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Effect of screen-time on cognitive functioning- A Review Article

[1]Amanda Teresa George
[1]B.Sc. Clinical Psychology student
[1]Department of Psychology
[1]AMITY University, Mumbai, Maharashtra, India

***Abstract*-** Over the years the usage of digital gadgets has drastically increased, everyone owns at least one gadget, the most basic one being the mobile phone, due to the pandemic, schools, colleges and workplaces were forced to shut down, which led everyone to function from home, in turn increasing screen time and screen use. Since everyone had to attend classes and work from home it has become inevitable for us to avoid looking at the screen. This literature review aims to understand whether screen time has a negative effect on one's cognitive functioning.

Keywords- Cognition functioning, Screen-time, Screen-Use, Negative effects

I. Introduction

According to the APA dictionary, cognitive functioning is the "performance of mental processes of perception, learning, memory, understanding, awareness, reasoning, judgment, intuition and language." We use our cognitive abilities on a daily basis, from the tiniest little task we do to the most difficult task we do, we use our perception skills, our understanding skills, our reasoning skills, decision making and all the other skills to do anything and everything. A task as simple as boiling water or frying an egg requires us to use our cognitive abilities, if we take the example of frying the egg; our cognitive ability is needed for us to make a judgment about the amount of salt and pepper that needs to be added according to our taste, we have to decide the way we want it cooked, all of these require us to use our cognitive abilities, which circles back to the fact of us needing to use our cognitive abilities on our daily basis. Screen-time is the amount of time spent by the person viewing the television, computer, phone or any electronic device. In a study conducted by the National Institute of Health, it was found that children who spend more than two hours a day on electronic devices scored lower in language and thinking tests, and the children who spent more than seven hours on these devices, found that their brain cortex was thinning, the brain cortex is the area that is related to critical thinking and reasoning. Through this paper, we try to understand how more screen time affects our cognitive functioning.

II. Review of Literature

In this review, we would look into different studies and research have done in order to understand how increased screen time affect one's cognitive functioning.

A study [1] conducted by Porarinsdottir belonging to Reykjavik University, aim to see if screen use had an impact on cognitive functioning, they also wanted to know if there were the possible moderating effects of factors such as depression, sleep, psychosomatic symptoms that have been shown to decrease cognitive functions in earlier studies. The results showed that screen use did have a negative impact on cognitive functioning. The results for the second aim showed that participants who were low on depression and were high screen users had slower reaction time on the Stroop task, but the participants who portrayed high depression and spent more time on screen performed better in the non-matching Stroop task.

Walsh, Barnes, Tremblay and Chaput belonging to the University of Ottawa, did a study [2] to investigate the relation between screen use and cognition. They hypothesized that screen use is negatively associated with cognition. The results showed that longer screen time can be related to lower cognition in children.

Research [3] done by Christakis, Zimmerman, DiGiuseppe, McCarty aimed to study the hypothesis that early television exposure is associated with attentional problems at the age of seven. The results did show that hours of television viewed by children per did affect their attention at the age of 7.

A study [4] done by Suggate and Martzog aimed to investigate the idea that screen time influences the development of children's mental imagery, the study focused on mental image generation and inspection done in the visual and haptic domains. The findings showed that screen-time does not stimulate mental imagery performance when this requires mental comparisons of visual/haptic images.

Zimmerman and Christakis did a study [5] to understand the independent effects of television viewing in children before age 3 years and at ages 3 to 5 years on several measures of cognitive outcomes at ages 6 and 7 years. The results showed that viewing televisions before the age of 3 did have adverse effects on the cognitive development of children. They also recommended that children below the age of 2 should avoid watching television or any screen device.

Crawley, Anderson, Wilder, Williams, Santomero did a study [6] to understand the Effects of Repeated Exposures to a Single Episode of the Television Program Blue's Clues on the Viewing Behaviors and Comprehension of Preschool Children. Through this study, they found that repetition, visual attention remained constant. Verbal and Non-verbal interaction increased with episode repetition. Comprehension also improved; the children were also able to apply the problem-solving strategies in their lives.

Soares, Oliveria, Wehrmeister, Menezes, Gonçalves conducted a study [7] that aimed to investigate the association between measures of screen time in adolescence and Working Memory. The results showed positive associations between television, video game and computer time and WM performance only in men, suggesting that the effects of screen time are not the same between genders.

III. Methodology

Porarinsdottir [1] conducted a study on the impact of screen use on cognitive function, the study was conducted on 45 participants, who belonged to the age group of 20-53. The participants were contacted through an email requesting their participation.

High screen use/low screen use- The high screen use/low screen use was checked by a questionnaire that asked the participants what kind of electronic devices they used at home or had access to, devices like "television", "laptop", "desktop", "smartphone", "kindle", "tablet", etc. They were also told they could add any other device that requires screen use. The participants were then asked which device they use the most, of the ones mentioned above and were asked to specify the amount of time they spend using these devices each day, the duration ranging from "almost no time" to "six hours or more" per day.

