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Original Research Article

EFFECT OF BODY MASS INDEX ON SIMPLE REACTION TIME IN YOUNG MALE ADULTS

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1. INTRODUCTION

Reaction time is crucial for our everyday lives and requires intact sensory skill, cognitive processing and motor performance, it determines the alertness of a person because how quickly a person responds to the stimulus depends on his reaction time. The reaction time is the interval between the application of the stimulus and the initiation of the response. In simple reaction time there is only one stimulus and one response.

It involves stimulus processing, decision making, and response programming. Reaction time has been widely studied as its practical implications may be of great consequence e.g., a slower than normal reaction time while driving can have grave results. It is a measure of function of sensor motor association and performance of an individual.

It involves stimulus processing, decision making, and response programming. Reaction time studies have been documented in both sexes for visual and auditory stimuli. It has physiological significance and is a simple and non-invasive test for peripheral as well as central neural structures. Reaction time provides an indirect index of the processing capability of CNS and it is a simple means to determine sensory motor performance, therefore, it represents the level of neuromuscular coordination via different physical, chemical, and mechanical processes decodes visual or auditory stimuli which travel via afferent pathways and reach the brain as sensory stimuli. There are various factors that affect the reaction time to a stimulus.
Body Mass Index (BMI) of the individuals have shown to affect the reaction time. BMI is a simple index of weight-for-height that is commonly used to classify underweight, overweight, and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2). World Health Organization (WHO) classifies BMI broadly in the following categories:

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Underweight	< 18.5
Normal	18.5 – 24.5
Overweight	25 – 29.9
Obese	>30

However, in Asians, the International Obesity Task Force (IOTF) has proposed the standards for adult obesity in Asia and India as follows.

Underweight	< 18.5
Normal	18.5 – 22.9
Overweight	>23
Obese	>25

Present study we have assess whether BMI is associated with any alteration of simple auditory & visual reaction time in healthy male students within age group of 18–25 years.

2. MATERIAL AND METHODS

The study was conducted in The Physiology Laboratory at Topiwala National Medical College and BYL Nair Ch. Hospital, Mumbai with facilities and all modalities including research facility which deals with all strata of society.

Menstrual cycle can act as a confounding factor affecting the reaction time in females, hence only male students within 18 to 25 years of age are selected. Students with the history of Smoking, Tobacco chewing, Alcohol consumption, Intake of Stimulants, Narcotics and anti-depressants drugs are excluded.

With the approval of ethics committee, well informed written consent after clearing all queries, were taken from students. All students fulfilling inclusion and exclusion criteria were included in the study. General examination & routine investigations were done. Procedure was conducted in the physiology laboratory between 8:30 to 9:30 a.m. Prior instructions were given to have 7-8 hrs of sleep the night before the tests and to avoid consumption of stimulants (tea, coffee, energy drinks), heavy food preceding the testing.

General history was taken. Weight was taken on a digital weighing scale with light clothes without their shoes, belts, watch and any other accessory worn. It was measured to the nearest 0.5kg. Height was measured on a stadiometer while the subjects was standing completely erect with their heads in the Frankfurt plane. It was measured to the nearest 1cm. Body Mass Index (BMI) was calculated using Quetelet index, by dividing the body weight in kilograms by the square of height in meters (kg/m^2). The categorisation of BMI was done according to the International Obesity Task Force (IOTF) has proposed the standards for adult obesity in Asia and India, and the subjects were divided into groups viz. underweight, Normal, Overweight, obese. The BMI of the 150 volunteers were calculated and then they were categorized into different groups depending upon their BMI.

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Each subject was given proper instructions and a two to three trial on the apparatus for both visual and auditory reaction time to alleviate any apprehension.

Procedure of the Test: - The Reaction Time was recording the Physiology Laboratory on the Reaction timer (101- 22012002) supplied by Bio-Tech (Ambala, Maharashtra, India). The reaction timer is used to find the reaction time of patient by visual means and auditory means. The reaction timer apparatus has the sensitivity of 0.0001seconds. The apparatus has two sides viz. subject's side and the instructor's side. Both sides are separated by an Opaque white partition. The barrier is placed in the slot provided on the apparatus to avoid the effect of a lateralized stimulus and to prevent the subject from viewing what switch the instructor presses.

