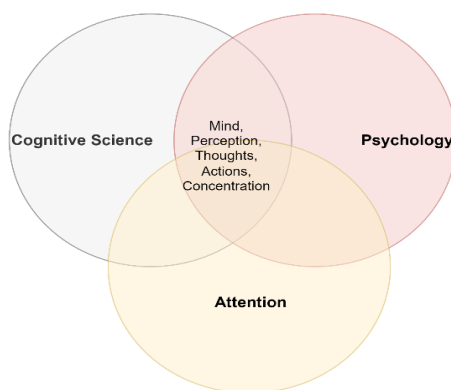

Figure 1 The relationship between CS, Psychology, and Attention.

The above figure 1 is a Venn diagram that illustrates the overlapping areas of CS, Psychology, and Attention. These three fields share the concept of Attention, CS, which focuses on mental processes related to perception, thoughts, actions, and concentration. Psychology encompasses a broader range of cognitive and behavioural processes.

ATTENTION AND ITS CORE CONCEPTS

What is attention:

Attention is a fundamental cognitive process of selectively focusing on a particular continuous flow of thought while ignoring other thoughts. Distraction is the opposite of attention, which means being unfocused from a specific action. The core aspects of attention are focalisation, concentration, and consciousness. Focalization has a genuine target for attention, whereas concentration means maintaining and holding the focus on the selected target for a particular period. Consciousness means being aware of the surroundings [4].

Attention Deficit Hyperactivity Disorder (ADHD):

*Attention***:** Selectively concentrating on a particular continuous flow of thought while ignoring other thoughts.

Attention Deficit (inattention): When a person has difficulty staying on task, sustaining focus, and staying organised, the problems are not due to intentional defiance or a lack of understanding.

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Hyperactivity: When a person seems to move constantly, including in situations that are not appropriate or excessive fidgets, taps, or talks.
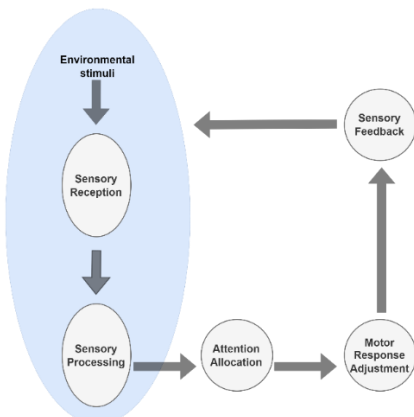
Impulsivity: A person may act without thinking or have difficulty with self-control.

ADHD: An ongoing inattention and hyperactivity/impulsivity pattern interfere with functioning and development [5].
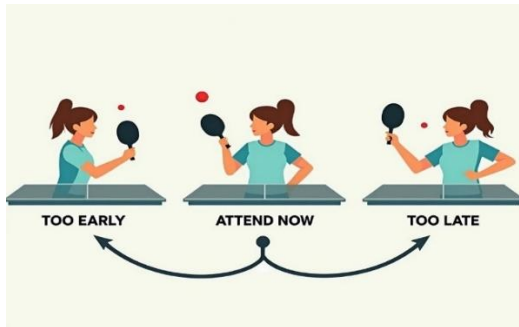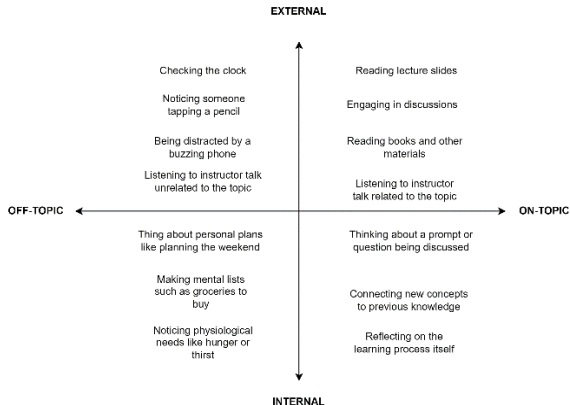
How ADHD is derived?

