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Research Article

The Effect of Music on Cognitive Control among Media Multitaskers

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Abstract

The objective was to understand the performance differences of heavy and light media multitaskers. Further, the differences across media multitasking groups when the subjects are performing a cognitive task in the presence of music were studied to understand the role of music in cognitive performance in terms of cognitive control. A sample of 300 girl students from the Government schools of Chandigarh in the age range of 14-18 years (mean age= 15.7 years) was taken for the purpose. The media multitasking questionnaire (Ophir et al., 2009) and the Stroop task (Stroop, 1935) were used. The two media multitasking groups, viz., heavy and light media multitaskers, significantly differed from each other. Media multitasking and cognitive control were found to be linked and the role of music indicated facilitating trend for performance. Studies conclude high levels of media multitasking result in poor cognitive performance in terms of cognitive control and music plays a facilitative role for such media multitasker's cognitive control.

Keywords: media multitasking, cognitive control, music, Stroop

Introduction

Most of the media consumption today seems to involve the simultaneous use of two or more media, also known as media multitasking (Pilotta & Schultz, 2005). Specifically, not only does it refer to engaging in multiple media activities simultaneously, but it also includes operating on multiple windows on a single media platform or using different media at the same time. Thus, media multitasking involves dividing or switching attention between multiple sources of media-based information (Vega, 2009).

Studies have revealed that 70 to 80 % of total media is consumed in the form of media multitasking. Also, there is a clear growth in media multitasking practices (Rideout et al., 2010). Researches show that multitasking has been embraced by teenagers as a way of life. Many teenagers send text messages throughout the day while being simultaneously engaged in school and social activities, combining television viewing (28%) and listening to music (63%) are the most common practices conducted while using the internet (Foehr, 2006).

Since cognitive control is the ability to direct attentional resources towards task-related information while inhibiting task-irrelevant distracters, it is vitally important for the maintenance of normal cognitive functions (Ma et al., 2014). Further, cognitive control refers to the ability to flexibly adapt one's behavior in the pursuit of an internal goal. It is a collection of cognitive processes, including setting up, maintaining, and implementing a task strategy for achieving a goal, monitoring the outcome of one's action to ascertain that the goal is being achieved and adjusting one's behavior if the chosen task strategy is not successful (Ophir et al., 2009). The major model domain for understanding behavioral effects and neural substrates of cognitive control processes has been the regulation of selective attention. Interestingly, heavy media multitaskers have been found to have impaired performance on the tests of attention and cognitive control.

Research paradigms show that the Stroop color-word interference paradigm has been commonly used to examine the ability of cognitive control. Stroop interference effect refers to the increase in response latency observed when an individual is required to identify the color of the color-word when these aspects of the stimulus are incongruent (word red presented in color blue) compared to the time required to name the color of congruent stimulus (word red presented in color red) (Stroop, 1935). Further, among all the forms of media for multitasking, individuals are more likely to media multitask while listening to music (Jeong & Fishbein, 2007). Recent research by Kang and Lakshmanan (2017) has also documented the positive effect of background music in shaping learning and memory.

Classically, two perspectives have been proposed to account for the effects of background music on cognitive processes: The Cognitive-Capacity model (Kahneman, 1973) and the Arousal-Mood hypothesis (Thompson et al., 2001). The capacity model postulates that only a limited pool of resources is available for cognitive processing at any given moment. When concurrent tasks compete for limited resources and their combined demands exceed the available capacity, capacity interference occurs. Only a portion of the task information is processed and therefore, performance deteriorates. The interference caused by task-irrelevant information (for example, listening to music) also depends on the complexity of the information that is being

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processed and on the workload that is required to process task-relevant information. Indeed, increasingly complex musical distractions may result in decreased cognitive performance (Furnham & Allass, 1999). In contrast, the Arousal-Mood hypothesis posits that listening to music affects task performance by positively influencing arousal and mood (Thompson et al., 2001), which is a phenomenon that is also known as the Mozart effect (Cassidy & MacDonald, 2007). Also, researches have indicated that music has been found to have both adverse and beneficial effects (Shih et al., 2009).

Objectives

1. To study the differences in the cognitive control among light and heavy media multitaskers in terms of performance on the Stroop task.
2. To study the differences in the cognitive control of light and heavy media multitaskers as they perform on the Stroop task under the two conditions of musical context and without musical context, respectively.

Methodology

Sample

A sample of 300 girl students in the age range 14-18 years (mean age = 15.7 yrs) was randomly chosen from the Government schools of Chandigarh, India.

Measures Used

1. **Media multitasking index.** It is a measure of individual multitasking behavior. The questionnaire consists of 15 items and 11 media forms under each item. Responses to the items are selected from options "Most of the time," "Some of the time," "A little of the time," or "Never" (Ophir et al., 2009).
2. **Musical context.** It comprised of two levels of musical context:

Condition 1. It shall comprise of Music India's "Walking in the Rain" music.

Condition 2. Under this condition, there shall be no music.

3. **The Stroop task.** The task measures the inhibition and interference facet of executive control. The subjects are presented with color nouns and are asked to name the color of the ink in which the noun is written. Errors are counted for scoring purposes. An error occurs in case the subject names the color wrongly (Stroop, 1935).

Statistical Analysis

Descriptive statistics and t-test based comparisons were carried out.

Procedure

The study comprised of two phases:

Phase 1. In this phase, Media Multitasking Index Questionnaire by Ophir et al. (2009) was administered individually to all the subjects. The scoring was carried out as per the manual (Table 1).