Photograph 1: Reaction Timer – Instructor's side

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Photograph 2: Reaction Timer with white opaque Partition

The instructor was sitting on the side with the primary controls, which consists of switch button for the red colour light for checking the visual reaction time. For checking the auditory reaction time, the primary control consists of switch button to generate high pitch sounds. The subject was sitting comfortably on a chair opposite to the instructor with the secondary control on his side, which consists of a switch button for each of the colour lights.

Once the unit is switched on, the instructor pushes the switch button which is for the generation of light as the visual stimulus for checking the visual reaction time. For checking the auditory reaction time the instructor pushes the switch button which generates the auditory stimulus. The reaction timer starts immediately and the corresponding light glow on both the sides in case of visual stimulus and a sound was generated in case of auditory stimulus. The subject saw the light or hear the sound and immediately push the corresponding switch button. The timer then stopped immediately as soon as the subject pushes the appropriate switch button and indicated the reaction time in seconds. Maximum resolution of time is 0.0001 seconds (1000 micro seconds).

In case if the subject pressed the wrong switch for visual or auditory stimulus, the timer continued to run without stopping and in such case the procedure was repeated.

For both visual reaction time and auditory reaction, three readings were taken and the mean of the three readings were calculated which was taken as the final value. The subjects were given the results after the completion of the procedure.

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STATISTICAL ANALYSIS

SPSS 21st version was used for the analysis. Mean Visual and Auditory Reaction Time was calculated and was expressed as Mean +/- SD. One way ANOVA (analysis of variance) was used to compare the mean of VRT and ART in different BMI groups. P value less than 0.05 is considered as statistically significant.

This was a single centric, prospective, randomized observational study conducted in our hospital physiology department, after obtaining permission from the Institutional Ethics Committee. The study entitled "The effect of Body Mass Index on simple reaction time in young male adults". In this study, we enrolled 150 male students between age group of 18 – 25 years. At the end of the study, we got the following results.

Table No 1 – Age wise distribution in the study population (n=150)

Age (years)	Number (n)	Percentage (%)
18-20	93	62
21-23	56	37.33
24-25	01	0.67
TOTAL	150	100

Graph No 1 – Age distribution in the study population (n=150)

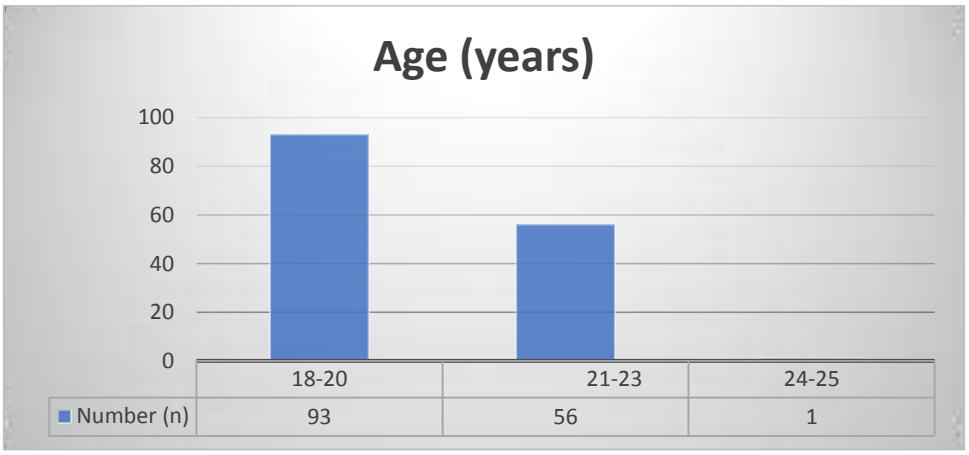

Table No 2 – Anthropometry parameters in the study population (n=150)

Parameter	Mean	SD
Height (m)	2.84	1.37
Weight (Kg)	64.44	11.67

Mean weight in our study population was 64.44 kg whereas mean height was 2.84 m.