In 1798, Sir Alexander Crichton suggested that attention issues could begin at birth or due to other problems. In 1844, Dr. Heinrich Hoffmann described similar traits in a child's story, Fidgety Phil. By 1902, Sir George Frederic linked attention and impulsivity issues to brain dysfunction from encephalitis lethargica. In 1932, German doctors Kramer and Pollnow defined it as hyperkinetic disease, with core symptoms of motor restlessness, impulsiveness, and inattention—similar to modern ADHD. Initially believed to be caused by brain damage, it was later termed minimal brain dysfunction. In 1968, DSM-II introduced "Hyperkinetic Reaction." DSM-III (1980) renamed it as attention deficit disorder (ADD), with or without hyperactivity. In 1987, DSM-III-R combined these into ADHD. DSM-IV (1990s) classified ADHD into three types: inattentive, hyperactive-impulsive, and combined. Research shows structural and functional brain differences in individuals with ADHD, and genetic studies indicate it can be hereditary [6].

TABLE I. BROADER CLASSIFICATION OF ATTENTION

Ref	Type of Attention	Description	Age group	Cognitive challenges
[4]	Sensorial Attention	The person's mental awareness drawn toward sensible entities such as vision, sound, and smell. it involves adjustments in sense organs and body muscles. It can be passive or voluntary.	Childhood and youth	It can be difficult for individuals to learn, concentrate, and retain new information.
[4]	Intellectual Attention	When a person's attention is driven toward a higher cognitive process, such as thinking, problem-solving, etc. It can be passive or voluntary. Intellectual attention is divided into derived and immediate. *Derived:* When thoughts are interesting because they are associated with other essential factors. *Immediate:* The train of thoughts that are interesting within themselves.	Any age group, but becomes more distinguishable when individuals mature	Absent-minded: neglecting the surroundings due to which the individual is not aware of what is happening around them.

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[4]	Immediate attention	Drawing attention to something interesting without any relation.	Individuals who are excited about the novelty of the environment or stimuli	It is not easy to maintain focus on less exciting tasks.
[4]	Derived Attention	This is later given the name of apperceptive attention. It is derived when an object is related to another excitingobject.	It can occur at any age but usually in older children (0-12) and adults (above 24)	One can get distracted while doing a task if reminded them of a strong interest.
[4]	Sustained attention	It is a voluntary effort. It is raised when one knows the importance of the task so they focus for a extended period of time.	Improves quickly in the age group from 5-6 and 8-9 improves to age 10 [7]	One can be exhausted due to the attention driven for an extended time.
[4]	Selective Attention	Concentrating on a particular thing and ignoring things that are not interesting to the person. [8]	Adults tend to focus on their long-term interests	less aware of what is happening in surroundings, which may lead to overlooking essentials
[9]	Spatial Attention	This focuses on a specific location, even if there is a disturbance in the environment. Usually, researchers perform trials by placing the task among the distractors and examining how attention is developed at different locations.	All age groups	When complete attention is drawn to one location, other areas may be missed, leading to a partial understanding.

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| [9]	Temporal Attention	Attention drawn towards a particular spatial location at intervals. Researchers study this to understand how the brain processes data over time. [10]	Infants are sensitive to temporal attention and can be present in all age groups [11].	Too much dependency on expected time may lead to problems when things do not happen within the scheduled time.
[9]	Internal Attention	Awareness of their mental content, such as thoughts, self-monitoring, and emotions. Internal attention helps in decision-making, avoiding distractions, and problem-solving. [12]	Can develop and change according to the age	When the number of tasks increases, one can become overloaded and decrease an individual's performance.

Symptoms of ADHD:
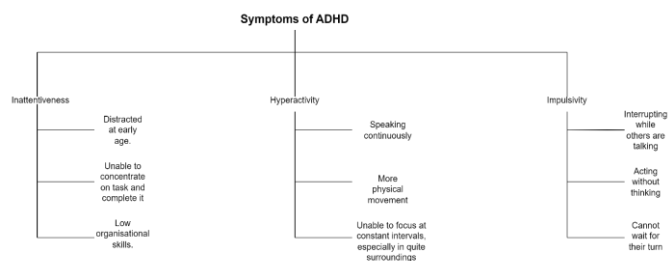
Figure 7 Characteristics of ADHD.

