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The Effects of Brain Games and Music on Short Term Memory

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ABSTRACT

Recent studies have indicated that attention and working memory abilities can be increased by cognitive training games as well as entertainment videogame. Studies conducted on the influence of music on short term memory show that its influence on memory is inclined towards the negative aspect. This review discusses the impact of game-based training and music on various aspects of attention and working memory including the tests that can be used to evaluate the efficiency of short term memory.

Key words: Working memory, Cognitive Training, Games, Music.

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INTRODUCTION

Memory is an essential part of our lifestyles that is not clearly understood. Memory is our brain's ability to encode, store, retain, organize, alter, and recover information and past experiences (Klatzky, 1975). It is often divided into three stages known as sensory memory, short-term memory, and long-term memory (Atkinson and Shiffrin, 1971). Sensory memory is the earliest stage of memory that holds information from the sensory input for a few seconds while some of this information passes into the short-term memory. Short-term memory is our limited ability to remember new information for a brief period of time, anywhere from twenty to thirty seconds (Atkinson and Shiffrin, 1971). According to Atkinson and Shiffrin, (1971), our short-term memory can retain approximately five to nine items. Without rehearsal, information will not be kept in short-term memory. However, if rehearsed, the information will eventually be processed into long-term memory (Bennet and Murdock, 1972). Although many areas of the brain are useful for processing information, the hippocampus is responsible for transferring information into long-term memory (Ericsson and Kintsch, 1995). Long-term memory is the unlimited capacity to hold information. Some of this information is easy to access while other information is much more difficult to recall (Ericsson and Kintsch, 1995).

Cognitive abilities are those elements that determine attention, concentration, perception, reasoning, intellect, and memory. They are usually thought of as higher functioning areas of thought.

EFFECTS OF MUSIC:

Some studies have come to the conclusion that music, especially classical, aids in the storage and recall of information in our memory (Berz,1995). This may be due to the fact that music helps reduce stress therefore making it easier for people to study and remember information. A study by Jenkins (2001) found that subjects who listened to classical music showed better spatial reasoning skills than subjects who had not. Although studies have shown a positive effect of music on memory, there have also been many studies conducted that have found music to have a negative effect on short-term memory recall. Because our senses are so engrossed in the music, most of our focus is on the music thus distracting us from the task at hand. A study by Hjortsberg (2009) found that students performed better on a memory game without listening to music than while listening to classical music. Also, a study by Fogelson (1973), found that students who took a reading comprehension test and simultaneously listening to music became distracted and therefore retained less detailed information. Moreover, a study by Deems (2009) found that students who regularly listened to music while studying scored higher on a reading comprehension test and a short-term memory test compared to those who did not usually listen to music while studying. These studies suggest that music distracts people trying to perform cognitive tasks that require memory whereas it is also hypothesized that repeating the same song during both the memorization and recall period will have a greater effect on the individual's memory, assisting them to remember and recall more items on a short-term memory recall task. There have also been studies that have concluded that classical music due to its soothing effect induces a relaxed state thereby helping in memorization and recall task better when compared to complex music.

Short-term memory also known as working memory and is composed of both processing and storage components. The most prevalent model of short term memory is divided into two independent subsystems: the "phonological loop" and the "visuospatial sketchpad" (Baddeley, 1981). Information held in short term memory can be easily lost if not rehearsed and is subject to disruption. More specifically, it has been suggested that the presence of an auditory distracter interferes with the "phonological loop" portion of Baddeley's model (Cocchini et al., 2001; Salamé and Baddeley, 1982). While memorizing verbal information, the phonological loop is engaged in maintaining and rehearsing the information. Auditory distraction on the other hand also requires use of the phonological loop. Thereby the two processes essentially compete for neural space and interfere with each other, resulting in impaired short-term memory. Additionally, it has been found that vocal music is significantly more detrimental to short term memory as compared to instrumental music (Alley and Greene, 2008).

EFFECTS OF COGNITIVE TRAINING GAMES

Cognitive functions continuously change throughout life. Some cognitive functions like executive functions and working memory are highly active in the 20's and 30's [1]. Other cognitive functions like semantic knowledge develop to the age of 60 or 70 [2]. Thus cognitive training to improve cognitive functions

is gaining much importance. Video games are also a type of cognitive training [3,4]. The transfer effect is defined as “the ability to extend what has been learned in one context to new contexts” [7]. Therefore the improvements of cognitive functions through playing video games are referred to as transfer effects [3,4,5,6,8,9,10]. In line with these results, commercial brain training games have been released which are expected to improve cognitive functions. Investigation of transfer effects from commercial brain training games on cognitive functions is only beginning.[4,8,9,10].

Recent studies have shown that the effects of playing commercial brain training games such as Brain Age, published by Nintendo Co. Ltd., can lead to improvement in the accuracy and speed of calculations in healthy children [9,10] and can improve executive functions and processing speed in healthy elderly people [4,8]. These results showed that brain training games like Brain Age, have transfer effect in healthy children and healthy elderly people. Previous studies have shown that younger adults have a great possibility of improvement of cognitive functions through performing cognitive training and playing video games compared to older adults [11,12,13,14,15,16].

