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# Comparison of the effect of caffeine containing energy drink and Glucon D on auditory and visual reaction time

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**ABSTRACT**

*There has been an increase in the consumption of energy drinks in the last decade which raises a concern regarding its safety. Glucose improves information processing and cognition. But research on only glucose containing drink is lacking. In the present study, we evaluated the effect of Red Bull,a caffeine containing energy drink and Glucon D on visual and auditory reaction time in medical students. A total of 30 students,15 boys and 15 girls, in the age group 18 to 22 yrs were recruited for the study after taking approval from the Institutional Ethical Committee. At the beginning, a baseline record of pulse, blood pressure, ART and VRT were taken for all students. The students were given Red Bull and readings were taken after 30 minutes. After an interval of five days the same procedure was repeated with Glucon D. All readings were taken between 10-12 a.m. On comparing the effect of Red Bull on either sex, there was no significant difference. On comparing the effect of the two energy drinks, the p value between the effect of Red Bull and Glucon D on ART was 0.457 and on VRT was 0.314.Both were not statistically significant. There was a significant increase in pulse rate with Red Bull (P=0.036). The mean DBP increased marginally with Red Bull which was not significant (P=0.496).*

**Key words:** Audiovisual Reaction time, Caffeine, Energy Drink, Glucon D, Red bull.

## INTRODUCTION

The development of energy drinks began in 1984 in Austria with popular brand Red Bull. Red Bull claims to enhance concentration, energy levels and reaction time while limiting fatigue[1]. It has psychomotor stimulant properties hence consumed by most college aged students to improve their memory and concentration.

There is a 30% increase in its consumption since 2001. The chronic consumption of energy drinks raises concerns about their safety and health risks. Several studies have shown changes in heart rate and blood pressure to be associated with consumption of energy drinks[2]. Their caloric content leads to the overwhelming problem of obesity and related diseases.

Red Bull is the most popular new age energy drink which is increasing in popularity among teens and young adults, in order to enhance mental performance. The term “energy drink” refers to beverages that contain caffeine in combination with other ingredients like taurine, guarana and B vitamins which provide extra mental and physical energy[3]. Red bull energy drink contains 80 mg caffeine, 1gm taurine, glucoronolactone[600mg], B vitamins,110 calories, 28gms carbohydrates and 27gms of sugar and glucose. Taurine is found in high concentration in skeletal muscles and plays an important role in modulating contractile function. It increases force of generation by enhancing sarcoplasmic reticulum’ s calcium accumulation and release. Glucuronolactone is found naturally in the body as a substance produced by glucose metabolism in the liver. It is a popular ingredient of energy drink and is thought to fight fatigue and provide a sense of well being.[4]

Caffeine users report feelings of increased alertness and enhanced concentration since caffeine decreases reaction time and enhances attentional processing[5].

The reaction time is the time taken to react to unexpected challenges. It involves reception of stimuli by sense organ, conduction of information through nerve to brain and from brain to muscle contraction and movement. Thus it is considered as an index of speed of processing and mental concentration[6]. Since reaction time involves speed and accuracy, it has provided a way to evaluate commonly used psychological tests for attention, concentration and cognitive skills with well proven diagnostic and predictive validity[7].Reaction time depends on age, sex, fatigue, fasting state, sleep and stress.

In order to improve reaction time and concentration, it is estimated that 900,000,000 gallons of energy drinks are consumed throughout the world every day. The caffeine content of a single serving of energy drink can [8-12 floz] ranges from 72 to 150 mg. However many bottles contain 2-3 servings, raising the caffeine content to as high as 294mg/bottle.[3]

Consumption of caffeine in amounts greater than 400 mg is associated with nervousness, irritability, sleeplessness, increased urination and abnormal heart rhythms. Energy drinks also contain other ingredients like guarana and ginseng to enhance the effects of caffeine.1gm of guarana is nearly equal to 40mg of caffeine and increases the total caffeine in an energy drink.

In recent years the marketing of these energy drinks has increased drastically due to their easy availability. Adolescents and young adults are the most vulnerable group who fall prey to these energy drinks especially those in a transitional stage of physical and psychological development. Dependence on energy drinks could be a potential risk of substance abuse later in life[8]. The body develops a tolerance to the positive effect of these energy drinks and not to the negative effects. A number of studies have shown the high consumption rate of these energy drinks among college students and also medical students [9-11]. This shows the lack of awareness among college students and adolescence about the importance of good nutrition and the high caloric and caffeine content of energy drinks.