The above figure 7 represents the core symptoms of ADHD. It categorises these symptoms into three primary areas, which are Inattentiveness, Hyperactivity, and Impulsivity.

Some children/teenagers may also have these symptoms:
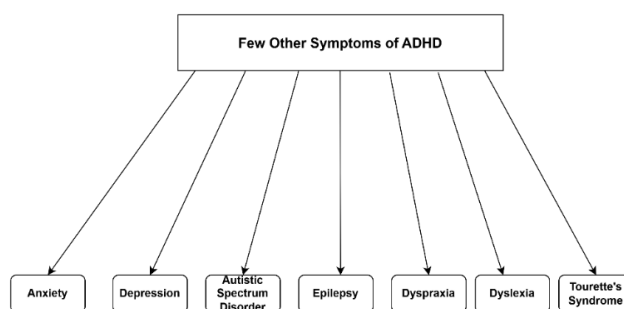
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Figure 8 Prevalence of Symptoms in Children/Teenagers.

Figure 8 represents the symptoms that lead to difficulties in a child's daily life, such as poor education and social interaction performance [13].

ADHD IN ADULTS AND CHILDREN

It is more challenging to define ADHD in adults than in children. Symptoms affect adults and children differently. Hyperactivity decreases in adults, but inattention can be the same, increased, and continued into adulthood. ADHD symptoms in adults are not easily recognised compared to the symptoms of ADHD in children. Children who have ADHD are easily noticeable due to their hyperactivity, impulsiveness, and learning difficulties in school, whereas adults with ADHD can be mistaken for other issues or personality traits [7] as shown in table 1

Differences in ADHD Across Genders:

ADHD is more frequently diagnosed in boys rather than girls. This is because girls have more symptoms of inattentiveness and do not show much disruptive behaviour, due to which girls with ADHD may not always be diagnosed. Men and women may have the same levels of ADHD symptoms but have different cognitive performance patterns in working memory and behavioural control tests. Women showed more deficits in working memory and behavioural control than compared to men. Working memory is the capacity to store and use information for cognitive tasks quickly [14].

Example: remembering a phone number until dialling it.

Behavioural control: the capacity to regulate one's actions (managing one's behaviour according to the situation) and stopping one's impulsive behaviours.

Example: In a classroom, there are students with behavioural control and those with low behavioural control. An excellent behavioural control student can sit quietly and raise their hand to ask a question even if they are excited. However, with low behavioural control, students act based on their impulse thoughts. The students might leave their seats without waiting for permission.

Causes of ADHD

- Smoking during pregnancy (risks relevant to ADHD) [15].
- Maternal stress (financial stress, marital stress, moving to a new home, having a fight with a friend) [16].
- Genetics (the mother's genes and certain environmental factors can impact ADHD): The Mother's genetic variations can be passed down to the maternal lines [15][17].
- Premature birth
- brain injury – brain is the considered as the central nervous system and any injury happens to brain may lead to imbalance in functioning like body movement co-ordination, decision making, motor challenges cognitive impairment, attention problems etc [17][18].
- Nutrition

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- Social environments [17].

DISCUSSION

CS helps to understand human behaviour and helps to solve neurological issues. ADHD is one of the issues faced by many people which will affect the quality of life. This paper helps to understand the reason ADHD is caused, how to handle it, and various types of attention, ADHD in adults and children and differences based on gender.

CONCLUSION

knowledge from various fields helps to understand and solve the challenges in CS. CS has many applications, such as helping to understand human behaviour, helping children who do not perform well in education, integrating it into medical AI to detect or predict diseases, etc. It helps to understand and support individuals with ADHD and other cognitive problems. It helps to understand how ADHD is caused by the external environment so that one can take precautions. This research primarily focused on attention deficiency. Many researchers have divided attention into various types, and this research helps to simplify the understanding of a few types of attention along with disadvantages, and age groups that may be affected by particular kinds of attention. More profound research should be conducted on scales to measure ADHD and which scale is suitable for detecting ADHD in all age groups. All scales follow traditional methods like rating and scoring; people who cannot rate themselves can get help from their parents, teachers, or anyone who observes them daily. These ratings can be influenced, they can be wrong, and sometimes they cannot rate for themselves due to confusion. Integrating the existing measures with technology can solve these problems.