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Graph No 2 – Anthropometry parameters in the study population (n=150)

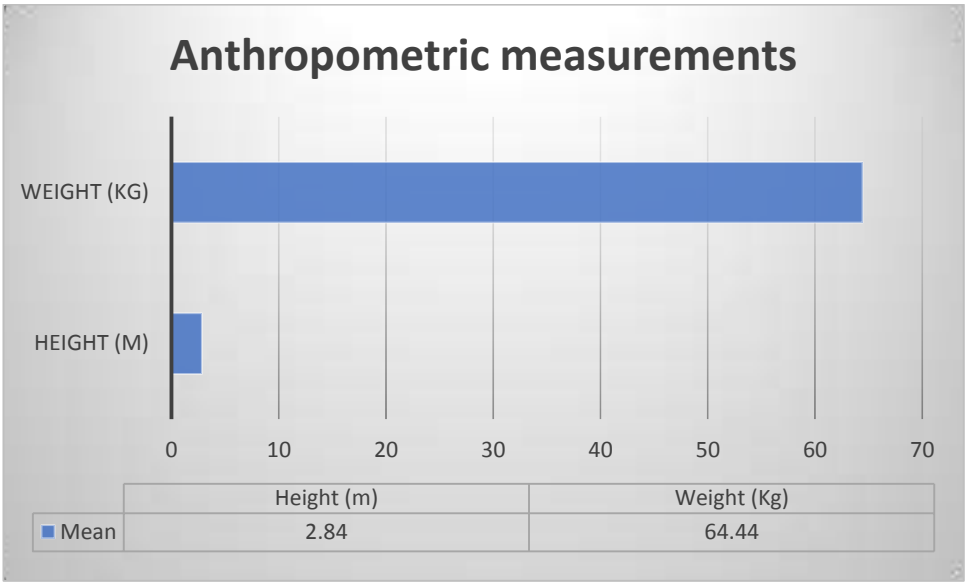

Table No 3 – BMI Categorization in the study population (n=150)

BMI Groups	Range	Mean ± SD	Number (n)	Percentage (%)
Group I	<18.5	17.18 ± 1.04	26	17.33
Group II	18.5 – 22.9	20.90 ± 1.20	74	49.33
Group III	>23	23.62 ± 0.41	28	18.66
Group IV	>25	27.16 ± 1.86	22	14.66

Our study population were divided into four groups based on their BMI. Group 1 with a BMI of <18.5, group 2 with a BMI of 18.5 – 22.9, Group 3 with a BMI of >23 and Group 4 with a BMI of >25. The mean BMI in group 1, group 2, group 3 and group 4, were 17.18 ±1.04, 20.90 ± 1.20, 23.62 ± 0.41 and 27.16 ± 1.86, respectively.

Graph No 3 – BMI Categorization in the study population (n=150)

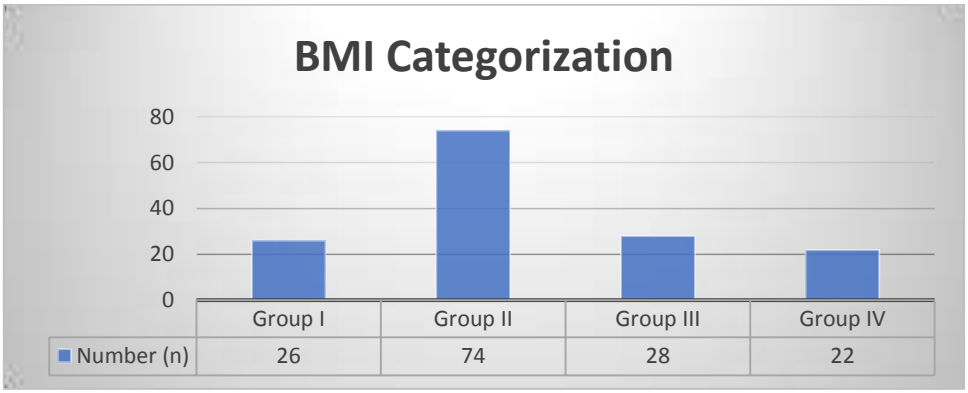

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Table No 4 – Age and anthropometry parameters in the study population (n= 150)

