

# Effects of Habitual Physical Activity Level (PAL) on Simple Visual and Auditory Reaction Time in Healthy Indian Adults

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## Abstract

**Aim** To find the correlation between physical activity level(PAL) and simple visual and auditory reaction time(SVRT and SART), which are tests for cognition .

**Material and Method:** One hundred(100) healthy volunteers of both the genders(males 52 and females 48), aged between 18 and 50 years were recruited. Reaction time (RT), is defined the elapsed time between the presentation of a stimulus and the subsequent behavioral response to occur. Subjects were presented with red light for VRT and pure tone sound stimuli for ART. Reaction time is a measure of the coordination between the sensory and motor system occurs. The physical activity level (PAL) was determined by administering a physical activity level questionnaire developed by the Division of Nutrition, St. John's Medical College, Bangalore. The PAL of an individual classified as follows: sedentary<1.4 moderately active 1.55 to 1.75, and heavily active .1.75.

**Result:** Statistical analysis of data was done by one-way ANOVA with Post-hoc by Turkey HSD test. The results were found to be significant. There is a negative correlation between the SVRT and PAL with R<sup>2</sup> value of 0.006; SART and PAL with R<sup>2</sup> value of 0.001 .

**Conclusion:** In this study we observed that when there is increase in the PAL, there is significantly faster ART and VRT. Therefore, more physically active individuals have better reaction times and are more coordinated at motor tasks when compared to less physically active.

**Key words:** BMI( Body mass index), Auditory reaction time(ART), Visual reaction time(VRT), PAL(Physical activity level)

## Introduction

Chronic diseases are already the primary disease cluster in India. Physical inactivity is one of the important risk factor in common for several chronic diseases including coronary artery disease, hypertension, diabetes, certain types of cancers (breast and colon), respiratory disorders, obesity and osteoporosis being responsible up to 60% of all deaths<sup>1</sup>.The problem is of particular concern in countries like India that has

transitional economies and changing lifestyles. These changing lifestyles may compound increased risks for ethnic groups. There are some data, for instance they suggest that Indians have a genetically determined risk for coronary artery disease. Physical inactivity would enhance that risks including cognitive disturbances<sup>2</sup>.

Physical activity comprises all types of muscular activity that increase energy expenditure substantially. Exercise is a regular and structured subset of physical activity, performed deliberately as preparation for athletic competition or the improvement of some aspect of health<sup>3</sup>.

Reaction time(RT) is defined as the time elapsed between administration of a stimulus and the appearance of appropriate voluntary response in a person. Luce and Welford described three types of RT 1. Simple RT: here

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there is one stimulus and one response. 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 stimuli and multiple responses<sup>4</sup>. Simple reaction time is usually defined as the time required for an observer to detect the presence of a stimulus. It is a physical skill closely related to human performance. It represents the level of neuromuscular coordination in which the body through different physical, chemical and mechanical processes decodes visual or auditory stimuli which travel via afferent pathways and reach the brain as sensory stimuli. Simple reaction time can be determined when an individual is asked to press a button as soon as a light appears or sound heard. Research done by Pain & Hibbs shows that simple auditory reaction time has the fastest reaction time for any given stimulus<sup>5</sup>.

Exercise can improve reaction time. In 1971 Levitt and Gutin showed that subjects had the fastest reaction times when they were exercising sufficiently to produce a heart rate of 115 beats per minute and in 1980 Welford found that physically fit subjects has faster reaction times<sup>6,7</sup>. In 2005, Kashihara and Nakahara found that vigorous exercise did improve the choice reaction time, but only for the first 8 minutes after exercise.