FUTURE SCOPE

There should be research on how technology can help change the traditional method for diagnosing ADHD so that it opens ways to self-assessment and reduces the cost of visiting the doctors.

REFRENCES

[1] Friedenberg, J., Silverman, G., & Spivey, M. J. (2021). *Cognitive science: An introduction to the study of mind*. Sage Publications.

[2] Driver, J. (2001). A selective review of selective attention research from the past century. *British journal of psychology*, *92*(1), 53-78

[3] Jeevakala, S. R., & Ramasangu, H. (2023). Classification of Cognitive States using Task-Specific Connectivity Features. Engineering, Technology & Applied Science Research, 13(3), 10675-10679.

[4] William, J. (1950). *The Principles Of Psychology Vol I* (Vol. 1). Brighthouse.

[5] Attention-Deficit/Hyperactivity Disorder (ADHD). (n.d.). Retrieved from https://www.nimh.nih.gov/health/topics/attention-deficit-hyperactivity-disorder-adhd#:~:text=Attention%2Ddeficit%2Fhyperactivity%20disorder%20(,interferes%20with%20functioning%20or%20development

[6] Lange, K. W., Reichl, S., Lange, K. M., Tucha, L., & Tucha, O. (2010). The history of attention deficit hyperactivity disorder. *ADHD Attention Deficit and Hyperactivity Disorders*, 2, 241-255.

[7] Betts, J., Mckay, J., Maruff, P., & Anderson, V. (2006). The development of sustained attention in children: The effect of age and task load. Child neuropsychology, 12(3), 205-221.

[8] Mangun, G. R. (2020). How we pay attention. *Frontiers for Young Minds*, *8*. https://doi.org/10.3389/frym.2020.00029

[9] Frey, J. N., Ruhnau, P., & Weisz, N. (2015). Not so different after all: The same oscillatory processes support different types of attention. *Brain research*, *1626*, 183-197.

[10] Denison, R. N. (2024). Visual temporal attention from perception to computation. *Nature Reviews Psychology*, *3*(4), 261-274.

[11] de Diego-Balaguer, R., Martinez-Alvarez, A., & Pons, F. (2016). Temporal attention as a scaffold for language development. *Frontiers in psychology*, *7*, 44.

[12] Keller, A. S., Davidesco, I., & Tanner, K. D. (2020). Attention matters: How orchestrating attention may relate to classroom learning. *CBE—Life Sciences Education*, *19*(3), fe5.

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[13] Website, N. (2025, May 12). ADHD in children and young people.Retrieved from https://www.nhs.uk/conditions/attention-deficit-hyperactivity-disorder-adhd/symptoms

[14] Stibbe, T., Huang, J., Paucke, M., Ulke, C., & Strauss, M. (2020). Gender differences in adult ADHD: Cognitive function assessed by the test of attentional performance. *PLoS One*, *15*(10), e0240810.

[15] Thapar, A., Cooper, M., Jefferies, R., & Stergiakouli, E. (2012). What causes attention deficit hyperactivity disorder?. *Archives of disease in childhood*, *97*(3), 260-265.

[16] Grizenko, N., Shayan, Y. R., Polotskaia, A., Ter-Stepanian, M., & Joober, R. (2008). Relation of maternal stress during pregnancy to symptom severity and response to treatment in children with ADHD. *Journal of Psychiatry and Neuroscience*, *33*(1), 10-16.

[17] Attention-Deficit/Hyperactivity Disorder: What you need to know. (n.d.). Retrieved from https://www.nimh.nih.gov/health/publications/attention-deficit-hyperactivity-disorder-what-you-need-to-know

[18] Lad, R. Y., Mapari, S., & Sibai, F. N. (2024). A Novel Approach to Image Classification for Detecting Abnormalities in Neuroimages based on the Structural Similarity Index Measure. *Engineering, Technology & Applied Science Research*, *14*(5), 17382-17387.