The evaluation of the effects of acute-intense exercise on visual and auditory reaction time

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Abstract

This study evaluated the effects ofacute-intense exercise on visual and auditory reaction time.

Materials and Methods: Study included 40 males in the age group of 18- 22 years. Participant's blood pressure and resting heart rate was measured using the sphygmomanometer and Pulse Ox (heart rate monitor), respectfully. Pulse Ox was placed on non-dominant index finger of the participant.

PC 1000 reaction timer was used for the measurement of VRT for red, blue & green light & ART. After the baseline measurements, subject started to exercise on the stationary bike till heart rate was doubled and subject maintained exercise for 5 more minutes. Immediately after the exercise, post exercise heart rate & post exercise blood pressure were measured, & VRT for all 3 colours& ART were retested.

Results were analysed statistically using Wilcox paired't' test comparing pre & post exercise measurements.

Results: The mean values of VRT for red, blue & green & ART was faster after exercise when compared to before exercise values & the difference was statistically significant. There was significant increase in heart rate & systolic BP & decrease in diastolic blood pressure after exercise compared to baseline values.

Conclusion: Results of the study can be associated to many people in improving their health in everyday life especially athletes & senior citizens.

Keywords: Visual reaction time, Auditory reaction time, Heart rate, Blood pressure.

Introduction

Physical exercise offers multiple benefits to an individual. Exercise is the planned, structured, purposive and repetitive with the aim of improvement and/or maintenance of components of physical fitness.[1] When challenged with any physical task, human body responds to integrated changes in function that involve many physiologic systems.

Reaction time is the neuromuscular coordination of the body to the visual or auditory stimuli.

Sensory information reaches the brain through the afferent pathways and converted into neural signals. Neural transmissions activate the muscle and generate the motor response. Reaction time is used as index of well-being of central nervous system and information processing.[2] Faster the signal reaches the brain, faster it is processed and necessary responses are generated.[3]

Movements require activation and control of musculoskeletal system. Cardiovascular and respiratory systems provide the ability to sustain these movements over extended periods. From cellular perspective, during acute intense physical exercise skeletal muscle utilizes an increased amount of ATP. This increases the heart rate and respiratory rate due to elevated demand of aerobic respiration. It has been shown that exercise causes changes in brain through overall cardiovascular conditioning and increases the cerebral blood flow and oxygen supply to the neurons.[4] Previous studies have focussed on effect of exercise on cognitive functions mainly by testing short term and working memory. Fewer studies have studied the connection between cognitive and motor functions.[5,6] Indian data on this subject is very limited. Hence, present study evaluated the effect ofacute-intense exercise on auditoryreaction time (ART) and Visual reaction time (VRT). In this study, acute-intense exercise was defined as the subject pedal on a stationary bike, set at a specific resistance and increase their heart rate to double the resting heart rate. A stationary bike was used in this experiment as it was a consistent way for the subject to exercise for a set amount of time. Also doubling the subject's heart rate was chosen compared to percentage of the maximum heart rate as it be could easily be controlled and monitored with the Pulse Ox monitor.

Materials and Methods

This open labelled, non-randomized study included 40 males in the age group of 18-22 years. Subjects with musculoskeletal disorders, neurological disorders, visual & auditory disorders, smokers, alcoholics & involved in any sports activity which might affect the reaction time were excluded from the study. Ethics committee approval was taken from institutional ethical committee before the start of the study. All participants were made to sign the informed consent document prior to inclusion in the study. Personal history and medical history of both groups was collected in the study proforma. The subjects were explained about the importance and procedure of the study. The study involved non-invasive procedures with no financial burden on the subjects. Sufficient time

was given (15 minutes) for the subjects to mentally & physically relax before recording the parameters.

Participant's resting heart rate and blood pressure was measured using the Pulse Ox (heart rate monitor) and sphygmomanometer, respectfully. Heart rate monitor was placed on the participant's non-dominant index finger.