It was seen in previous studies that cognitive performances improved after playing classic and recent videogames. For instance, playing the classic video games such as *Tetris*, Donkey Kong and Pac Man improved the reaction time [17,18]. Also, playing the recent action video games such as Medal of Honor improved visio-spatial and attentional skills [5,6]. Thus, to prove the beneficial effects of the brain training game, it is important to compare improvement of cognitive functions after playing brain training games like Brain Age with that after playing other types of video games like tetris. Brain Age was popular and was developed based on knowledge of neuroscience and psychological evidence [31,32]

There are basically two cognitive training methods. They are:

- Strategy training helps individuals remember increasing amounts of information of a particular type. It involves teaching effective ways of encoding, maintenance, and/or recall from working memory. The main goal of strategy training is to increase performance of tasks that require retention of information. Studies indicate that the amount of information remembered can be increased by rehearsing out loud, telling a story with stimuli, or using imagery to make stimuli stand out. Strategy training has been used in children with Down syndrome and also in older adult populations [33].
- Core training revolves around repetition of demanding working memory tasks. Some core training programs involve a combination of several tasks with widely varying stimulus types. A goal of cognitive training is to positively influence the ease and success of cognitive performance in one’s daily life. Core training is able to reduce the symptoms of Attention deficit hyperactivity disorder (ADHD) and may help improve the quality of life involving patients with multiple sclerosis, schizophrenia and also, those who have suffered from stroke [33].

In this context we shall talk about a study that was carried out as a basis to understand the effect of cognitive training games on memory [19]. This study investigated the beneficial transfer effects of a commercial brain training game on cognitive functions in healthy young adults. A de facto (double-blinded) intervention [20] with two parallel groups (a brain training group and an active control group) was conducted. The de facto intervention [20] was similar to a double-blinded intervention in which participants and testers were kept blind to the experimental hypothesis [19]. The participants were asked to perform each type of video game training (*Brain Age* or *Tetris*) for 5 days a week for at least 4 weeks. On each training day, participants used the video game for about 15 min [19].

TESTS TO ASSESS COGNITIVE FUNCTION:

To study the transfer effects of the commercial brain training game on cognitive functions, a broad range of cognitive functions like fluid intelligence, executive functions, working memory, short-term memory, attention, processing speed, visuo-spatial ability, and reading ability were assessed. Fluid intelligence was measured using Raven’s Advanced Progressive Matrices Test (RAPMT) [21]. Executive functions were measured using Wisconsin Card Sorting Test (WCST) [22], and Stroop Task (ST) [23]. Working memory was measured using Operation Span (OpS) [24], letter–number sequence (LNS) [25], and arithmetic (Ari) [25]. Short-term memory was measured using Digit Span (DS) [25] and Spatial Span (SpS) [26]. Attention was measured using the Digit Cancellation Task (D-CAT) [27] and Simple Reaction Time (SRT) [28]. Processing speed

was measured using Digit Symbol Coding (Cd) [25] and Symbol Search (SS) [25]. Visuo-spatial ability was measured using the Mental Rotation task (MR) [29]. Reading (verbal) ability was measured using the Japanese Reading Test (JART) [30].

Based on previous studies [4,8,9,10,17,18] , it was expected that playing video games would improve cognitive functions and the advantages of video games on cognitive functions would vary according to the types of video games (*Brain Age* and *Tetris*). Three specific hypotheses related to improvements of cognitive functions after playing video games were made. First hypotheses was that playing *Brain Age* would lead to improve executive functions and processing speed compared with playing *Tetris*. The reason was that the previous study using *Brain Age* in the older adults showed improvements of executive functions and processing speed [4]. Second was that playing *Brain Age* would improve working memory like how it improved executive functions and processing speed. Thirdly, playing *Tetris* would improve the visuo-spatial ability and the attention compared with playing *Brain Age*.

The most important findings of this study was that playing the commercial brain training game i.e., *Brain Age* significantly improved executive functions, working memory, and processing speed in contrast to playing the non-brain training game like *Tetris* in young adults. Hence this study had provided scientific evidence demonstrating that the commercial brain training game had beneficial effects on cognitive functions (executive functions, working memory, and processing speed) in healthy young adults.

CONCLUSION

Discovering that the brain can change as a result of experience has resulted in the development of cognitive training. Cognitive training improves cognitive functioning, which can increase working memory capacity and improve cognitive skills and functions in clinical populations with working memory deficiencies [33]. Cognitive training may focus on attention, speed of processing, neurofeedback, dual-tasking and perceptual training[33]. Engaging in activities like sudoku and crossword puzzles also show a significant and positive change in memory functions. Cognitive training has been shown to improve cognitive abilities for up to five years.

The effect of music on short term memory is disputed and vague but is majorly accepted to influence the short term memory negatively. Hence reasearches are still being conducted to understand their effects with a better definition.

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