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Original Research Article

A Non-Randomized Assessment of the Effects of Acute-Intense Exercise on Visual and Auditory Reaction Time

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Abstract

Aim: To evaluate the effects of acute-intense exercise on visual and auditory reaction time.
Material & Method: This is a non-randomized study included 60 males in the age group of 18-22 years. Personal history and medical history of both groups was collected in the study proforma. 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).
Results: Statistically significant decrease in VRT & ART after the acute exercise. 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.
Conclusion: Respond to visual stimuli presented in the periphery of the visual field is vulnerable to moderate to severe exercise, as compared with the ability to respond to visual stimuli presented in the central portion of the visual field. An exercise- induced increase in arousal level and a consequent narrowing of attentional focus would explain the present results.
Keywords: Visual reaction time, auditory reaction time, Heart rate, Blood pressure.

Introduction

The visual field is the area perceived by the eyes while people focus on a point, and it may be divided into central and peripheral portions. In sports such as football or basketball, a player gathers visual information from the peripheral visual field to see other players and objects beyond the central visual field. [1]

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. [2]

Reaction time (RT) is a measure of the quickness with which an organism responds to some sort of stimulus. RT is defined as the interval of time between the presentation of the stimulus and appearance of appropriate voluntary response in the subject. [3] Luce [4] and Welford [5] described three types of RT.

(1) Simple RT: Here there is one stimulus and one response.

(2) Recognition RT: Here there is some stimulus that should be responded to and other that should not get a response.

(3) Choice RT: Here there are multiple stimulus and multiple responses.

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. [6]

Hence, present study evaluated the effect of acute-intense exercise on auditory reaction time (ART) and Visual reaction time (VRT).

Material & Method:

This is a non-randomized study included 60 males was conducted in the Department of Physiology, ANMMC, Gaya, Bihar, India over the period of 1 year.

Inclusion and exclusion criteria

Male patients in the age group of 18-22 years provided informed consent were included in the study.

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.

Methodology

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 Oximeter (heart rate monitor) and sphygmomanometer, respectfully. Heart rate monitor was placed on the participant's non-dominant index finger.

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 (VRTR), green (VRTG) & blue (VRTB) light was recorded in Millisecond (ms) using Audacity software. Subjects were given 5 trials for each color& measurement was recorded after practice. Lowest of the 5 recording was considered as final visual reaction time for that particular color.

ART Measurement:

Headphone 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 Oximeter 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 colors& 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 analyzed statistically using Wilcox paired't' test comparing pre & post exercise measurements. Minimum level of significance was fixed at $p<0.05$.

Results:

The mean resting heart rate (per minute), mean systolic BP (mm Hg) & mean diastolic BP (mm Hg) was 71.4 ± 0.8, 120.3 ± 2.2 & 75.8 ± 1.5 respectively.

Fig. 1 shows the visual reaction time for red, green and blue colors, and auditory reaction time, before & after the exercise. Simple VRTR before exercise was 283.93 ± 20.21 ms & after approximately 8 minutes of exercise (3 minutes to double the heart rate & 5 minutes maintained at elevated heart rate) was 233.18 ± 23.71 ms. This difference was statistically significant. The mean VRTB (ms) before exercise & after exercise were 309.41 ± 22.63& 242.32 ± 18.28 respectively ($p<0.05$). The mean value of VRTG 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 (251.63 ± 14.07 ms) than the after-exercise values (206.11 ± 14.11 ms) ($p<0.0001$). These results indicated statistically significant decrease in VRT & ART after the acute exercise.

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 76.3 ± 1.6 & pHR was 151.6 ± 1.9 & mean systolic BP (mm Hg) before exercise was 120.6 ± 2.4 & after exercise was 133.7 ± 1.8 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.