Measurement: Devices used to take measurements in study are:

Table 1

Heart Rate	Pulse oximeter From Choicemed, Model MD300c2
ART & VRT	PC 1000 Reaction timer[7]
Blood pressure	Aneroid sphygmomanometer

VRT Measurement: Subjects were made familiar with the Reaction timer instrument before the start of the measurement of VRT. On click of start button by the Examiner in the 1st component, subject was asked to react by pressing the STOP button in 2nd component of the instrument as soon as he sees the light. RT for red (VRT_R), green (VRT_G) & blue (VRT_B) light was recorded in Millisecond (ms) using Audacity software. Subjects were given 5 trials for each colour & measurement was recorded after practice. Lowest of the 5 recording was considered as final visual reaction time for that particular colour.

ART Measurement: Head phone was connected to second component. Subject was instructed to press the STOP button as soon as he hears the sound (1000 Hz). ART was recorded in Millisecond (ms) using Audacity software.

The sphygmomanometer & Pulse Ox remained attached to participants during the experiment to reduce delay in recording the parameters. All the subjects were tested in the same area to keep the environment relatively constant for all subjects.

After the baseline measurements, subject started to exercise on the stationary bike. Exercise task was done to achieve the goal of increase the heart rate to double that of resting heart rate (rHR). After reaching the double than rHR, subject maintained exercise for 5 more minutes. Immediately after the exercise, post exercise heart rate (pHR) & post exercise blood pressure (pBP) were measured, & VRT for all 3 colours & ART were retested. The whole process including exercise period took 15 minutes per subject.

Statistical Analysis

The SPSS 20th version of the statistical software was used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc. Reaction time was reported as mean ± Standard Deviation (SD). Results were analysed statistically using Wilcox paired 't' test comparing pre & post exercise measurements. Minimum level of significance was fixed at $p<0.05$.

Results

The demographic profile of the subject was as follows: The mean age of the subjects was 20.12 ± 1.3 years & mean weight was 63.30 ± 3.2 kgs. The mean resting heart rate (per minute), mean systolic BP (mm Hg) & mean diastolic BP (mm Hg) was 73.6 ± 0.9, 122.4 ± 2.6 & 78.6 ± 1.3 respectively.

Fig. 1 shows the visual reaction time for red, green and blue colors, and auditory reaction time, before & after the exercise. Simple VRT_R before exercise was 296.71 ± 21.06 ms& after approximately 8 minutes of exercise (3 minutes to double the heart rate & 5 minutes maintained at elevated heart rate) was 246.27 ± 24.92 ms. This difference was statistically significant. The mean VRT_B (ms) before exercise & after exercise were 302.42 ± 24.52 &256.46 ± 19.56 respectively ($p<0.05$). The mean value of VRT_G was faster after exercise when compared to before exercise values & the difference was statistically significant. The mean ART of subjects was significantly higher before exercise (242.69 ± 14.42 ms) than the after exercise values (201.53 ± 14.06 ms) ($p<0.0001$).

These results indicated statistically significant decrease in VRT & ART after the acute exercise.

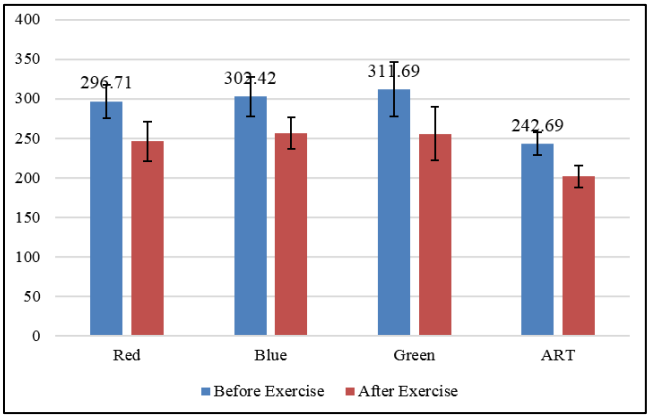

Fig 1. Before and after exercise values of VRT_R, VRT_B, VRT_G and ART

Study assessed whether exercise increases subjects heart rate & blood pressure, both variables were measured before & after the exercise (Fig. 2). The mean rHR (per minute) was 73.6 ± 0.9 & pHR was 144.2 ± 1.2, & mean systolic BP (mm Hg) before exercise was 122.4 ± 2.6 & after exercise was 139.05 ± 1.1. This shows that there was a significant increase in heart rate & systolic BP after the exercise (p<0.05). Present study also observed significant decrease in diastolic blood pressure after exercise compared to baseline value.

