

Executive Functioning and Doodling Among Students

Gayathri Belram^{1*}, Venkatesh Kumar G²

ABSTRACT

The aim of the study is to examine the relationship between executive functioning and doodling among students. Executive functions (EFs) include various cognitive processes. The core EFs are inhibition control, working memory and cognitive flexibility. For learning, academic achievement and daily functions, executive functions play an important role. Many students involve in doodling while attending classes. Doodling may act as a facilitator to executive functions by limiting the usage of cognitive resources while one gets distracted. To examine the relation between EFs and doodling, a sample of 90 (30 in each group) was selected. Stroop Color Word Test (SCWT) and a checklist (to understand the classroom behavior, to place the students to different groups) were used. Students were divided into 3 groups-Doodling, Note-taking and Non-doodling. Stroop color and word test was conducted. The scores of the Stroop test was analyzed using statistical method of ANOVA. The result showed no significant score, which indicates no significant differences between the groups. Therefore, it was concluded that there is no significant relation between executive functioning and doodling.

Keywords: *Executive Functioning, Doodling, Stroop Color Word Test, Note Taking And Non-Doodling*

Executive functions in classroom

Executive functions (EF) or executive skills are important for functioning of a human being. Any goal directed activity for say, daily routines, professional duties or academic activities need executive functioning. Executive function is an umbrella term for cognitive processes an individual indulge in, to achieve various goals. These processes include working memory, inhibition, and shifting (Blair, 2016; Miyake et al., 2017). Executive functions can be examined by measuring cognitive flexibility, working memory and inhibitory control (Miyake et. al., 2000).

Cognitive flexibility is thinking about something in multiple ways (Zelazo et al., n.d.)for example, finding different methods to solve a particular puzzle.

¹Research Scholar, ICSSR Doctoral Fellowship, Department of Studies in Psychology, University of Mysore, Karnataka, India

²Professor, Department of Studies in Psychology, University of Mysore, Karnataka, India

*Corresponding Author

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Executive Functioning and Doodling Among Students

Working memory involves holding back information and manipulating it to make changes (Zalezo et.al, 2016), for example, solving a mathematical problem by trying out steps. Working memory skills has association with academic achievement in childhood years in mathematics and English and during adolescence in mathematics and science (Gathercole et. al., 2003) Working memory capacity has found to have high relation with Mathematical performance (Batool et. al., 2019).

Inhibitory control is suppressing other stimulus to focus on a particular task (Zalezo et.al, 2016), for example, ignoring background noise to focus on a lecture. Inhibitory control has shown correlation with early math and reading ability (Razza and Blair, 2007). Poor reading comprehension has shown impaired performance in Working memory and inhibitory control tasks (Borella et. al., 2010).

In a classroom, executive functions are important for learning to happen. EF is a key factor in reflective learning. EFs are important for academic success (Blair & Razza, 2007; Meltzer, 2010; Morrison et. at., 2010; Best et. al., 2011; Pascual et. al., 2019). Executive functions are associated with emerging math and reading ability (Best et. al., 2011) in kindergarten children (Blair & Razza, 2007). Executive functions are the cognitive processes used by students in the classroom (Anderson, 2002) and are the skills for successful goal directed behaviour (McCloskey et. al, 2008). Students use executive functions in the classroom for planning, organising, prioritizing tasks, memorizing, shifting strategies, self-monitoring etc (Rosen et. al, 2014).

Executive functions have a key role in listening and note taking. Note taking involves attention to the information, leading to proper encoding of information. Therefore, the information is properly retrieved leading to effective learning (Di Vesta et. al., 1972; Hartley et. al., 2006). Thus, notetaking assists in retention of information (Kiewra, 1989). There are other studies which confirm the positive effect of note taking on learning (eg. Kobyashi 2005, 2006; Schoen, 2012).

A study by Rosen et. at., 2014 showed improvement in executive functions of middle school students with learning disabilities using note taking intervention. Case studies of 3 participants were done using interviews, notes and pre and post intervention assessment. The study shed light on note taking acting as a scaffold to improve executive functions of students with learning disability.

Executive Functions and doodling

Executive functions are important for school readiness and success (Duncan et. at., 2007). Many programs aim at improving executive functions. In a study by Anderson, Klausen and Skogli (2019), on Art of learning (AoL), an art-based intervention aimed at improving children's executive functions, a significant improvement of executive functions was seen in students compared to other students who were not part of the intervention. It was also seen that many skills which was needed for EF development and academic success was also seen in these students. This study gives a glimpse of art-based programs enhancing the growth of executive functions. Similar studies have been done where art based programs are seen to have a positive effect on executive functions (Kuhn et. al., n.d.).

