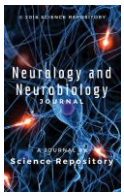

Available online at www.sciencerepository.org

Science Repository

Research Article

Possible Effect of Headphone Usage on Working Memory Among Students in Faculty of Medicine, Ahmadu Bello University, Zaria–Nigeria

Yusha'u Y*, Muhammad U.A and Isah F.A

Department of Human Physiology, Faculty of Medicine, Ahmadu Bello University, Zaria–Nigeria.

ARTICLEINFO

Article history:
Received: 13 June, 2019
Accepted: 25 June, 2019
Published: 20 July, 2019

Keywords:
Headphone
working memory
n-back task
hearing aid

ABSTRACT

Working memory is a system that is responsible for transient holding and processing of new and already stored information. It also involves processing for reasoning, comprehension, learning and memory updating. Headphones are a pair of small loudspeakers that are designed to be held in place close to a user's ear. They are electroacoustic transducers which convert electrical signals to a corresponding sound in the user's ear. Several studies have recently shown a link between cognitive abilities and response to hearing aid and signal processing in the brain. Therefore, the relationship between headphone usage among healthy subjects become pertinent. This study is aimed at evaluating the effect of headphone on working memory using N-back task. One hundred (100) participants (55 headphone users and 45 non-headphone user's) within the age range of 18-31 years were assessed. Participants were instructed to keep in memory, a series of letters and say "target" whenever there was a repetition of letter with exactly one intervening letter and to remain silent when any other letter appeared. The results of this study showed that there was no statistically significant difference in working memory between headphone and non-headphone users with $p>0.05$. In conclusion, this study revealed headphone use has no effect on working memory of the participants subjected to N–back test.

© 2019 Yusha'u Yusuf. Hosting by Science Repository.

Introduction

Working memory is a type of short-term memory which has a crucial cognitive function that allows storage of information across delay periods supporting ongoing and upcoming behaviors [1]. Working memory includes subsystem that store and manipulate visual images and verbal information, as well as central executive that coordinates the subsystems. It included visual representation of the possible moves, and awareness of the flow of information into and out of time [2]. Individual differences in working memory predict individual differences in a broad range of cognitive abilities, and this is because of both differences in the number of items that can be maintained and the ability to control access to working memory [3]. Particularly, in noisy environments listeners with hearing loss commonly report having difficulty understanding speech. Their difficulties could be due to auditory and cognitive processing problems [4]. There are many studies that show working memory capacity is correlated with a wide range of brain functions and higher order cognitive skills such as attention task, resistance of being distracted, sustained attention, reading comprehension, reasoning, problem solving and fluid intelligence [5, 6].

In the last 20 years, worldwide mobile phone subscriptions have increased from 12.4 million to over 5.6 billion, involving about 70% of the global population Electromagnetic field radiations from mobile phones may cause adverse health problems such as headache, sleep disorders, impairment of memory, lack of concentration, dizziness, increased frequency of seizures in epileptic children, brain tumors and high blood pressure [7]. These electromagnetic field radiations are mostly mediated into auditory pathway via the headphones. Listening to headphones while memorizing words triggered a mood-dependent effect that caused mental disruption, and therefore, a decrease in memory retention [8]. Women have been reported to be more subjective to hearing problems when compared with men but exhibited better hearing

Correspondence to: Yusha'u Yusuf, Department of Human Physiology, Faculty of Medicine, Ahmadu Bello University, Zaria–Nigeria; Tel: +2348100872166; E-mail address: yusufshau@gmail.com

© 2019 Yusha'u Yusuf. *This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.* Hosting by Science Repository.
http://dx.doi.org/10.31487/j.NNB.2019.02.02

thresholds [9]. The present study aimed at investigating the possible adverse effects use of headphones caused to working memory in long term mobile headphones users.

Methods

I Participants

Participants included 100 young students (55 headphone users and 45 non headphone users) aged 18-31 years. The experimental group was made up of 19 males and 36 females, the control group was made up of 21 males and 24 females. Participants were recruited from Faculty of Medicine, Ahmadu Bello University, Zaria–Nigeria. The baseline for the screening of subjects was obtained using a questionnaire with consent of the subjects. The inclusion criteria for the subjects were those using headphones for at least three years for the experimental group and those not using headphones for up to three years for the control group. Ethical clearance was obtained from Health Research Ethics Committee, Ahmadu Bello University Teaching Hospital Shika-Zaria, Nigeria, with reference number: ABUTH/HREC/UG/6.

II Sample size

Sample size was determined using the sample size calculator software G* Power version 3.1.9.2. An effect size of 0.7 was selected for the effect of headphone use on working memory. It was assumed that prolonged headphone use has moderate to large effect on working memory. The alpha level was set at 0.05 with a power of 0.95. The calculated total sample size was 110.