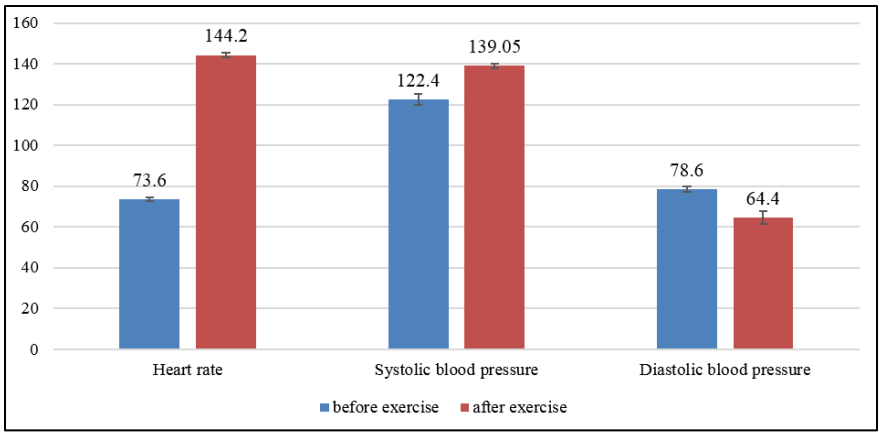

Fig. 2: Before and after exercise values of heart rate, systolic blood pressure and diastolic blood pressure

Discussion

The present study evaluated the effect of acute-intense exercise on auditory and visual reaction time. The study observed a significant decrease in the visual reaction time for red, green and blue colors, and auditory reaction time following an Acute-intense exercise. Similar results have been observed in previous studies about the positive effect of exercise on reaction time.[8-11] In 2008, Ozyemisci-Taskiran et al studied the effects of aerobic exercise on Reaction time & found that after exercise premotor fraction of reaction time decreased after the exercise session where as insignificant decrement of values was observed for control group. Similarly in 2013 Monica et al studied the effect of aerobic exercise on ART & VRT. Compared to non-exerciser control group, aerobic exercisers had better ART & VRT irrespective of age & gender.[12] Study done at University of Colorado Boulder that reaction time deteriorates when the subject is either too relaxed or too tensed.[13] One study reported the beneficial effects of aerobic exercise in older individuals.[14]

Possible mechanism for decrease in the reaction time in this study may be due to increase in the heart rate during Acute-intense exercise increases cortical and muscular blood flow and increases in the speed of information processing and enhances cognitive function due to greater state of arousal. During the exercise, heart rate increases as a physiological response which indicates a state of arousal. It has been documented that exercise induced aroused state is associated with maximum cognitive function by increasing the cortical and muscular blood flow. This increases the speed of information processing and decrease in reaction time.[2] In this study reaction time was measured immediately after the exercise when subjects were in an aroused state.

Also, during exercise the sympathetic nervous system was activated resulting in increase in heart rate and blood pressure. Epinephrine was also released and it binds to beta-2 receptors on the vessels. This causes vasodilatation and decrease in peripheral resistance, allowed increased blood flow to all areas of the body including the brain. More blood to the brain causes better cognitive functioning.[15]

Conclusion

Study results indicated statistically significant decrease in VRT for red, green & blue colour & ART after the acute exercise. Results of the study can be related to many individuals in improving their everyday life and their health especially athletes& senior citizens. Acute – intense exercise improves the reaction time of the athletes, making them betterprepared to participate in a fast paced environment. Also incorporating acute-intense exercise regimen in daily schedule early in life and maintaining it, senior citizens would ultimately improve reaction time which would aid in balance & coordination.

Limitations of our Study

Gender related differences in reaction time were not done. Automated instrument measurement of reaction time may produce different results.

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