Doodling is an important tool in art based programs. Doodling is “to draw pictures or patterns while thinking about something else or when you are bored” (Cambridge Dictionary). Doodling is a common behaviour among students while attending classes. It

Executive Functioning and Doodling Among Students

usually happens as response to boredom (Smallwood & Schooler, 2006) or when someone is not fully concentrating (Singer, 1966).

But similar to art based interventions, doodling was found to aid concentration (Andrade, 2010). In a prominent study by Andrade (2010) on whether doodling hinders or improves attention, 40 participants monitored a monotonous mock telephone message for the names of people coming to a party. Half of the group was randomly assigned to a 'doodling' condition where they shaded printed shapes while listening to the telephone call. The doodling group performed better on the monitoring task and recalled 29% more information on a surprise memory test.

One possible reason of doodling aiding concentration is by keeping our minds in an optimum level of arousal and not letting us to day dream or doze off (London et. al., 1972; Andrade 2010). Also, mind wandering and day dreaming needs much more resources (Aellig et al. 2009; Smallwood et al.2007) comparing to doodling. Doodling leads to better learning by integrating visual, auditory and kinetic senses (Brown, 2011).

Another study was done by Tadayon and Afhami (2016) on effects of doodling on learning in junior high school students in Tehran with a treatment group (doodling) and a control group of 27 participants. The test results found that doodling group outperformed the control group significantly, indicating learning better in doodling group.

In a study by Kercood and Banda (2012) on the effect of added physical activity on performance of listening comprehension tasks on children with or without attention problems, doodling was studied as a fine motor activity. The study included four students and it was concluded that doodling or using therapy balls during lectures has increased the student performance comparing to just listening.

However, there are very few studies on the role of doodling on various cognitive process, there are a few studies which do not show any significant effect of doodling on recall (Meade et. al., 2019; Burger et. al., 2018; Boggs et. al., 2017), concentration or learning. Also, there are studies showing structured doodling group recalling better than unstructured doodling group (Boggs et. al., 2017; Belram et. al., 2020). In visual tasks doodling, act as a hurdle (Chan, 2012).

Executive functions include the usage of prefrontal cortex (PFC) of the brain (Zalezo et.al, 2016). Similarly, the brain activities such as visual, somatosensory, motor, memory, emotions etc. were seen during art expression (Lusebrink, 2004). Thus, there are a few evidences of doodling acting as a facilitator to learning, which involves the executive functions.

Executive functions and Stroop test

Stroop interference test is one of the widely used tests to measure executive functions and cognitive functions. It was originally developed by Stroop in 1935. It measures the major executive skills such as cognitive flexibility, inhibitory control and working memory. Stroop test is a commonly used test while executive skills are to be examined.

A validation study of a numerical and manual version (CANUM) of stroop interference task where quantity-number is used showed predictive validity on general intelligence and

Executive Functioning and Doodling Among Students

working memory capacity. This study validates stroop as the global measure of executive functions (Gutiérrez-Martínez et.al, 2018).

Stroop color and word test was used to identify executive function deficits in children and adolescents including ADHD and other developmental disorders (Homack & Riccio, 2003). The effect of positive mood states on frontal cortex which controls executive functions was measured using Stroop test (Philips et. al., 2002). Many brain imagery tests have shown proof for the activation of prefrontal cortex and other parts of the brain while doing stroop test. PET has shown activation of prefrontal cortex and other areas of brain (Cabega & Nyberg, 2000). Similarly, fMRI has shown activation of different brain areas (Peterson et. at., 1999). Many other studies examining executive functions has used stroop interference task (Bjekić et. al., 2016; Xu et.al, 2016; Levinson et. al., 2018)

Stroop test is usually used to measure cognitive interference. But there are studies which reports that stroop test measures other cognitive functions such as attention, processing speed, cognitive flexibility (Jensen and Rohwer, 1966), and working memory (Kane and Engle, 2003)

METHODOLOGY

Objectives

- To examine the relationship between executive functioning and doodling among students.
- To examine if there is any differences in executive functions among doodling and note taking students.
- To examine if there is any differences in executive functions among doodling and non doodling students.

Hypotheses

- There is no difference in executive functions between doodling and note taking groups.
- There is no difference in executive functions between doodling and non-doodling groups.

Sample

The study was conducted on 90 high school students of an age range of 14 to 17. 30 students (15 girls and 15 boys each) were selected for each group.