Parameters	Group I	Group II	Group III	Group IV	P value
Age (years)	19.80 ± 1.13	20.12 ± 1.20	20.53 ± 1.34	21.27 ± 1.51	**0.004 (S)**
Height (m)	1.72 ± 0.07	3.99 ± 1.90	1.70 ± 0.08	1.73 ± 0.07	**0.0001 (S)**
Weight (kg)	51.69 ± 5.01	61.98 ± 6.70	68.60 ± 7.03	82.45 ± 11.49	**0.001 (S)**
BMI (kg/m^2)	17.18 ± 1.04	20.90 ± 1.20	23.62 ± 0.41	27.16 ± 1.86	**0.01 (S)**

Footnote- ANOVA with post hoc test was applied

(S) – Significant P<0.05

Table No 5 – Visual reaction time to red light in the study population (n =150)

Parameter	Group I	Group II	Group III	Group IV	P value
VRT (msec)	0.56 ± 0.16	0.56 ± 0.18	1.12 ± 0.18	1.23 ± 0.25	**<0.0001 (S)**

Footnote- ANOVA with post hoc test was applied

(S) – Significant P<0.05

The visual reaction time increased from 0.56 ± 0.16ms (group 1) to 1.23 ± 0.25ms (group 4). This increase in the visual reaction time was found to be statistically significant (p<0.05).

Graph No 5 – Visual reaction time to red light in the study population (n =150)

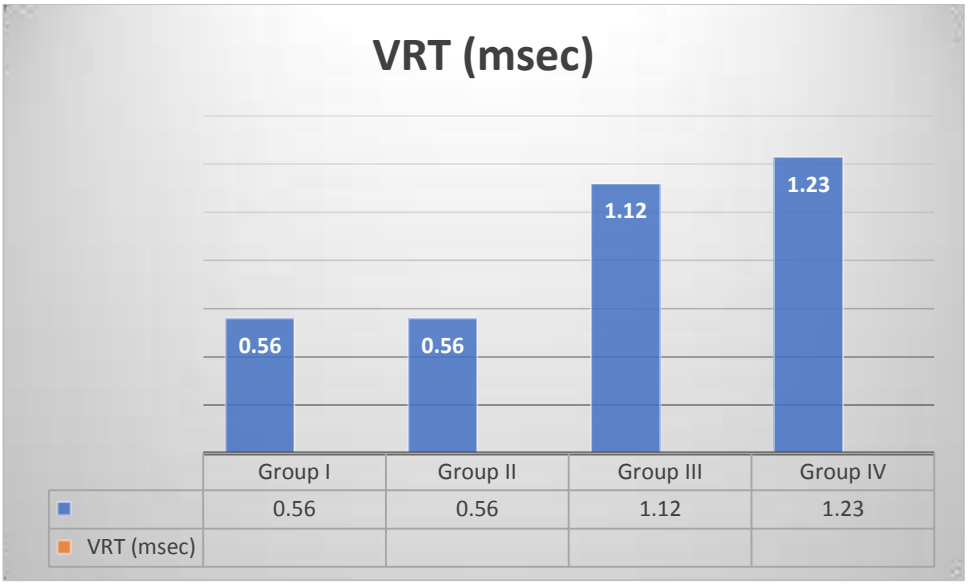

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Table No 6 – Auditory reaction time to high pitched sound in the study population (n =150)