Some benefits occur immediately after a session of moderate-to-vigorous physical activity, commonly referred to as the “last bout effect.” Reduced feelings of anxiety, improved sleep, and improved cognitive function are examples of benefits that can occur after a single episode of moderate-to vigorous physical activity. If participation in physical activity becomes regular, reductions in routine (baseline) feelings of anxiety occur, the last bout effect on deep sleep becomes more pronounced, and components of executive function continue to improve. Executive function includes the processes of the brain that help organize daily activities and plan for the future. Tasks such as the ability to plan and organize; monitor, inhibit, or facilitate behaviors; initiate tasks; and control emotions all are part of

executive function<sup>8,9,10</sup>

Many studies have been conducted to assess reaction time in soccer players, badminton players, basketball players, yoga practitioners but no studies have yet been done in the general population with measured regular general cores and exercise is not there. We undertook this study to assess the correlation between measured habitual physical activity and simple reaction times<sup>11,12,13</sup>

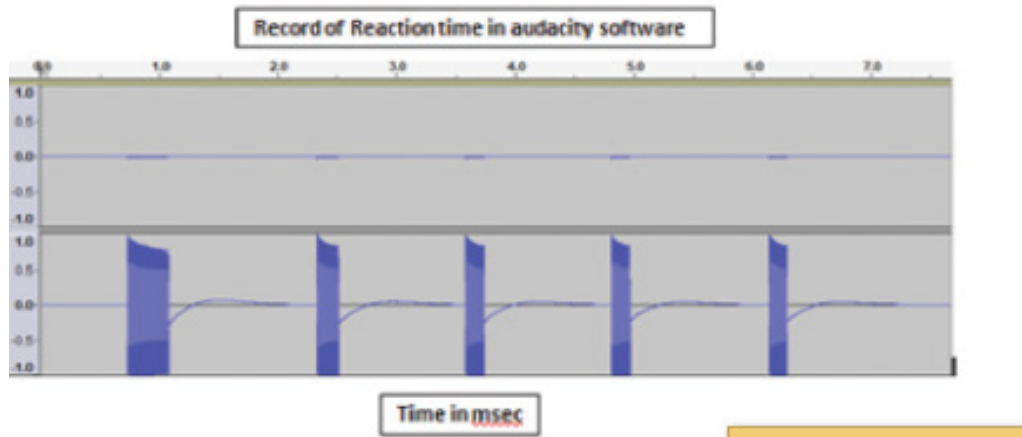
## Material and Method

One hundred(100) volunteers, aged between 18-50 years, male(n=52) and female(n=48) were recruited for the present study<sup>2</sup>. The subjects had no history of diabetes, hypertension, visual and auditory disturbances, alcohol intake, smoking, and no history of recent illness from any diseases. Ethical clearance for the study was obtained from the Institutional Ethical Committee. Participation in the study was voluntary and a written informed consent was obtained from every participant<sup>13,14</sup>

PC 1000 Hertz’s Reaction Timer: We used an in house build add on device called PC 1000, to measure visual reaction time. PC 1000 is a 1000 hertz square wave oscillator which has a soft key for start and stop function. PC 1000 Reaction timer instrument has two components (A &B) connected to each other.

First component (A) has a start button which is handled by the examiner only.

Second component (B) has a stop button which will be handled by the subject alone and also it has a small red LED which receives the visual stimulus. Red light is selected for the experiment as it persists for a long time in retina. Component A and component B are in turn connected to a personal computer which has audacity software installed in it. Audacity software records the reaction time with 0.001sec accuracy in wave format[10]. Minimum five trials were given for SVRT and SART measurements. Minimum time recorded was considered as the final SVRT and SART<sup>15,16</sup>.



**Physical activity level (PAL):** This is used as composite index of Physical activity patterns and is calculated as: 24 hr energy expenditure/basal metabolic rate. 24 hr energy expenditure is calculated as the sum of energy expenditures of all reported activities computed for a single day. Basal metabolic rate is calculated from age and gender specific regression equations recommended by WHO, that include height and weight as predictor variables.

Cutoffs for PAL’s that describe grades of physical activity are <1.4 sedentary, 1.55-1.6=moderately active and >1.75= heavily active. Thus, lower PAL’s indicate more sedentary physical activity profiles<sup>2</sup>.

**Calculation of 24 hour energy expenditure:** The activity reported for one month are recomputed for 24 hours as the sum of energy expenditure related to sleep, occupational energy expenditure, discretionary leisure time energy expenditure and “residual energy expenditure”. In order to calculate energy expenditure for each of these components BMR/min is first computed. For every reported activity MET (metabolic equivalent) which is essentially a multiple of BMR is applied. Higher MET ‘s indicate higher levels of physical activity.