Cognitive Function- The participants were asked to complete the Sustained Attention to Response Task, to measure attention. The test was conducted in a quiet room, in front of a computer screen. For the task, numbers ranging from 0-9 appeared randomly on the computer screen, the numbers were black in color and were 30 millimeters, they were presented on a white background. For this task, the participants had to push the 'space bar' or the 'enter button' as fast as possible, except when the number 3 appeared. The reaction time was measured in milliseconds. The time gap between the numbers appearing was 1125 milliseconds. The task that was conducted lasted for 9 minutes and 375 milliseconds where 500 numbers were displayed and each number was displayed for 250 milliseconds.

The participants were also asked to complete a STROOP task, in which they had to identify the color of the font of particular color names they saw instead of the meaning of the word.

Depression- Symptom Checklist (SCL-90) was used to measure depression. The participants answered using a four-point Likert scale ranging from 1= 'almost never', 2= 'seldom', 3= 'sometimes', 4= 'often'.

Participant's sleep- For this, the participant was asked about the length of their sleep also the quality of their sleep.

Psychosomatic symptoms- The participant's symptoms were assessed by assessing summing two items on the questionnaire.

Walsh, Barnes, Tremblay and Chaput [2], did a study to investigate the relation between screen use and cognition. The data for this study was collected from the ABCD study site, the data that was used was collected between September 1, 2016, to November 15, 2018. The data they obtained from the site included 11,875 children between the ages of 9-10 years. The participants were obtained using probability sampling of public and elementary schools. The principal outcome was global cognition, which was measured via the Youth National Institutes of Health (NIH) Toolbox administered by a researcher on tablets. Global cognition checks domains of crystallized and fluid intelligence. The subcomponents of global cognition - crystallized and fluid intelligence - were assessed as secondary outcomes.

The use of electronic devices during their free time was measured using the Youth Screen Time Survey, the survey questions asked the participants to report the number of hours a day they spend, i) TV watching, ii) video watching (YouTube), iii) video game playing, iv) texting on a cellphone, tablet, or computer, v) visiting social media sites, or vi) using video chat.
Associations between screen use and cognition were quantified using multivariable linear mixed-effects regression models.

Their finding matched the hypothesis as higher amounts of TV, video, and social media composite time were negatively associated with cognition. However, if it is done in moderation, it can have a positive effect on one's cognition.

Christakis, Zimmerman, DiGiuseppe, McCarty conducted research [3] that aimed to study the hypothesis that early television exposure is associated with attentional problems at the age of seven. The data for this study was collected from the National Longitudinal Survey of Youth 1979 Children and Young Adults. The sample size for this study was 12700 individuals who were aged 14-22 years and had been interviewed annually and biennially.

Their out measure of attentional problems at or near the age of 7 was measured using the hyperactivity subscale of the Behavioural Problem Index, this consists of five items that ask whether the child has difficulty concentrating, is easily confused, is impulsive, has trouble with obsessions, or is restless. There were three possible responses for each of the items 'often true', 'sometimes true', 'not true.'

One of the main variables of the study was the number of hours the children spent watching television per day. Mothers were asked the number of hours children watched on a typical weekday and on a typical weekend. The responses that showed no television at home were portrayed as '0' hours and the responses that were more than 16 hours a day were portrayed as '16' hours. The number of hours per week was computed as 5 times the number of hours watched during a typical weekday plus 2 times the number of hours watched on a typical weekend day.
The results did show that hours of television viewed by children per day did affect their attention at the age of 7.

Suggate and Martzog did a study [4] that aimed to investigate the idea that screen time influences the development of children's mental imagery, the study focused on mental image generation and inspection done in visual and haptic domains. 266 children participated in the study between the age of 35 months to 120 months.
Demographic data were collected by sending a questionnaire to the parents which asked about language spoken at home, educational background, home country, screen time usage, device ownership and contact with media.

Screen-media Questionnaire- Screen-time and media usage were measured by asking parents to fill out a questionnaire but the questionnaire used was a diary format questionnaire since using a normal questionnaire would be influenced due to bias. Screen time was rated on a 6-point Likert scale.

Mental Imagery- Mental Imager was measured with the help of previously used mental size comparison tasks. For this task, the children had to rely on their own knowledge to form the mental image, no declarative knowledge about the images were given. Children were asked to imagine two specific objects, and then asked to imagine two specific objects, and then asked to make a judgment as to which from the target and distractor item was better to encapsulate by a sensory feature.

Vocabulary- Children's vocabulary was assessed using the Kaufmann ABC (Kaufman & Kaufman, 2015). In this task, children are shown pictures and are required to name the object in the pictures. One point was awarded for each correct item and there was a discontinue rule after 4 consecutive errors, and a basal item was established after three correct responses. The maximum number of points possible was 39.

The study tested three hypotheses:

- Screen time affected children's mental imagery abilities
- The two features of screen time i.e., sensory narrowing and ready-made and often rapidly changing images that potentially suppress the active mental life might lead to negative associations with mental imagery accuracy.
- Different (i.e., active vs. passive) screen-media might differentially affect mental imagery.