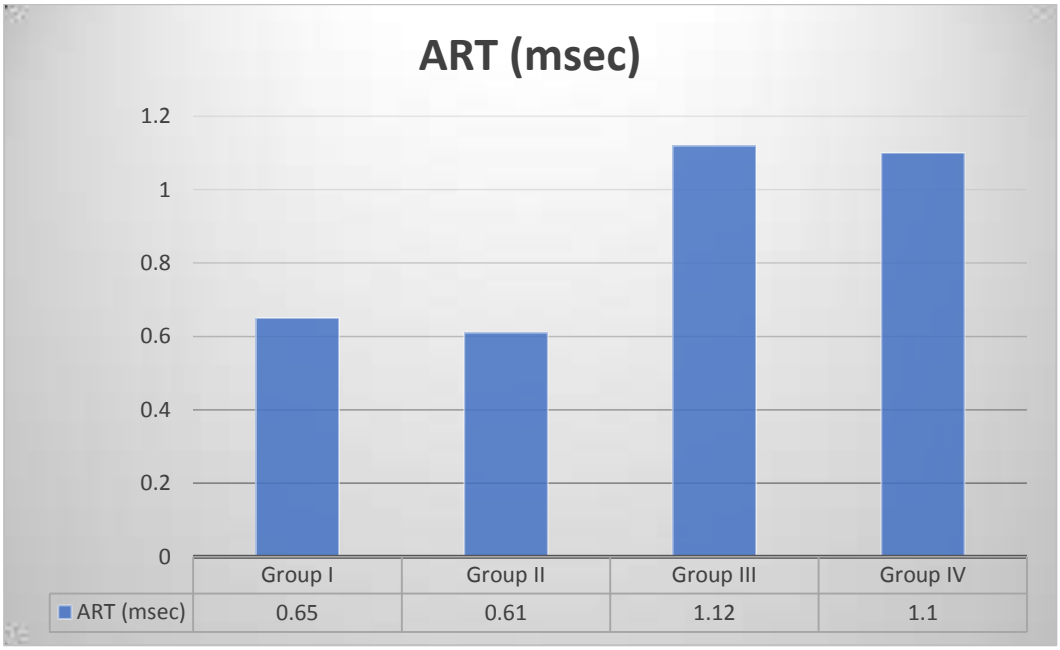
Parameter	Group I	Group II	Group III	Group IV	P value
ART (msec)	0.65 ± 0.24	0.61 ± 0.24	1.12 ± 0.18	1.10 ± 0.19	**<0.0001 (S)**

Footnote- ANOVA with post hoc test was applied

(S) – Significant P<0.05

The auditory reaction time increased from 0.65 ± 0.24ms (group 1) to 1.10 ± 0.19ms (group 4). This increase in the auditory reaction time was found to be statistically significant (p<0.05).

Graph No 6 – Auditory reaction time to high pitched sound in the study population (n =150)



3. DISCUSSION

Reaction Time is the interval between the presentation of the trigger signal and the time of the end of the action, when its measure is taken. It is a measure of function of sensor motor association and performance of an individual. In our study the reaction time for visual and auditory stimuli was considered. Reaction time represents the level of neuromuscular coordination via different physical, chemical, and mechanical processes decodes visual or auditory stimuli which travel via afferent pathways and reach the brain as sensory stimuli. Reaction time is found to be altered by a number of factors both physiological and pharmacological. There is growing evidence that overweight & obesity have been found to be associated with a host of medical conditions, like cardiovascular, pulmonary, and endocrine diseases.

Important criteria in assessing obesity is Body Mass Index. BMI is weight in kilograms divided by height in metre squared. It was developed by Belgian polymath Adolphe Quetelet in the course of working out his systems of “social physics” between 1830 and 1850 (also

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known as Quetelet index). BMI less than 18.5 is under weight and may indicate malnutrition, while a BMI greater than 25 is overweight and above 30 is considered obese. These range boundaries apply to adults over 20 years of age.

Neurophysiological studies have shown that BMI influences cognitive function, attention & memory.[9]This provides a possible physiological explanation for BMI influencing reaction time. Hence, we conducted this study with an effort to assess whether BMI is associated with any alteration of simple auditory & visual reaction time in healthy male students within age group of 18–25 years. With this background we conducted a single centric, prospective, randomized observational study in our hospital physiology department, after obtaining permission from the Institutional Ethics Committee. The study entitled "The effect of Body Mass Index on simple reaction time in young male adults". In this study, we enrolled 150 male students between age group of 18 – 25 years. The results obtained are compared with other studies and discussed below.

