Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/9525
DOI URL: http://dx.doi.org/10.21474/IJAR01/9525

RESEARCH ARTICLE

COMPARISON OF COGNITIVE ABILITIES BETWEEN MUSICIANS AND NON-MUSICIANS.

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Manuscript Info

Manuscript History
Received: 06 June 2019
Final Accepted: 08 July 2019
Published: August 2019

Key words:-
cognitive ability, musicians, non-musicians, intelligence.

Abstract

Existing body of knowledge demonstrates that musicians experience improved mental abilities than non-musicians in variety of mental ability tasks. The present study made a comparison of cognitive abilities (immediate auditory and visual memory, auditory and visual working memory load, spatial thinking ability and cognitive information processing) between musicians (N=30, 19 males and 11 females) and non-musicians (N=30, 10 males and 20 females) of Nepal. All participants had similar level of education. The mean age of the participants from the musical group was M=26.97 years (SD= 3.285) and from non-musical group was M=23.83 years (SD= 1.487). Series of tests including Immediate Span of Memory (Visual and Auditory), Visual and Auditory n-back tasks, Cross Section Test and Digit Symbol Test (WAIS Form I) were performed. The results showed no significant difference in any of the aforementioned cognitive tasks between the two groups. Participants who did not perform well in one task could not perform well in other similar tasks also. Results from the present study indicate that intelligence perhaps may not be a unitary construct as it possibly could be affected by variables including cultural framework, level of educational experience and increase in age. In spite of the fact that studies such as these are mostly conducted in the western context, comprehensive analysis of the non-western cultures may as well provide wealth of unexplored knowledge on music cognition. Nonetheless, this study tried to explore the probable causes for the variability of results between the West and the East.

Introduction:-

Intelligence is not a unitary construct but an umbrella term for collection of cognitive abilities. That is to say, intelligence can vary across population depending upon their genetic makeup, nurture, socioeconomic status and so on (Carter, 2014). According to Gardner (2011), the theories of intelligence can be understood by dividing it into four major categories. They are: psychometric theories, cognitive theories, cognitive-contextual theories, biological theories. These theories could either be understood in explicit from, based on the factual data collected from performing tasks, or implicit form, based on people’s conceptions, state Sternberg and Powell (1982). Since the term intelligence does not bear any specific meaning,the manner in which it is explained differs from theory to theory. Each theory presents its own perspective and approach in understanding intelligence. This study focuses largely on Spearman’s two-factor theory of intelligence which puts forward that cognitive abilities could be explained through

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two variables: g factor and s factor. g and s signifies general intelligence and specific intelligence respectively (Pomerantz, 2008). According to Spearman, intelligence is a single construct having singular characteristics. Fundamentally, his theory considered intelligence as a single entity which was not affected by cultural experiences, educational experiences or maturation (Ackerman & Beier, 2005). Moreover, Spearman maintained that g factor was not sufficient to explain specific abilities that were unique to each test. For instance, someone who performed well in verbal comprehension task may not necessarily perform competently on task related with spatial ability. Hence, the s factor was developed (Nairne, 2013).

The mystery of musical experience, it's rejoice and relish, have been examined since time immemorial. It is believed that Aristotle was the first to ask questions regarding music and its exceptional ability to remind us of our soul. Ancient scholars including Pythagoras, Helmholtz and Kant as well made speculations regarding the enigmatic nature of music (Perlovsky, 2016). How music generates such enormous impact on human cognition is still an ongoing debate. Bialystok and DePape (2009) studied the relationship between musical training, bilingualism and executive functioning. The study suggested that executive functions are enhanced in musicians. Their study indicates higher level of cognitive flexibility in musicians as compared to non-musicians. Identical results have been found in numerous researches conducted to study associations between musical training and its cognitive benefits. A study by Schellenberg (2004) found an increase in general IQ of 6-year-old children after 1 year of conservatory-based musical training (as cited in Moreno et al., 2011). In Zuk, Benjamin, Kenyon and Gabb's (2014) study that examined the behavioral and neural correlates of executive functioning between musicians and non-musicians, they concluded that musically trained adults were high on measures of cognitive flexibility, working memory and verbal fluency and that, musically trained children exhibited enhanced verbal fluency and processing speed than musically untrained children. Vasuki, Sharma, Demuth and Arciuli (2016) conducted an experiment to compare the auditory processing, cognitive abilities and statistical learning between musicians, N=17, (either vocal or instrumental) with ten years of experience and non-musicians, N=18, having less than three years of musical experience. The participants performed previously published embedded triplet tasks. They found musicians performing better in auditory but not in visual statistical learning task than non-musicians. The results of musical benefit are not just consistent over individuals with good condition or health but children with dyslexia as well showed significant improvement in their phonological and reading skills with musical training as in the study conducted by Flaugnacco et al. (2015).