III N-back task

The N–back task (2–back target) was used to assess working memory. During the task, number of stimuli must be held in the mind at any one time to be varied constantly [10]. A single consonant was presented for 500 milliseconds every 2 seconds in the middle of a computer screen [11]. The participants were instructed to match and identify the letter previously seen after an intervening letter (e.g. X–Y–X, X is a target letter or X–Y–K, K is a non–target).

IV Statistical Analysis

Data was presented as Mean ± SEM and analyzed using independent T-test. Data for score by gender were presented as Mean ± SEM analyzed using one way ANOVA and Schaffer post hoc test for multiple comparison, values with $p < 0.05$ were considered statistically significant.

Results

I Effect of Headphone use on Working memory between headphoneusers and nonheadphone users using N back test.

In the present study, the mean value of headphone users was 59.49 ± 1.25 and that of non–headphone users (control) was 62.64 ± 1.22. Statistical analysis of the finding demonstrated no statistically significant difference in working memory between the subjects using headphones and non-headphone users, [T (98) = 0.12 and p = 0.913] (Figure 1).

II Gender Effect of Headphone use on Working Memory between Headphone Users and Non headphone users using N back test.

We evaluated the effect of gender on prolonged use of headphone on working memory. The mean value of male headphone users was 56.68 ± 2.13 and male non–headphone users was 63.33 ± 2.09, while, mean value of female headphone users was 60.52 ± 1.53 and female non–headphone users was 62.45 ± 1.52. There was no statistically significant difference in working memory between male and female users and non–users of headphones, [F (3, 96) = 2.208 and p = 0.92] (Figure 2).

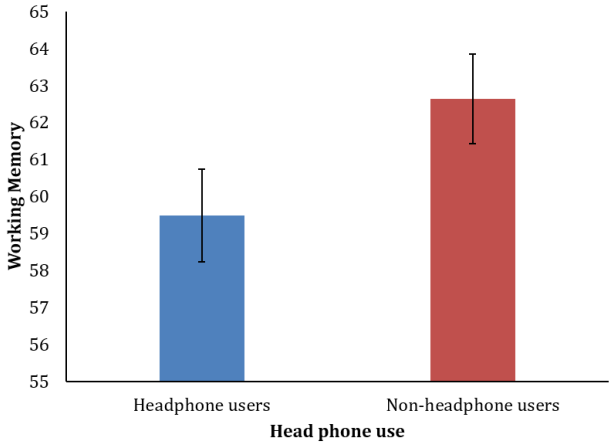

Figure 1: Effects of prolonged use of headphone on working memory. The mean difference is not statistically significant, p >0.05, (N = 100).

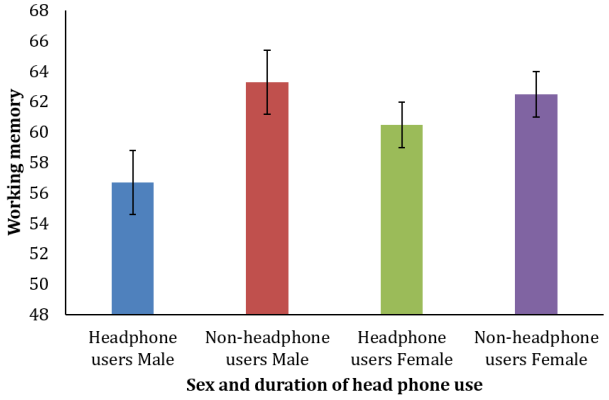

Figure 2: Gender effect of prolonged use of headphone on working memory.
The mean difference is not statistically significant, p >0.05, (N=100).

Discussions

The present study assessed effect of headphone on working memory. It has shown that there is no significant effect in working memory between headphone and non- headphone users. However, the study of Jurkovic *et al*. (2013) showed that memory recall and retention increased while listening to headphones [8]. The results of their findings were interpreted as an arousal response to the sound that enhances neurotransmission in certain pathways. Similarly, the findings of Salame, and Baddeley,

(1989) revealed that listening to sounds while attempting to perform a memory task caused mental disruption and therefore, a decrease in memory retention [12].

The results of gender effect of headphones on working memory in this study revealed no significant change between headphone users and non-headphone users. When the two groups were compared and matched, the durations of using headphones which were further divided into duration of time and sex, the results demonstrated no statistically significant difference between the female headphone users when compared with their male counterparts. This is in conformity with the study of Rossi *et al*. (2009) who showed that, working memory is a limited capacity system that involves both storage and processing, that is, working memory allows a person to actively store task related information while concurrently carrying out other relevant processing [13]. The role of working memory in listener's responses to headphones signal processing can be considered in the context of basic information processing models for speech. These models suggest that processing resources are both finite and shared. Listeners may have to allocate a greater share of processing resources to the recovery of degraded information at the auditory periphery in the case of degraded speech information, leaving fewer resources available for successfully processing and identifying the linguistic content in the message. That is, listeners may have to rely more on working memory to process the degraded signal, and when the working memory is reduced this processing may be more difficult. Recent studies have further expanded the scope and possible role of working memory for adjusting the allocation of executive control in dynamic environments. This was established by showing that information of a more abstract nature (including a behavior-guiding rule, or the occurrence of a conflict in information processing) can also be maintained in short-term memory [1].