Our study population were divided into four groups based on their BMI. Group 1 with a BMI of <18.5, group 2 with a BMI of 18.5 – 22.9, Group 3 with a BMI of >23 and Group 4 with a BMI of >25. The mean BMI in group 1, group 2, group 3 and group 4, were 17.18 ±1.04, 20.90 ± 1.20, 23.62 ± 0.41 and 27.16 ± 1.86, respectively.

In our study population majority of the age group belonged to group 2 (49.33%), followed by group 3 (18.66%), group 1 (17.33%) and group 4 (14.66%). These findings were similar with the study conducted by Sabia et.al.

The mean age of the study population in the group 1 was 19.8 ± 1.13, in group 2 was 20.12 ± 1.20, in group 3 was 20.53 ± 1.34 and in group 4 was 21.27 ± 1.51.

Group 1 had a mean height of 1.72 ± 0.07 metres, group 2 with 3.99 ± 1.90 metres, group 3 with 1.70 ± 0.08 metres and group 4 with 1.73 ± 0.07 metres. The following were the mean weight of the study population in kgs: group 1 - 51.69 ± 5.01, group 2 – 61.98 ± 6.70, group 3 – 68.60 ± 7.03 and group 4 – 82.45 ± 11.49.

In our study population, the visual reaction time and the auditory reaction time were increased in the study population with high BMI. The visual reaction time increased from 0.56 ± 0.16ms (group 1) to 1.23 ± 0.25ms (group 4). This increase in the visual reaction time was found to be statistically significant ($p<0.05$). These findings were in co-ordnance with the study conducted by Deepmala Deore et.al and Bhat N et.al., wherein they found the visual reaction time to be higher in obsess patients.

The auditory reaction time increased from 0.65 ± 0.24ms (group 1) to 1.10 ± 0.19ms (group 4). This increase in the auditory reaction time was found to be statistically significant ($p<0.05$). These findings were resonant with the study conducted by Deepmala Deore et.al in which the auditory reaction time increased from 0.16 ± 0.09ms to 0.17 ± 0.06ms.

The study by Deepmala deore et al revealed that the reaction times were longer for the responses to the auditory stimuli than for the responses to the visual stimuli. The cause of the visual reaction time being greater than the auditory reaction time was not very clear, although almost all of the research which was done on the reaction time had reached the same conclusion. Most likely, it was thought to be due to the fact that the visual reaction time involved chemical changes in its occurrence. Also, the visual pathway involved many

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collateral pathways to various association areas and hence, a greater delay in the comprehension of the visual stimulus, as it was interpreted in a more complex and an elaborate fashion. There was some degree of difference in the type of receptor and the manner in which the receptor got stimulated i.e. the retina versus the organ of corti.

In contrast to the above study mentioned, Shenvi et al.,found that the auditory reaction time was greater than the visual reaction time and they rationalized that the auditory pathway must be more polysynaptic as compared to the visual pathway.

The reaction time is an important component of the motor movements. The reaction time includes the latency in the sensory neural code which traverses the peripheral and the central path- ways, the perceptive and the cognitive processing, a motor signal which traversed both the central and the peripheral neuronal structures and finally, the latency in the end effecter activation i.e. the muscle activation. It is one of the important methods to study a person's central information processing speed and the fast coordinated peripheral movement response.

Gunstad J et al., showed that the younger and the middle-aged adults (age 21-50 yrs) and the obese individuals had a poorer memory performance when they compared persons across the adult lifespan (age 21-82 yrs). They also showed the relationship between the elevated BMI values and the reduced cognitive performance and suggested that this relationship does not vary with age.

Gustafson D. observed that in the elderly, the association between underweight and the cognitive functions was likely to be the result of a preclinical dementia. Our results on the cross-sectional associations between underweight and cognition in the early midlife were consistent with this hypothesis. Underweight could be a result of poor health; a further possibility is that the underweight persons experience a dysregulation in the hormone secretion which corresponds to that in anorexia, which results in cognitive disorders.

In the present study, both ART and VRT were increased in the overweight individuals when they were compared to the values in the normal weight male students, within age group of 18 – 25. It was statistically significant for both ART and VRT. ($p<0.05$).

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