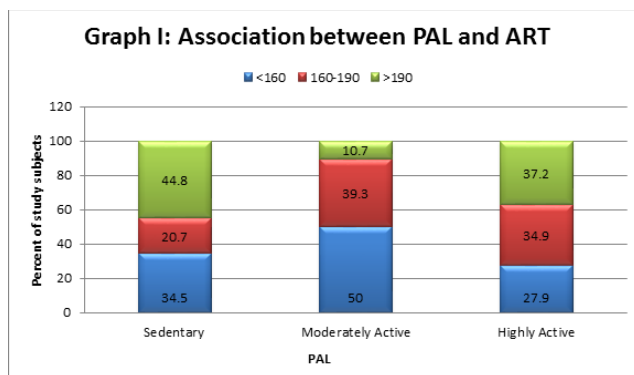
“Residual energy expenditure” relates to those periods in a day which are unaccounted for by recall, and for which intensities of activities have to be assumed. Individuals tend to underreport sedentary, therefore we employ a uniform MET of 1.4 for all “residual time”<sup>11,12,17,18</sup>.

### Results

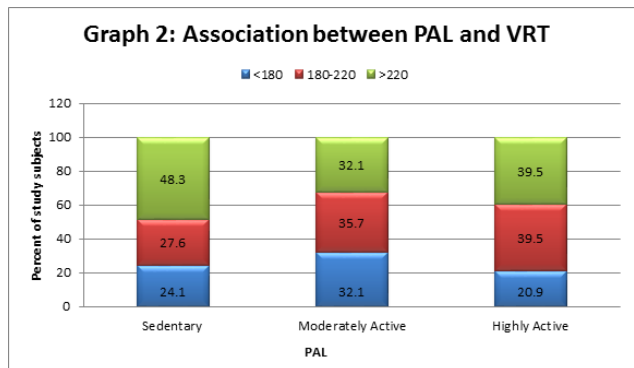
**Statistical Analysis:** Data was entered into Microsoft Excel (Windows 7; Version 2007) and analyses were done using the Statistical Package for Social Sciences (SPSS) for Windows software (version 16.0; SPSS Inc, Chicago). Descriptive statistics such as mean and standard deviation (SD) for continuous variables, frequencies and percentages were calculated for categorical Variables were determined. Association between Variables was analyzed by using Chi-Square test for categorical Variables. Comparison of mean of quantitative variables were analyzed using unpaired t test and ANOVA (Analysis of Variance) respectively for categories having 2 and more than 2 categories. Levels of significance was set at P<0.05. In table 1 the subject characteristic of male and female is depicted

**Table 1: Descriptive Statistics of Male and Female**

Subject Characteristics	Male	Female
AGE(yrs)	24±7.05	25.27±8.75
BMI (kg/m <sup>2</sup> )	23.24±3.67	23.72±4.32
PAL	1.66±0.34	1.64±0.42
VRT( msec)	0.198±0.044	0.233±0.059
ART (msec)	0.176±0.046	0.193±0.065



Graph 1 tells the association between PAL and ART



Graph 2 depicts the association between PAL and VRT

## Discussion

This cross-sectional study was conducted on hundred healthy students and staff of age group of 18 to 50 years of both the genders. The questionnaire assessed physical activity of the past month across multiple domains including discretionary leisure time, household chores, work, sleep, sedentary activities and other common daily activities. The frequency and average duration for each activity were documented. Frequencies were ascertained using fixed categories of 'daily, once a week', '2-4 times a week', '5-6 times a week', 'once a month' and '2-3 times a month'. When all reported activities did not cumulatively account for 24 h, a standard MET (metabolic equivalent) of 1.4 was applied to the 'residual time', as in previous studies(12). For manual occupational activity, the integrated energy index (IEI) of the activity was applied instead of the MET value. Unlike MET, IEI accounts for 'rest' periods that participants are likely to take when engaged in manual activities<sup>14</sup>. PAL cut-offs have been described to classify physical activity patterns into sedentary/light, moderately and vigorously active lifestyles<sup>17</sup>.