The results showed that the first hypothesis was accepted that screen time affects children's mental imagery, for the second hypothesis they did not have much evidence that could approve or reject the hypothesis, the last hypothesis results showed screen-time did not relate to children's response latencies on the mental imagery task.

Zimmerman and Christakis did a study [5] to understand the independent effects of television viewing in children before age 3 years and at ages 3 to 5 years on several measures of cognitive outcomes at ages 6 and 7 years. The data for this study was collected from the National Longitudinal Survey of Youth 1979 Children and Young Adults. The sample size for this study was 12700 individuals who were aged 14-22 years and had been interviewed annually and biennially. The children who participated in this study were approximately 6 years old.
The study measured the components of the Peabody Individual Achievement Test, the test was administered on children who were at or within 6 months of age 6 years. Three tests were used: mathematics, reading recognition and reading comprehension. They also measured the memory for digit span using the Wechsler Intelligence Scale for children.
Before age 3 years, the children in this study watched an average of 2.2 hours per day; at ages 3 to 5 years, the daily average was 3.3 hours. Daily television viewing before age 3 years was associated with deleterious effects on the Peabody Individual Achievement Test Reading Recognition Scale of 0.31 points (95% confidence interval [CI], −0.61 to −0.01 points), on the Peabody Individual

Achievement Test Reading Comprehension Scale of 0.58 points (95% CI, −0.94 to −0.21 points), and on the Memory for Digit Span assessment from the Wechsler Intelligence Scales for Children of −0.10 points (95% CI, −0.20 to 0 points). For the Reading Recognition Scale score only, a beneficial effect of television at ages 3 to 5 years was identified, with each hour associated with a 0.51-point improvement in the score (95% CI, 0.17 to 0.85 points).

Crawley, Anderson, Wilder, Williams, Santomero did a study [6] to understand the Effects of Repeated Exposures to a Single Episode of the Television Program Blue's Clues on the Viewing Behaviors and Comprehension of Preschool Children. For this study children belonging to the age group of 3,4 and 5 years old were used. One group of children viewed Blue's Clues episode once and were immediately tested for comprehension. The children belonging to the second group were made to watch the same Blue's Clues episode for five consecutive days, for this group the comprehension test was taken after they watched the episode on the fifth day. A control group was used and they were made to watch an episode of another pre-school television programme on time. The study included 108 participants: 36 three-year-olds, 38 four-year-olds and 34 five-year-olds.
The test consisted of five types of items. Educational items contained questions about the educational content, primarily the games in which the audience was invited to provide the answers (e.g., using the clues cup, straw, and cow to infer what Blue wanted with her snack). Entertainment items contained questions about the entertainment content, including names of characters and questions such as what happened when the telephone rang (Steve fell down). The third type we called far transfer. In these items, the concepts of the thinking games (color identification, shape recognition, and matching) were tested using stimuli different from those shown in the episode. The fourth type examined a strategy that was modelled in the program for solving the matching problems (placing the standard next to the comparison stimuli). How often the child used this strategy was assessed for the items using the same stimuli shown in the episode, as well as for far transfer problems using different stimuli.

Soares, Oliveria, Wehrmeister, Menezes, Gonçalves conducted a study [7] that aimed to investigate the association between measures of screen time in adolescence and Working Memory. For this study mothers of newborns were asked to participate. 5249 people voluntarily participated, the mothers were interviewed about their demographics, socio-economic status and others that would help understand them better.
The participants were contacted again when they reached the mean ages of 11, 15, 18 and 22. Out of 5249 participants only 3810 participants were followed up to the age of 22.

Working Memory and Short-term Memory- When the participants reached the age of 22 their working memory and screen time was assed using the Digit Span subset from the WAIS III. This task consists of two sections. Digits forward is administered first and requires the repetition of digits in the same order presented, while in digits backward participants must repeat digits in an inverse or backwards order. The digits forward involve attention and short-term memory, and the digits backward more closely involves working memory. The total score was the sum of the item scores; the maximum forward digit span total score was 16 points and backwards digit span was 14 points.

Screen-time- When the participants were at the ages 11, 15, and 18 information about their scree time was collected through a face-to-face interview using a standardized questionnaire, which included questions about time spent watching television, playing video games, and using a computer on a normal weekday.

Intelligence Quotient- The intelligence quotient was measured using the Wechsler Adult Intelligence Scale, third version, when the participants had reached the age of 18. with the arithmetic, digit symbol, similarities, and picture completion subtests. The test was administered individually by trained psychologists using a standardized procedure in a private and quiet room.

A two-step analysis was conducted to investigate the association between screen time and working morning. The first association was done between screen time and memory without considering IQ and Digit Span forward. The second analysis was done to find whether mediation of IQ and Digits Span forward (short-term memory performance) has association between screen time variables and the WM.

IV. Conclusion

Through previous studies, we can understand that screen use does have negative effects on different cognitive functions like attention, memory, mental imagery performance [1-5]. But we cannot fully disregard the fact if screen time and screen is appropriately moderated it can have positive effects too, like watching blue's clues improved children's problem-solving skills [6].

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