In order to establish a possible association between musical training and improvements in working memory, George and Coch (2011) conducted a study wherein 32 undergraduate students' (16 males -16 females), between the ages of 18-24 were examined. The participants were divided into two groups: musicians (N= 16) and non-musicians (N=16). Through the finding of their study, they concluded that "long term musical training in non- professional musicians is associated with improvements in working memory in both auditory and visual domains and on both behavioral and ERP measures, and perhaps improvements in attention" (George & Coch, 2011, p. 1092). A recent study conducted by Talamini, Carretti and Grassi (2016) to examine the difference in the working memory between musicians and non-musicians concluded that musicians outperformed non-musicians in verbal working memory tasks. Also, musicians performed better irrespective of the sensory modality (audio or visual) and task complexity. In their research, Rodrigues, Loureiro and Caramelli (2013) indicate numerous studies which conclude that musical training brings structural and functional changes in the brain of musicians including regions such as the corpus callosum, motor cortex, somatosensory cortex, auditory cortex and hippocampus (as cited in Rodrigues et al., 2013). Likewise, in a meta-analysis conducted by Besson, Chobert and Marie (2011) they assert that skills learned during musical training is transferable onto information processing, attention and memory.

The present study examines whether musical training is possibly associated with enhanced auditory and visuo-spatial abilities including cognitive information processing and working memory load. Numerous body of works reveal that musical training seems to enhance cognitive abilities. The focus of this study is to examine whether those findings are replicable within the Nepalese population? This paper will further determine whether intelligence is influenced by variables other than inherited dispositions?

Method:-

Participants

30 students each for musical (19 males and 11 females) and non-musical (10 males and 20 females) group were chosen as samples under study. The mean age of the participants from the musical group was M=26.97 years (SD= 3.285) and from the non-musical group was M=23.83 years (SD= 1.487). The study was conducted among the

students at Tribhuvan University (TU), Kathmandu, Nepal. However, a small number of participants excluding TU students were also chosen as samples. Musical group consisted of Master of Fine Arts (Vocal) students (N= 22) and the non-musical group was composed of Master of Business Administration students (N=22). Other than that, music professionals (N= 8) and non-musical individuals (N= 8) were also selected as participants those were not currently TU students. Students from Master of Fine Arts (Vocal) degree were assumed to have at least 4-5 years of formal music education before enrolling into their master's degree. Similarly, another group of participants (non-musicians) lacked that prior experience or preexisting condition as compared to the musical group. Additional participants (N=8) for the musical group, were selected on the basis of the years of informal music training they received. Participants who had at least 5 years of informal music training were chosen for this study. In the like manner, additional participants for the non-musical group (N=8) had an educational background other than Master of Business Administration but were of the similar age group, held similar education level and had no prior experience in music.

Measures

Visual and Auditory Working Memory Load.

Brain Workshop, version 4.8.4, a computer-based software was used to assess the visual and auditory working memory load of the participants. 1-back, 2-back and 3-back tasks were programmed in the software. Participants performed their response on the computer through which their working memory load was measured. The n-back tasks were performed for both visual and auditory modalities. The number of correct response were recorded for each task and for each modality. More the number of correct responses more the working memory load capacity in that particular modality.

Immediate Visual and Auditory Memory.

Span of Immediate Memory (Visual and Auditory) (Bhargava, 2012) was administered to measure the immediate visual and auditory memory span of the participant. Three tests each for visual and auditory modality were administered with every participant. After making sure that participants had understood the instructions, they were shown the stimuli letters from the first list. Participants were allowed to see the letters for 15 seconds after which it was removed. They had to reproduce the letters in written (in the sheet provided) as much as possible after viewing it for 15 seconds. The letters were supposed to be reproduced in the same pattern and order, taking into consideration the empty spaces between the letters as well. A 30 second inter-list interval was kept between every stimulus. The auditory test followed the same procedure. It consisted of three list of numerals ranging from 3 to 10. Participants were presented with number strings starting from 3 gradually increasing up to 10 numbers. They had to reproduce the strings (in the paper provided) after being presented by the experimenter. Each number was provided as a single unit and not as cluster. The numbers were presented with half a second interval between two units. Pronunciation and speed were kept constant at all times. After the presentation of each list, no specific inter-list interval was given for the subject. However, their convenience was considered before presenting the next stimulus. The stimuli were spoken only once for each string. In both visual and auditory tests, the participants were not allowed to look at the stimuli list, however, they had the privilege of asking questions during and after the experiment. The total correct number of last string produced by the participant from each list divided by number of trials would give the score for immediate auditory memory. Similarly, the total correct number of letters reproduced by the participant divided by the number of trials would give the score for immediate visual memory. There were 3 trials presented each for immediate auditory and visual memory.