Also, these findings agree with the study of Lutz and Pascale. (2010) who demonstrated that verbal learning during the exposure to different background music varying in tempo and consonance did not influence learning of verbal material [14]. They concluded that, there was neither an enhancing nor a detrimental effect on verbal learning performance (a form of working memory). Different cortical activations are evoked as a result of the different acoustic backgrounds. The reason for these different cortical activations is unclear. Compensatory mechanism such as masking might have played a vital role.

Possible reason for the results of this study might be due to exposure of the control and the experimental groups to the same degree of noise in the same environment. Rudner *et al.* (2007) and Pamela *et al.* (2015) argued that, listeners must rely to a greater extent on cognitive processing to extract meaning from the auditory signal in situations where the incoming auditory information is deficient (as with background noise or other distortions to the acoustic signal) [15, 16]. In those situations, listeners with low working memory may be at a disadvantage. Indeed, subjects with high working memory have been shown to perform better than patients with low working memory under degraded listening conditions, such as when speech is rendered less audible by hearing loss masked by background noise.

Conclusion

This study revealed no significant effect of headphones on working memory of the students subjected to N–back test. Hence, there is certainly a need for more studies and continuous surveillance.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgements

Our acknowledgement goes to Mr Yusuf Abdulkadir who helped us with N–back task computer software for this research work.

References

1. Mansouri FA, Rosa MG, Atapour N (2015) Working Memory in the Service of Executive Control Functions. *Front Syst Neurosci* 9: 166. [Crossref]
2. Cowan N (2008) What are the differences between long-term, short-term, and working memory? *Prog Brain Res* 169: 323-338. [Crossref]
3. Nash Unsworth, Keisuke Fukuda, Edward Awh, Edward K Vogel (2015) Working Memory Delay Activity Predicts Individual Differences in Cognitive Abilities. *J Cogn Neurosci* 27: 853-865. [Crossref]
4. Smith SL, Pichora-Fuller MK (2015) Associations between speech understanding and auditory and visual tests of verbal working memory: effects of linguistic complexity, task, age, and hearing loss. *Frontiers Psychol* 6: 1394. [Crossref]
5. Tsuchida Y, Katayama J, Murohashi H (2012) Working memory capacity affects the interference control of distracters at auditory gating. *Neurosci J* 516: 62-66. [Crossref]
6. Sharaf A (2015) The therapeutic potential of working memory training for treating mental disorders. *Front Hum Neurosci* 9: 481. [Crossref]
7. Gupta N, Goyal D, Sharma R, Arora KS (2015) Effect of Prolonged Use of Mobile Phone on Brainstem Auditory Evoked Potentials. *J Clin Diagn Res* 9: CC07-CC09. [Crossref]
8. Jurkovic A, Anderson C, Myklejord D, Levin C, Lotz A (2013) The effect of music tempo on memory retension. *J Adv Student Sci* 15: 221-223.
9. Widen SE, Basjo S, Moller C, Kahari K (2017) Headphone Listening Habits and Hearing Thresholds in Swedish Adolescents. *Noise Health* 19(88): 125-132. [Crossref]
10. Owen AM, McMillan KM, Laird AR, Bullmore E (2005) N-back working memory paradigm: A meta analysis of normative functional neuroimaging studies. *Human Brain Mapping*, 25: 46-59. [Crossref]
11. Koivisto M, Krause CM, Revonsuo A, Lane M, Hamalainen H (2000) The effects of electromagnetic field emitted by GSM phones on working memory. *Neuroreport* 11: 1641-1643. [Crossref]
12. Salame P, Baddeley A (1989) Effects of background music on phonological short-term memory. *Quarter J Experiment Psychol* 41: 107-122.
13. Rossi-katz J, Arehart KH (2009) Message and talker identification in older adult: Effects of task, distinctiveness of the talkers voices and meaningfulness of the competing message. *J Speech Language Hear Res* 52: 435-453. [Crossref]
14. Jancke L, Sandmann P (2010) Music listening while you learn: No influence of background music on verbal learning. *Behav Brain Funct* 6: 3. [Crossref]

15. Rudner M, Foo C, Ronnberg J, Lunner T (2007) Phonological mismatch makes aided speech recognition in noise cognitively taxing. *Ear Hear* 6: 879-892. [Crossref]
16. Pamela Souza, Kathryn Arehart, Tobias Neher (2015) Working Memory and Hearing Aid Processing: Literature Findings, Future Directions, and Clinical Applications. *Front Psychol* 6: 1894. [Crossref]
17. Ernst M, John AM, Stephen JH, John DV, Peter HJ et al. (2001) Effect of nicotine on brain activation during performance of a working memory task. *Proceed Nat Acad Sci* 98: 4728-4733.