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**Comparison of Auditory Working Memory Task Performance in Older and Younger Adults**

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Ethical report

Ethical Clearance was obtained from research committee of the Institute

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Authors have nothing to disclose

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**STRUCTURED ABSTRACT**

**Background:** Age-related changes in brain structure-function and cognition are not uniform across individuals. The basic cognitive functions like attention and memory will be affected by age. Working memory is one among the most useful memory which is essential and assumed to be a temporary storage system under attention control that underpins the capacity for complex thought. Working memory allows to remember information when processing a message and contemplating the response to the message. The elderly population will experience constraints on working memory due to decline in cognitive process which helps to account for problems with comprehension in old age. Thus the current study was planned to investigate auditory N Back test performance among older adults and compare with younger adults.

**Method:** Total of 60 participants participated in the study and divided them in to two groups. Group 1 included 30 healthy younger adults between 20-30 years of age and Group 2 included 30 older adults in the age range of 50 – 60 years. Auditory 1- Back and 3 back tests were administered on all the participants. The obtained scores of their auditory performance on both the tasks were tabulated and subjected to statistical analysis.

**Results:** The results of the present study showed the significant difference in both the groups. Older adults performed significantly poorer than younger adults in both 1 back and 3 back auditory tests and indicated that auditory working memory is influenced by aging.

**Conclusion:** The findings of the current study support the fact that N Back auditory test can be considered as objective tool to mark working memory among older adults. Assessment of auditory working memory and understanding may further aid in formulating rehabilitation program for cognitive decline among elderly individuals.

*Keywords:* Age related changes, auditory working memory, N Back test, memory in ageing

**Introduction**

Age-related changes in brain structure, function and cognition are not uniform across individuals. The basic cognitive functions like attention and memory are affected by age (“Handb. Aging Cogn.,” 1992) and these are not unitary functions, however evidence suggests that some aspects of attention and memory holds up well with age while others show significant decline with perception. Most of the theories of cognitive aging implicate working memory (WM). Although there are several models of WM, all agree that it is a limited capacity system that involves the active manipulation of information that is currently being maintained in focal attention. Short-term or primary memory, on the other hand, involves the simple maintenance of information over a short period of time. For example, one might maintain a phone number in short-term memory by simple rehearsal of the number. Older adults show minimal or no deficits in short-term memory and can typically hold about 7 ± 2 digits in mind as long as that the digits are being rehearsed. However, it requires an active reorganization or manipulation of the information held in short-term memory which is called as WM.

WM is assumed to be a temporary storage system under attention control that underpins the capacity for complex thought (Baddeley & Hitch, 1974). WM allows one to remember information while they are processing a message and contemplating ones response to the message. According to WM model given by (Baddeley & Hitch, 1974)it can be applied to explain the cognitive functions such as reasoning, perception, memory, attention and other brainfunctions. It is based on three components: a main component, central executive and two subsystems: the phonological loop and the visual sketchpad. The central executive is mainly responsible for relating information from support subsystems. WM is assumed to be limited by attention span as it is dependent on attention deployment. A similar view has been proposed by (Engle et al., 1999)suggested that WM requires activation capacity, which is directly related to attention.

Many of the routine complex tasks such as decision-making, problem-solving, and the planning of goal-directed behaviours require the integration and reorganization of information from a variety of sources. It is likely that attention, speed of information processing, and the ability to inhibit irrelevant information are some of the important functions for effective performance of these higher-level cognitive tasks. Whether these functions might be subsumed under a domain-general executive controller that is impaired by normal aging —something akin to the central executive in model of working memory (Baddeley & Hitch, 1974)or whether there might be multiple control processes that are independently affected by aging, is currently an issue under investigation. Results suggest that different areas are activated in young and older adults, particularly within the prefrontal cortex, indicating that younger and older adults are performing these tasks distinctly (Reuter-Lorenz & Sylvester, 2005). Most of studies of WM capacity have been carried out in young adults, in the last several decades researchers have also investigated how WM changes with increasing age (Fergus I M Craik & Byrd, 1982). Auditory WM performance declines with increasing age and hence a range of different approaches have been used to study the auditory WM (Bopp & Verhaeghen, 2005). Despite very different theoretical styles and methods, there is a general agreement on a need to assume a role for some form of executive controller, probably of limited attention capacity, aided by temporary storage systems, with verbal and visual storage probably operating separately (Miyake and Shah, 1999).

Working memory can be measured in both visual and auditory modes. There are various tests available to measure the capacity of working memory in which visual WM will be measured by recalling visual information. Similarly, Auditory WM is measured by recalling auditory information. The N-Back test is one such frequently used experiment to measure auditory WM (Kirchner, 1958). N-Back test is a continuous task used as an assessment in cognitive neurosciences and Clinical psychology to measure the capacity of working memory.

N Back test is valuable as it does not solicit a verbal response and can be applied in individuals with oral language alterations. The N Back task uses 1, 2 or 3 back-digits either in visual (N-Back visual) or auditory (N-Back auditory) presentations. 1 back means that the subject has to remember the position of the item, one turn back. 3 back means the subject has to remember the position of the item two turns back and so on (Gazzaniga et al., 2009). The participant need to identify the current item displayed is as same as that presented back with varied position in each series.

There are many tests available for measuring WM capacity. Some measure visual working memory by recalling visual information, others measure auditory WM by recalling auditory information. The auditory N back test is one of the test measures the auditory working memory introduced by (Kirchner, 1958). The N-back task is a continuous performance task that is commonly used as an assessment in cognitive neuroscience to measure WM in which the subject is presented with a sequence of stimuli and the task consists of indicating when the presented stimulus matches the one from N-back steps earlier in the sequence. This test is valuable as it does not seek a verbal response and thus can be applied in individuals with oral language alteration.

