Original Article

Submaximal Exercises Cause Immediate Reduction in the Visual Reaction Time in Normal Individuals

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ABSTRACT

Context: Reaction time (RT) is the time taken by an individual to respond suitably and quickly to an appropriate stimulus. It is an objective indicator of the ability of the central nervous system to receive information and coordinate the most appropriate response. It is an important part of inherent balance response in a human being. Our sensory faculties of vision, hearing, and their respective RTs form the basis of our feedback mechanisms required for balance. Both are important factors in fall prevention strategies for the elderly. Physical exercises have innumerable benefits that are well documented except the possible effects on RT. This study is designed to see immediate effects of submaximal exercises on visual RT in healthy adults. **Aim and Objectives:** The aim of this article is to study the immediate effect of submaximal aerobic exercises on visual RT in healthy adults. **Settings and Design:** The study was a clinical trial with pre-test-post-test design conducted in community centers with convenient sampling. **Materials and Methods:** One hundred healthy adults in the age group of 18–55 years were selected. RT at rest was assessed using Inquisit 4.0 by Millisecond Software. There was 30 min of aerobic exercise in the form of walking with 70% heart rate response as submaximal aerobic exercise. Immediately after the RT was noted, analysis of data was done using the paired *t*-test. **Results:** There was a statistically significant reduction in visual RT after exercise from 293.16 to 272.78 ms ($P < 0.01$). **Conclusion:** Submaximal aerobic exercises reduce the visual RT immediately.

KEYWORDS: *Normal individuals, Submaximal exercises, Cisual reaction time*

INTRODUCTION

Reaction time (RT) is the time taken by an individual to respond suitably and quickly to an appropriate stimulus. Usually, RT denotes a quick response to any threatening stimulus. It is built in for a defense from any potential injury to the human body. More importantly, it shows the speed with which our central nervous system (CNS) processes and responds to a stimulus.[1] Measuring RT is an objective way of measuring the central processing time required to generate a response.[2]

Studies on RT provide an indirect index of capabilities of CNS processing and form a basis of investigating sensory-motor performance. RT can indicate the efficiency of biological processes in brain. For any response to occur, the stimulus should activate the sense organs and the impulse is then conducted to brain and following which a response is sent back to execute the movement required to accomplish the task.[2]

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Luce in 1986, as a part of series of psychology experiments, has classified RTs as follows. First is the simple one in which the subject has to respond to only a single presented stimulus. The second one is called as a recognition and RT where the subject has to identify the correct stimulus from the pool of presented stimuli, and the last one is the choice RT where there are many stimuli with many possible responses.[3] Simple RT can also be divided into visual and auditory RTs. Both visual and auditory RTs form the basis of our feedback/feedforward mechanisms that contribute actively toward maintaining balance. Human balance responses are a mix of feedback and feedforward mechanisms. RT represents both of them. It is important for anticipatory as well as reactive balance strategies. Slow and poor visual and auditory RT in response to any situation can alter our life considerably.

A range of factors affect human RT. Some are modifiable and others non-modifiable. Factors that affect the human RTs are age, hand dominance, acuity of vision, frequent attempts, subjective fatigue threshold, time of the day, any medicines or drugs that affect the alertness or arousal of an individual, and inbuilt personality traits that make someone more focussed and competitive. One important modifiable factor that has an effect on the RT is exercises. Exercises have many known beneficial effects on human body that include positive systemic effects. An important effect of exercises is its facilitatory effect on human CNS. Our resting vagal tone is shown to have increased after exercises along with release of serotonin that relates to reduction in stress levels.[4] Neurological effects of exercise suggest that it increases the cellular proliferation with important changes in the levels of certain proteins and receptors that contribute to neural plasticity.[5] There appears to be change in the perfusion level of the prefrontal cortex that adds to the neuro-facilitatory effect of exercises.[6]