Table 1
Mean and SD of Media Multitasking Scores of the Initial Sample

M	*SD*
4.70	1.64

On the basis of the obtained scores, the subjects were divided into two groups viz. light media multitaskers (a1) and heavy media multitaskers (a2) groups as per the formula of mean ± ½ *SD* (Table 2).

Phase 2. In this phase, the Stroop experiment was conducted individually on light (a1) and heavy (a2) media multitasking group subjects. Specifically, this experiment consisted of 2 levels of musical context viz., musical context (b1) and no musical context (b2)—a total of 6 performance trials on the color Stroop task by each subject. Further, the conditions of musical context and no musical context were randomly distributed across all trials for the Stroop task. The Stroop color words were individually presented for 1.25 seconds and responses were taken. After each trial, a blank screen was shown for 20 seconds for rest. Precise instructions were given to the subjects and in order to avoid errors of habituation and anticipation, proper randomization of musical contexts was done.

Table 2
*Distribution of Initial Sample amongst the Two Groups**

	Light media multitasking (a1) *M* - ½ *SD* 4.70 - ½ (1.64) = 3.06	Heavy media multitasking (a2) *M* - ½ *SD* 4.70+ ½ (1.64) = 6.34
Media multitasking	*N1* = 123*	*N2* = 112**

Note. *criteria for a1 scores = ≤ 3.06; **criteria for a2 scores = ≥ 6.34; *N2 had the smallest sample i.e. 112. For the sake of uniformity, an equal number of students, i.e., 112 each, were taken from each of the Media multitasking groups for proceeding with Phase II.

Results and Discussion

The research aimed at studying the performance differences across heavy and light media multitaskers on a conflict task as well as to study how the performance of the two groups differed across two levels of musical contexts, viz. musical and no musical context. The study revealed interesting results given as under:

Table 3
Means and t-ratio for Stroop Errors for Media Multitasking Groups

Group	Variable	*M* (Errors)	t-ratio
Light media multitaskers (a1)	Cognitive control	17.71	15.83**
Heavy media multitaskers (a2)	Cognitive control	33.59	

Note. **significant at .01 level.

The present study revealed (Table 3) significant differences between performances of Heavy Media Multitaskers (HMMs) and Light Media Multitaskers (LMMs) with more Stroop performance errors in the case of HMMs as compared to LMM. It may be noted that more Stroop performance errors indicate less cognitive control and vice versa. This difference, in turn, points out the negative effect of media multitasking on executive functioning. A more pertinent point to note here is that the sample, in this case, is that of adolescents.

Overall, the results of the study seem to be consistent with earlier findings in which it was reported that heavy media multitaskers and light media multitaskers perform differently on cognitive tasks (Cain & Mitroff, 2011). It is possible that with respect to information processing, individuals who infrequently multitask aka light media multitaskers are effective at volitionally allocating their attention in the face of distractions than those who frequently use multiple media aka heavy media multitaskers, as they have a breadth biased cognitive control and are distracted by multiple streams of media they are consuming and it negatively affects their performance on any task requiring cognitive control (Ophir et al., 2009; Sanbonmatsu et al., 2013).

The study in hand also indicated better performance under musical context than under no musical context. Less mean Stroop performance errors were seen under musical context than under no musical context (Table 4).

Table 4
Means and SD for Stroop Task Performance Errors under Musical and No Musical Context

Variables	*M* (Errors)	*SD*
Musical context (b1)	10.68	4.20
No musical context (b2)	14.91	7.58

The results of the study also reflect an earlier finding that music context leads to enhanced performance on cognitive tests and such effects perhaps stem from the impact of music on arousal level and mood, which, in turn, might be affecting cognitive performance (Schellenberg, 2015). This perhaps leads to resource conservation in terms of executive functioning as accurately envisaged by Kahneman a long time back.

The present study further revealed significant differences between performance under Musical and No Musical Context of HMMs, but no significant differences were reported between the performance under musical and no musical context of LMMs (Table 5). This indicated that heavy media multitasking perhaps leads to fatigue which might be dispersed by musical context.

Table 5
Means and t-ratios for Stroop Errors under Musical and No Musical Context across Media Multitasking Groups

Groups	Variables	*M* (Errors)	t-ratio
Light media multitaskers (a1)	Musical context (b1)	8.57	1.71**
	No musical context (b2)	9.11	
Heavy media multitaskers (a2)	Musical context (b1)	12.79	16.78**
	No musical context (b2)	20.71	

Note. **significant at .01 level.

The Stroop task performance is a task of conflict and music has been found to have a beneficial effect on attention (Chhabra & Sharma, 2012). Also, it has been seen in an earlier study that the participants scored higher on the attention test when music was played before the test compared to when music was not played before the test (Shih et al., 2012).

The study seems to fall in line with the research findings of David et al. (2013), which indicated that media multitasking results in a bottleneck in information processing and thus diminishes the performance of heavy media multitaskers. Also, cognitive control is one of the essential components of attention and increased media multitasking activity is also associated with poorer cognitive control. Music seems to be linked with the execution of cognitive performance. The study in hand has indicated that music facilitates cognitive control in media multitaskers.

Conclusion

The study assumes importance in the cognitive and mental health area as the phenomenon of media multitasking has a habit-forming divided attention tendency encrypted into its very functioning. The consequent cross-modality switching of attention between task stimuli is a challenge that all such multitaskers have to grapple with continuously. So, the results of the study in hand seem to have significant implications for young people's ability to attend to things, to plan their performance, to relate to other people as well as to understand the world. A lowered cognitive control is a result of the huge scope for trainers of attention. A valuable finding of the study is that music has a facilitative role and that low levels of media multitasking shall be beneficial in situations that involve a challenge to optimum and healthy cognitive functioning.

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