**Materials and Methods**

**Participants**

Total of 60 volunteer participants participated in the study. Participants were divided in to two groups. Group 1 included 30 healthy younger adults (M-15, F- 15) between 20-30 years of age (mean age 26.4 years) and Group 2 included 30 older adults (M-15, F- 15) in the age range of 50 – 60 years (mean age 57.8 years). Participants with no complaint of hearing loss, neurological, psychological and medical problems were included for the study by collecting the background information and written consent. Participants with complaint of systemic illness, cognitive problems and inability to understand instructions to perform task were excluded from the study.

**Stimulus**

N-Back task is a process of temporary storage and response that is frequently used to measure WM. The 1 back and 3 back stimuli of N Back auditory was considered in the present work. A list of 80 words drawn from different categories (Vehicles, fruits, animals, objects, and colors) with bi syllable and tri syllabic structures were selected and randomly distributed. Later a familiarity test was conducted among those categories out of which 30 stimulus were selected as target stimulus based on frequency and familiarity of the words and recorded digitally in stereo at 44.1 kHz.

**Procedure**

The recording was carried out in sound treated room designated for audiological evaluation. The participants were made to seat comfortable on the chair facing a laptop (Dell Inspiron, 15 3000) on the table and clear instructions were given with trial run of the N back auditory task to make them understand. The sequences of 500 milliseconds auditory stimuli recorded, with one second inter stimulus intervals, and were presented binaurally using calibrated Sennheiser headphones. The actual test administration was carried out based on the child’s understanding following trial run to remember 1 back and 3 back task. Children were asked to indicate by gestures to point at which the stimulus is repeated in both one turn back task (task 1) or three turn back task (task 2). Based on the observation of the participant response the examiner score 1 for every correct response and score 0 for incorrect responses. The total scores obtained by each participant were noted. The obtained data were tabulated and subjected to suitable statistical analysis.

**Results & Discussion**

The scores obtained on task 1 (N1 back) and task 2 (N3 back) in group 1 and group 2 were subjected to statistical analysis using SPSS software (Version 17). The mean scores of group 1 on N1 back (M=14.3, SD=0.93), N3 back (M=14.2, SD = 0.91) and mean scores of group 2 of N1 and N3 back tests (M=11.8, SD=2.15) (M=11.7, SD=2.65). However, participants in group 1 obtained better scores on both the tasks i.e. The mean scores obtained for task 1 and task 2 were compared between the groups using independent sample t test and results revealed significant differences between the groups [p<0.01] in both task 1 and task 2 indicating that younger adults performed better than older adults. The results on individual tasks across the groups also showed significant difference [p<0.03] indicating that both the group participants performed better in N1back test than N3 back test. The obtained results were tabulated and represented in table 1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Group | TASK | MEAN | SD | SIG | Df |
| Group 1  (Younger adults) | N1 | 14.3500 | 0.93330 | 0.000 | 19 |
| N3 | 14.2500 | 0.91047 | 0.000 | 19 |
| Group 2  (Older Adults) | N1 | 11.8500 | 2.15883 | 0.000 | 19 |
| N3 | 11.7000 | 2.65766 | 0.000 | 19 |

***Table 1:*** Mean, Standard deviation, Significance values of both the groups and both the tasks.

The finding of the current study is in consonance to the earlier studies suggesting that auditory WM declines as age increases. According to a study (Reuter-Lorenz & Sylvester, 2005)which stated that against the background of the age-related frontal lobe degradation one may rather expect reduced activation of frontal lobe brain areas during high WM load. However, several studies reported even increased activation of bilateral frontal lobe areas in older vs. young participants during WM tasks as measured with neuroimaging methods.Substantial evidence also showed a decline in auditory WM among normal older adults (Verhaeghen & Salthouse, 1997). The elderly population will experience constraints on WM due to decline in cognitive process which helps to account for problems with comprehension in old age (Qualls & Harris, 2015). Some of the researchers (Hasher & Zacks, 1988) proposed that lack of inhibitory control might account for cognitive deficits which associated with aging. Specifically, failure to suppress any irrelevant information in working memory may effectively reduce its capacity, denying access to relevant information. For example, working memory span tasks involve the successive presentation of increasingly long strings of digits or words across trials. Age related deficits could be attributable to the failure to delete from working memory digits or words from prior trials, thus reducing the “working space” for new stimuli. Although considerable data suggest that older adults experience more interference from irrelevant information under some conditions, findings are mixed and other data fail to support an inhibitory deficit account. Significant deficit is exhibited by older adults in tasks that involve active manipulation, reorganization, or integration of the contents of working memory. Although the mechanisms underlying these age-related deficits are as yet poorly understood, the effects of such deficits are very likely far-reaching.

The present study also suggests that assessing auditory WM in elderly population is important as auditory WM is required for executive functioning. Aging process is characteristically heterogeneous and aging encompasses a number of difficulties in auditory processing. Hence assessing WM in aging is important and N-back test acts as a valuable tool for measuring the performance which include reaction time, increase in memory load and decay facilitation

**Conclusion**

The results of the present study indicated that there was a significant difference in the auditory WM skills among younger adults and geriatric population. These results suggested that auditory N-back test can be used as an assessment protocol in elderly population. Hence it infers that the N Back test can be used as it is valuable in measuring auditory WM by reflecting the language abilities like sentence comprehension and communicative competence.

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