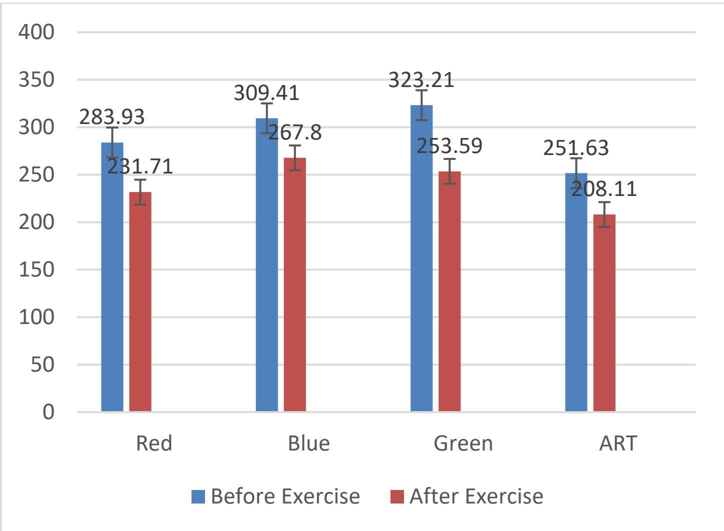

Figure 1: Before and after exercise values of VRTR, VRTB, VRTG and AR

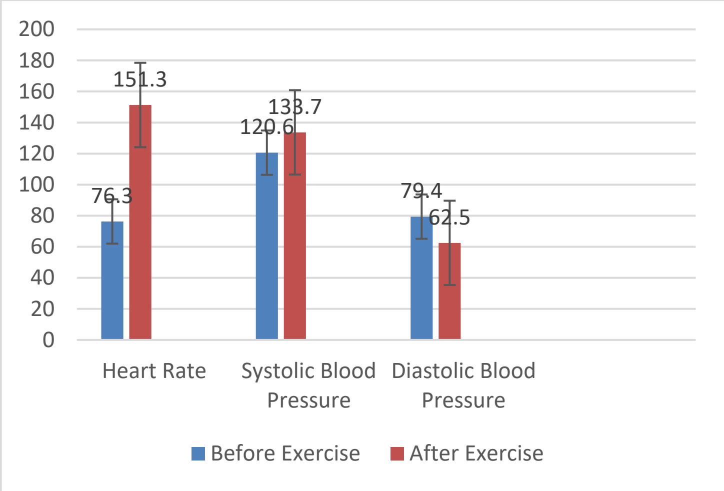

Figure 2: Before and after exercise values of heart rate, systolic blood pressure and diastolic blood pressure

Discussion:

Since the auditory stimulus reaches the cortex faster than the visual stimulus, the ART is faster than the VRT. Shelton and Kumar [7] also concluded that simple RT is faster for auditory stimuli compared with visual stimuli and auditory stimuli has the fastest conduction time to the motor cortex along with fast processing time in the auditory cortex.

A narrowing of attentional focus reflects the view that an increase in arousal level causes progressive elimination of inputs from peripheral aspects of the environment [8, 9]. According to this view, our data suggest that the exercise-induced increase in arousal level led to a narrowing of attentional focus, resulting in the increase in Premotor time to the visual stimulus presented in the periphery of the visual field during moderate to severe exercise. Premotor time includes time needed for visual information processing, perceptual and central motor processes. The increase in Premotor time, which was exclusively observed in the peripheral visual condition, suggests that the delay occurred in a separate, rather than a common, process.

Research done by Pain and Hibbs, [10] shows that simple ART has the fastest RT for any given stimulus. A study was carried out by Thompson et al. [11] has documented that the mean RT to detect visual stimuli is approximately 180-200 ms, whereas for sound it is around 140–160 ms. Research by Kemp [12] show that an auditory stimulus takes only 8–10 ms to reach the brain, but on the other hand, a visual stimulus takes 20-40 ms. Therefore, since the auditory stimulus reaches the cortex faster than the visual stimulus, the ART is faster than the VRT.

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]

Ghuntla et al. [15] showed that basketball players show faster RT than healthy controls. There are several possible explanations for this. Spirduso [16] proposed that less RT of athletes as compared to non athletes was attributed to faster central nervous system processing times producing faster muscular movements in athletes. According to Gavkare et al. [17] shorter RT in athletes could be due to improved concentration and alertness, better muscular coordination, improved performance in the speed and accuracy task. Also, motor response execution is a physical task, so it is logical that people trained in physically reactive sports may have superior motor response ability. [18,19]

Conclusion:

Respond to visual stimuli presented in the periphery of the visual field is vulnerable to moderate to severe exercise, as compared with the ability to respond to visual stimuli presented in the central portion of the visual field. An exercise-induced increase in arousal level and a consequent narrowing of attentional focus would explain the present results.

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