Instruments

Two measures were used in this study,

Stroop colour – word test (Stroop, J.R., 1935): It measures the interference on the reaction time of a task. The test has 2 tasks. There would be a sheet with the name of colours written in different colours. The first task is to read out the font colour of the word. The second task is to read out the word ignoring the colour in which it is written. The highest number of correct response would indicate good executive functioning, higher selective attention skill, processing speed etc. and vice versa.

Checklist and interview: To identify the classroom behaviour in order to categorize students to doodling, nondoodling and notetaking groups.

Executive Functioning and Doodling Among Students

Procedure

The study was done on 90 high school students of an age range of 14-17 years. The students were interviewed and a checklist was used to identify the classroom behaviour of the students. The students were categorized into 3 groups – doodling, note taking and nondoodling after identifying their classroom behavior. Each group consisted of 30 participants (15 girls and boys each). Once the students were categorised into the groups, Stroop word color test was administered on them individually.

Doodling group	Notetaking group	Nondoodling group
<ul style="list-style-type: none">• 15 girls• 15 boys	<ul style="list-style-type: none">• 15 girls• 15 boys	<ul style="list-style-type: none">• 15 girls• 15 boys

Data analysis

ANOVA was used to see if any differences exist between groups. ANOVA was done on stroop scores.

RESULTS

Table No. 1 shows the mean and standard deviation of the doodling, nondoodling and notetaking groups.

	N	Mean	Std. Deviation
Doodling	30	46.3333	8.23924
Note Taking	30	45.9000	9.35267
Non Doodling	30	44.2333	7.04020
Total	90	45.4889	8.22198

Table 2 shows the ANOVA score for the doodling, nondoodling and notetaking groups.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	73.756	2	36.878	.540	.585
Within Groups	5942.733	87	68.307		
Total	6016.489	89			

The 3 groups were compared to see if any differences existed. The mean of the doodling group is 46.33 with a SD of 8.23. The mean and SD of note taking group is 45.90 and 9.35. the mean and SD of non doodling group is 44.23 and 7.04 respectively. The ANOVA for stroop test between the groups was not significant ($F = .540, p = .585 > .05$). This shows that there is no difference between the stroop scores of doodling, note taking and non doodling groups. This indicates that there is no particular relation between doodling and executive functions.

DISCUSSION

The aim of the study is to see if any relation exists between executive functioning and doodling among students. Executive function is a term covering many high cognitive skills including attention, cognitive flexibility, inhibitory control, working memory etc.

Doodling, though it happens when boredom strikes, it acts as a facilitator to attention, concentration (Andrade, 2010; Taydon & Afhami, 2016; Kercood & Banda 2012) and in

Executive Functioning and Doodling Among Students

turn, student performance. Since art-based interventions has seen to improve executive functions, there is a need to see if the executive functions of students who doodle in the classroom is better than other students. Note taking also has a positive effect on learning (Kobyashi 2005, 2006; Schoen, 2012; Rosen et. al, 2014). Therefore, a comparison with note taking group is also done.

The first hypothesis of the study is that there is no difference in executive functioning between doodling and note taking groups. This hypothesis was retained as the result showed no significant difference between doodling and note taking groups. As the previous research shows, both doodling and note taking has relation with concentration, attention and efficient learning.

Students who take notes are directly involved in executive skills since they have to hold back information and write it down. Thus students who take notes fully concentrate leading to proper encoding and efficient learning (eg.Di Vesta et. al., 1972; Hartley et. al., 2006; Kiewra, 1989; Schoen, 2012; Rosen et. al., 2014). Similarly, as the students engage in doodling, hinders the possibility to daydream (London et. al., 1972; Andrade 2010), which leads to lesser usage of cognitive resources comparing to daydreaming (Aellig et al. 2009; Smallwood et al.2007). This keeps the executive functions intact leading to effective learning. Therefore, both notetaking and doodling groups may not vary much in their executive function skills.

The second hypothesis of the study is that there is no difference in executive functioning between doodling and non-doodling groups. The previous research has shown doodling to be better than day dreaming because it uses lesser cognitive resources than day dreaming (Aellig et al. 2009), which may have an advantage for doodling in attention and other executive skills. But it may not be much different from the group who do not doodle as there is no as such evidence of the processes one goes through during doodling other than not dozing off or daydreaming (London et. al., 1972; Andrade 2010).

CONCLUSION

The difference in executive functions of students who doodle, take notes and do not doodle were not found significant. Although, the doodling group has scored more, followed by note taking and non-doodling group respectively, no significant differences were found. Therefore, it is concluded that there is no particular relation between doodling and executive functions while comparing to other groups.

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Executive Functioning and Doodling Among Students

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Executive Functioning and Doodling Among Students

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Conflict of Interest

The author declared no conflict of interest.

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