Since the introduction of the 1993 Compendium, many studies have used the coding scheme and standard MET values to assign intensity levels to PA questionnaires globally. The results from these studies

have supported conclusion that regular physical activity is health enhancing and that physical inactivity is a major risk factor for chronic diseases and premature mortality. The 2011 Compendium provide 821 codes that reflect 21 major headings, numerous specific activities and their detailed descriptions, and associated MET values that can be used to identify the energy cost of PA<sup>17,18</sup>. Compendium provides a timely update with adoption of evidenced-based MET values

RMR represents as 3.5ml/kg/min. **Resting metabolic rate** (also called RMR) is the rate at which our body burns energy when it is at complete rest. We can **calculate your resting metabolic rate** to see how many calories our body needs to perform basic functions like breathing and circulation. Our RMR or resting metabolic rate is part of our **total daily energy expenditure (TDEE)** or the total number of calories you burn each day.

Moderate evidence indicates that moderate-to-vigorous physical activity can have beneficial effects on cognition though the intensity of activity required to preserve cognitive function remains unclear. Relative to studies of children and older adults, there is dearth of several reviews (SR) and meta-analyses on the relationship of PA and cognition in young and middle-aged adults(18-50 yr). The review of the 2018 physical activity guidelines concluded the grade as not assignable<sup>25</sup>.

The cardio-metabolic profile also shows improvements soon after an episode of moderate-to-vigorous physical activity. Blood pressure is reduced, and insulin sensitivity is increased. These cardio-metabolic benefits persist for hours to days after the last bout. They also may be sufficient to lower the blood pressure of people with pre-hypertension and hypertension into normal ranges for a major portion of the day. Other benefits, such as reduced risk of cardiovascular disease (CVD), diabetes, falls, and fall-related injuries among older adults, and improved physical function accrue as the physiologic adaptations to greater physical activity transpire. Improved cardio-respiratory and muscular fitness and biomarkers of disease risk start to accrue within days, and for a given amount of physical activity, maximize after a few months. Additional benefits accrue if physical activity volume is further increased. The reductions in risk apply every day and at all ages, including young adults, even though their risk for chronic disease is lower than for middle-aged and older



adults<sup>24,3</sup>.

Prospective study of older women, higher levels of long-term regular physical activity were strongly associated with higher levels of cognitive function and less cognitive decline. Specifically, for getting the apparent cognitive benefits of greater physical activity were needed. Walking the equivalent of at least 1.5 hours per week at a 21-30 min/mile pace was also associated with better cognitive performance<sup>18,19,20,,21,22,24</sup>.

This cross-sectional study shows that the ART is faster than VRT which supports the other studies conducted in India and elsewhere<sup>13,14,19,22</sup>. The mean and standard deviation of ART in our study is 176±0.046 ms and VRT is 198±0.044 ms in males and 193±0.065 msec, and 233±0.059 msec in females (Table 1). Researches by Kemp et al., show that an auditory stimulus takes only 8-10 milliseconds to reach the brain, but on the other hand, a visual stimulus takes 20-40 milliseconds<sup>6</sup>. This implies that the faster the stimulus reaches the motor cortex, faster will be the reaction time to the stimulus. Therefore since the auditory stimulus reaches the cortex faster than the visual stimulus, the auditory reaction time is faster than the visual reaction time. There is an increase of reaction time both ART and VRT in females than males irrespective their age which also supports other data<sup>19,21</sup>.

Our study shows a significant decrease in reaction time in both the auditory and visual forms with the increase of measured habitual activity level of (>1.4 to <1.75). The ART is decreased from 190.35 msec to 162.07milisec and VRT from 220.58 msec to 199.78 msec in males. The difference is not so evident in sedentary(<1.4) and moderately active(PAL 1.4-1.75) people but quite evident in moderately and heavily active people(PAL>1.75). From this study, we understood that to acquire better cognitive benefit one person has to do more vigorous physical activity than habitual (PAL>2).

### Conclusion

The more active people definitely has the faster reaction time than the lesser active and cognitive function is better. The dose of the activity can be calculated and introduced to other form of activities like sports and exercises in future studies as they are all measurable.

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