The debate as to which type of exercises is best suited for improvement in the RT is ongoing. Exercises can be given in many forms. First one among them are the aerobic exercises using oxygen and aerobic mechanism for energy production. This category comprises longer duration activities; for example, running, jogging, and other similar exercises that require sustenance over a period of time. The anerobic exercises are the ones that generate energy through glycolysis. This category involves short-lived intense workouts. Some studies cite an improvement in the RT following an acute bout of intense exercises. Some of them also cite an improvement after prolonged time of exercises. The literature review gives mixed results for the choice of exercises for training RT. Aerobic exercises have a greater utility clinically for the ease of training and lower threshold of fatigue. Aerobic exercises have also known to cause several beneficial changes that not only involve the physical benefits but also the improvement of higher cognitive functions and psychomotor functions in exercising individuals. The other categories of exercises such as yoga have been shown to improve attention and focus.[7,8]

There have been contradictory and inconclusive reports on the effect of immediate- or long-term exercises on RT. It has been stated that there is not much change in a moderate exercise session but after maximal exercises there is considerable slowness in the RT.[9]

Although majority of the studies have been done considering the RT training and testing in sports and athletic performance, they are concentrated on high intensity and acute exercise effects on RT. In a non-sporting scenario, the ADL requires submaximal and moderate exercises that can be used for rehabilitation in patients and elderly to improve the RT. We need to study the facilitatory effects of exercises that can be easily translated into activities of daily life. The clinical relevance and applicability of simple moderate exercises are more than acute intense exercises. So, this study is designed with the same objective in mind to study the immediate effect of submaximal exercises in healthy adults.

Subjects and Methods

Institutional ethical approval was applied for and obtained after which the study was conducted across the community centers in urban metropolitan areas. One hundred adult healthy participants were selected after taking their written consent. The inclusion criteria were adult healthy participants within the age group of 18–55 years with corrected or normal vision and normal comprehension. The exclusion criteria were participants who for any medical reason could not walk for 30 min or any participant who was on any additional performance enhancing supplements or was professionally being trained for improved RT.

After recording their baseline characteristics and vital parameters, their pre-exercise simple visual RT was tested using Inquisit (version 4.0) by Millisecond Software, Washington, USA.[10] The task was to identify a red circle that appeared at random time intervals after a black cross on a white background screen. As soon as the participants saw it, they were supposed to press the space bar button as quickly as they can be using their dominant hand. Best of five attempts was taken as the final value. After this, subjects were given

the task of walking for 30 min at a pace similar to the 6-min walk test. Their target HR was calculated and was continuously monitored throughout the walk. It was expected and monitored to remain at their 70% of target HR. Immediately after exercises, the visual RT was checked again. Data were analyzed using SPSS version 19. Pre-exercise and post-exercise values of the visual RT in milliseconds were analyzed using the paired *t*-test.

Results

The demographics and sample characteristics are as given in Table 1. The pre- and post-exercise scores were as follows. The pre-exercise VRT was 293.16 ms and post-exercise VRT was 272.78 ms, $t(99) = 12.70$, $P < 0.01$. The data showed statistically significant difference between pre-exercise and post-exercise VRT.

Discussion

RT training is vital for any form of physical training, be it for professional athletic training or a balance training program in individuals at risk for fall. The present study demonstrates the facilitatory effect that exercises have on the nervous system, more importantly the speed of indexing that may change after the exercises. The possible mechanisms of a reset vagal tone and release of endorphin-like substances and serotonin discussed previously may be responsible for it. Ploughman[11] identified neurotrophins and brain-derived nerve growth factors as the potential source for improving brain plasticity and other positive effects of exercise. It can be suggested that regular low intensity exercises can cause an increase in neurotrophin levels. Ashnagar *et al.*[2] observed the auditory and visual RTs of 29 individuals after cycling exercise which reduced the RTs in healthy young females. But significant positive changes were seen more in auditory than visual RTs.

Although the beneficial effects of exercises on cognitive function are unanimous, the type of exercises that produce the best cognitive facilitation and change in psychomotor performance measures like RT remains ambiguous with mixed reviews. Acute and intense exercises have shown to be beneficial on the overall cognition. However, they always have the risk of running into fatigue especially if applied to the elderly, which is why we need to pay attention to moderate exercise protocols. Moderate aerobic exercise is shown to reduce the auditory RT in normal individuals, and the present study concurs with the results of previous studies in this aspect. This is also concurrent with the results of Yagi *et al.*,[12] in which the RTs in young healthy students were found to be considerably shortened after exercises. There was a significant reduction of visual P 300 latencies during and after exercises. It also corroborates the results given by Ozyemisci-Taskiran *et al.*,[13] who in their single session submaximal aerobic exercise protocol concluded that a single bout of cycling exercise increased the processing of premotor fraction of RT in healthy young sedentary subjects.