Spatial Thinking Ability.

Santa Barbara Solids Test or Cross Section Test (Cohen & Hegerty, 2012) measured the spatial thinking ability of participants. The 'Cross Section Test' is a 30-item multiple-choice test that presents the pictures of geometric solids. The geometric complexity is divided into three levels: simple, joined and embedded figures. The geometric figures are intersected in either orthogonal (horizontal or vertical) or oblique cutting plane. From the given multiple options for the answer, the participant has to select the two-dimensional shape that would result when the given three-dimensional object was sectioned. For every right answer the participant will receive one score. The maximum score for this test is 30 and minimum is 0. More the score, more the spatial thinking ability. Also, there is no time limit to complete this test.

Cognitive Information Processing.

'Digit Symbol Test', a subset of Wechsler Adult Intelligence Scale (Form I) was administered to measure the cognitive information processing between two groups of participants. This test is to be completed using a record form that contains 100 horizontal boxes divided into 4 groups (25 boxes in each group). There are nine sample boxes provided on the top section of the form. In those sample boxes are numbers 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively. Below each number is a specified symbol. The participant has to fill empty boxes with the appropriate symbol presented for each number. The time duration for this test is 90 seconds. Within that time, the participant has to fill as many empty boxes as possible with the specified symbol. The participant receives one point for each square filled correctly. The maximum score for this test is 90 and the minimum score is 0. More the score, more the processing speed.

Procedure

Each group of participants were briefed individually about the purpose and objective of the study. A room to conduct the study was set prior to the experiment. For TU students, rooms were allocated at their respective departments. Similarly, for non-TU students, the study was conducted at the researcher's house where a room was assigned for this particular study. The room for this study was arranged with special consideration to insulation of noise and interference from external objects. The study was conducted on a one-to-one basis between the participant and the experimenter.

Initially, the 'Span of Immediate Memory (Visual & Auditory)' (Bhargava, 2012) was administered on the participants. Three tests each for visual and auditory modality were administered with every participant. The immediate visual and auditory memory test was followed by the n-back tasks. Firstly, visual n-back (1-back, 2-back and 3-back) tasks were performed by the participants. For n-back tasks, the participants were initially given 1-trial chance to get them acquainted with the test. After the visual n-back tasks, the participant performed the Santa Barbara Solids Test (Cross Section Test), then the auditory n-back tasks, followed by the Digit Symbol Test. The tasks had been randomized in order to avoid the priming effect due to the 'perceptual, semantic or conceptual stimulus repetition' (Bermeitinger, 2016, p. 44). Moreover, for each n-back tasks (both auditory or visual) the participants had to perform two trials. Since the first trial was devoted to acquaint participants with the task, data collected from that trial was not applied for analysis. Only the data received from the second trial was examined.

Before the start of the experiment, a written consent was taken from the participant. Similarly, assurance about the confidentiality of the test results and anonymity of their identity were also stated to them.

Results:-

A comparison was made between musicians (N=30) and non-musicians (N=30) on the basis of their cognitive abilities. An independent samples t-test was conducted to compare the means of two groups in order to determine statistically significant difference between them. There was no significant difference found between two groups in any of the cognitive abilities at $p< .05$. In 1-back, 2-back and 3-back tasks measuring visual working memory load capacity, p-value was .763, .721 and .900 respectively. Similarly, in 1-back, 2-back and 3-back tasks measuring auditory working memory load capacity, $p= .763$, .721 and .900 respectively. Cross Section Test presented a p-value of .385. Also, no statistical difference could be found between males and females on all tests. There were no significant differences found in cognitive information processing ($p=.161$), Immediate visual memory ($p=.428$) and Immediate auditory memory ($p=.864$) between the two groups.

Discussion:-

The results from the present study showed no significant difference between musicians and non-musicians in all cognitive ability tasks conducted in this study including tasks for immediate auditory and visual memory, auditory and visual working memory load, spatial thinking ability and cognitive information processing. The findings of this study are firmly inconsistent with the literatures cited in this text and also with the existing body of knowledge. This raised a question, are there differences between cognitive abilities among people from West and the East regardless of musical training?