The clinical application of this study can be made in the area of geriatric rehabilitation where RT training is often necessary. It could be a part of the fall prevention program in the geriatric population. Submaximal exercises could be an effective way to improve the RT in the elderly. Although this study dealt with a single session exercise protocol, the training effects can be studied by giving a protocol for 6 months or more and evaluating not just the objective RT values but also the change in performance measures. The findings can also be applied to the individuals with CNS lesions in whom balance training would often incorporate RT training, particularly with extrapyramidal lesions in which automatic reactions and RT are affected.

This study has several limitations; it has a limited sample due to the pandemic and the sample is collected from a restricted geographical area which is urban, thus not representing the population at large. Rural individuals may respond differently. Also, the other factors that were not controlled or considered were the arousal level and motivation. Even though the time of day at which the testing was done was kept consistent,

Table 1: Demographic data

Sample size	100
Males	50
Females	50
Mean age with SD (in years)	36.79 ± 24.04
Mean height (in cm)	166.9 ±14.5
Weight (in kg)	66.38 ±12.5
Pre-existing co-morbidities (controlled with medication)	
Diabetes mellitus	8
Hypertension	5

individual arousal levels may fluctuate throughout the day and can in turn affect the RT.

Conclusion

The study does support a facilitatory effect of submaximal exercises on RT and that visual RT reduces immediately after submaximal exercises.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Ethics committee statement

The Institutional Ethics Committee approval was sought and approved.

Patient declaration of consent statement

Verbal and written consent was taken from the participants.

Data availability statement

The data set used in the current study is available on request from the author.

References

1. Garg M, Lata H, Walia L, Goyal O. Effect of aerobic exercise on auditory and visual reaction times: A prospective study. Indian J Physiol Pharmacol 2013;57:138-45.
2. Ashnagar Z, Shadmehr A, Jalaei S. The effects of acute bout of cycling on auditory & visual reaction times. J Bodyw Mov Ther 2015;19:268-72.
3. Duncan Luce R. Response Time and Their Role in Inferring Elementary Mental Organisation. Oxford Psychology Series 8, New York: Oxford Press; 1986. p. 47-9.
4. Nanda B, Balde J, Manjunatha S. The acute effects of a single bout of moderate-intensity aerobic exercise on cognitive functions in healthy adult males. J Clin Diagn Res 2013;7:1883-5.
5. Lojovich JM. The relationship between aerobic exercise and cognition: Is movement medicinal? J Head Trauma Rehabil 2010;25:184-92.
6. Tomporowski PD. Effects of acute bouts of exercise on cognition. Acta Psychol (Amst) 2003;112:297-324.
7. Desai R, Tailor A, Bhatt T. Effects of yoga on brain waves and structural activation: A review. Complement Ther Clin Pract 2015;21:112-8.
8. Sungkarat S, Boripuntakul S, Chattipakorn N, Watcharasaksilp K, Lord SR. Effects of Tai Chi on cognition and fall risk in older adults with mild cognitive impairment: A randomized controlled trial. J Am Geriatr Soc 2017;65:721-7.
9. McMorris T, Keen P. Effect of exercise on simple reaction times of recreational athletes. Percept Mot Skills 1994;78:123-30.
10. Inquisit 4.0 Computer Software year 2014 by Millisecond Software Precision software for psychological and neurophysiological experiments, Washington. Available from: www.millisecond.com. [Last accessed on 03 Sep 2018].
11. Ploughman M. Exercise is brain food: The effects of physical activity on cognitive function. Dev Neurorehabil 2008;11:236-40.
12. Yagi Y, Coburn KL, Estes KM, Arruda JE. Effects of aerobic exercise and gender on visual and auditory P300, reaction time, and accuracy. Eur J Appl Physiol Occup Physiol 1999;80:402-8.
13. Ozyemisci-Taskiran O, Gunendi Z, Bolukbasi N, Beyazova M. The effect of a single session submaximal aerobic exercise on premotor fraction of reaction time: An electromyographic study. Clin Biomech (Bristol, Avon) 2008;23:231-5.