Jensen (1971) writes that simultaneous presentation of visual and auditory stimuli produces the best immediate recall. However, there are studies (Binet, 1894; Koch, 1930; Miinsterberg & Bingham, 1894) that have found auditory memory superior to visual. On the other hand, alternate studies (Hawkins, 1897; Henmon, 1912; Kirkpatrick, 1894; O'Brien, 1921; Worchester, 1925) found visual memory superior to auditory memory (as cited in Jensen, 1971). Articulating on the recall of the items, Nairne (1990) states that immediate recall of auditory items is quite high than visual items in terms of modality related effects such as the modality effect (superior recency auditory performance as compared to visual), the stimulus suffix effect (a phenomenon where a word presented aloud masks the modality effect) and grouping (presenting stimulus in small groups mainly through pauses). On the basis of above-mentioned works, the question raised at this stage is that besides immediate memory of the musicians, non-musicians as well presented a low performance. That is to say, there may exist a relative lag in encoding of information in participants from both groups. Alternatively, the issue may be of the retrieval of information. It is believed, unless something is learned, one cannot forget it. As a matter of fact, participants may have faced difficulty with retrieval of information (Kasschau, 2003; Marnat, 2003). Since the information could not be encoded precisely, the retrieval may have been affected accordingly. These occurrences can be understood in terms of Craik and Lockhart's (1972)levels of processing model of memory (as cited in Bernstein, 2018).

Culture plays a definite role in constructing the world around us. It is pivotal in shaping attention and filtering process of the environmental cues to form memories. People from western cultures are more object-based, attend more to information that are related to self and focus on categorically relevant information whereas people from eastern cultures are more of collectivistic nature hence are context-based and rely heavily on group-based information which in turn influence the encoding and retrieval of memories. The degree of details that are valued and prioritized across cultures also shape towards memory formation (Gutchess & Indeck, 2009). Another similar study conducted by Gutchess, Schwartz and Boduroglu (2011) suggest that there exists bottleneck that filters important information and stimuli which is highly influenced by culture. They further state that culture explains individual differences in terms of attention and memory. In similar studies (Boduroglu, Shah, & Nisbett, 2009; Gutchess et al., 2006), researchers maintain that information processing capacity in human brain is limited. Hence, few details in the environment are prioritized over others. These prioritizations are dependent upon the cultural framework with which one views the world (as cited in Schwartz, Boduroglu, & Gutchess, 2014). Previously mentioned studies (Gutchess & Indeck, 2009; Gutchess, et al., 2011) have pointed out that culture shapes the way individuals attend to certain stimuli in their environment. Therefore, cultural lens acts as bottleneck which filters certain information over other. There exists large and consistent body of research (Engle, 2002; Kane, Bleckley, Conway, & Engle, 2001) which suggests that working memory capacity evidently is determined by one's control over attention (as cited in Barrett & Tugade, 2004).

Men and women differ on numerous levels of cognitive performances. In general, spatial ability is one such capability that shows gender gaps. Various biopsychosocial factors contribute towards differences in spatial performance (Reilly et al., 2017). Studies (Silverman & Eals, 1992; Voyer, Postma, Brake & Imperato-McGinley, 2007) show that while males present superiority over sub-processes such as mental rotation and spatial perception, females superiority could be found over memorization of object location (as cited in Goede, 2009).

Individual difference in processing speed is evident. Processing speed is primarily concerned with the goal of the activity, the manipulation of information in the working memory and decision making ability of the individual. The difference can be attributed to age-related neuronal changes which causes the decline of axonal myelination (as cited in Cepeda, Blackwell, & Munakata, 2013). Further, the decrease in cognitive processing speed is related with increasing age in adulthood. This reduction in speed leads to impairment of numerous cognitive functions in an individual. Overall, the cognitive performance may become significantly affected because the functions could not be successfully executed (Salthouse, 1996). A study conducted by Roivainen (2011) concludes with results that exhibit no gender differences when it comes to general intelligence, fluid and crystallized intelligence.

Conclusion:-

The present study tried to make a comparison of cognitive abilities between musicians and non-musicians in Nepal, the results of which were relatively contrary to earlier findings. Nearly all research conducted to study cognitive performances between musicians and non-musicians are carried out in the western context. However, this study tried to deduce causes for the inconsistency of results between the west and the east. The results from this study indicate that the possibility of intelligence being a unitary construct perhaps may be questionable. Also, the present study demonstrates no correlation between musical training and improvement in cognitive abilities in the Nepalese population. Finding as such, allows researchers to investigate intellectual capacity among non-westerners which may affect their social and personal functioning.

Recommendations

Future studies could explore other approaches to address this issue. For instance, to examine the causal evidence of musical training on cognitive performance, cross-sectional or longitudinal approaches could be undertaken. With due consideration to cultural and individual differences,larger sample size with diverse but similar samples examined through mixed method approach might bring interesting results too. Furthermore, considering musicians with more number of years in instrumental rather than vocal training, may bring intriguing results to the foreground.

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