These energy drinks are normally taken 30 minutes before the start of a task because this is the time required for the ingredients to be effective. Energy drinks and alcohol are sometimes consumed together which can be detrimental.

Glucose present in the energy drink improves information processing. But research showing effect of only glucose on reaction time is lacking. This study compares the difference of effect between caffeine containing energy drink which contains caffeine, taurine, glucose to a drink containing only glucose on auditory and visual reaction time in medical students.

## MATERIALS AND METHODS

In this study 30 Students, 15 males and 15 females in the age group 18 to 22 yrs were recruited after taking approval from the Institutional Ethics committee. Proper informed consent was taken at the start of the study. The study was conducted in the Department of Physiology, MGM Medical College, Navi Mumbai between March 2013 and December 2013.

Data was recorded with a 1000Hz Reaction timer, between 10 am and 12 pm, in order to avoid factors like fasting, fatigue which interfere with the recording of reaction time. Eliminating factors like exam stress was also ensured.

Following criteria were considered:
**Inclusion criteria**:
a. Students with normal sleep patterns.
b. Students who take breakfast everyday.
c. Students without significant medical history.

**Exclusion criteria:**
a. Students who consume alcohol and smoke.
b. Physically handicapped candidates.
c. Students with history of allergy to caffeine or taurine.
d. Students with family history of Diabetes, Hypertension and IHD.

e. Habitual coffee drinkers.

A 250 ml can of energy drink, Red Bull, was administered to consenting students after taking a baseline reading of BP, pulse, auditory and visual reaction time. Half an hour later all the parameters were recorded again.

After a gap of five days, the same students were given 250 ml of Glucon D containing 27 gms glucose. BP, pulse, auditory and visual reaction time were recorded before and half an hour after drinking Glucon D.

While measuring the audio-visual reaction time, the subject and the examiner were seated on either side of the machine, facing, but not able to see each other. The start button was operated by the examiner. The procedure was explained to the subjects before recording the data.

For auditory reaction time, as soon as the examiner pressed the start button, there was a beep, hearing which, the subject had to instantly press the stop button .The time interval between the beep and pressing of stop button was taken as the subject's auditory reaction time. An average of three readings were taken. For visual reaction time, the examiner pressed the start button which flashed a light on the subject's side .On seeing it, instantly, the subject pressed the stop button. The time interval between flashing of light and pressing of stop button was taken as the subject's visual reaction time. An average of three readings were taken.

A comparison between the auditory and visual reaction time after consuming Red Bull and Glucon D was done using paired 't ' test. Also a comparison between the effect of the drinks on either sexes was done using unpaired 't' test. The results were analysed using Statistical Package for Social Sciences(SPSS) 17.0.

## RESULTS

**Table1** shows the baseline values of pulse, blood pressure, ART and VRT before and after administration of Red Bull and Glucon D.

**Table 1**

| **RED BULL** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Pre-test** | | | | **Post-test** | | |
| | Gender | N | Mean | SD | Mean | SD | Pvalue |
| **Pulse** | Male | 15 | 71.429 | 8.074 | 71.929 | 8.526 | .333 |
| | Female | 15 | 66.867 | 5.303 | 75.267 | 9.625 | |
| **DBP** | Male | 15 | 68.286 | 9.343 | 64.857 | 10.007 | ***.006*** |
| | Female | 15 | 73.867 | 6.346 | 74.000 | 6.141 | |
| **SBP** | Male | 15 | 122.143 | 12.315 | 119.143 | 14.201 | .135 |
| | Female | 15 | 108.000 | 8.384 | 112.133 | 10.099 | |
| **ART** | Male | 15 | 89.500 | 39.628 | 45.524 | 15.406 | .514 |
| | Female | 15 | 50.332 | 15.063 | 50.311 | 22.642 | |
| **VRT** | Male | 15 | 96.119 | 36.170 | 57.239 | 17.856 | .437 |
| | Female | 15 | 54.378 | 16.521 | 51.244 | 22.562 | |

| Glucon D | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Pre-test** | | | | **Post-test** | | |
| | Gender | N | Mean | SD | Mean | SD | Pvalue |
| Pulse | Male | 15 | 75.333 | 8.457 | 75.800 | 11.900 | ***.017*** |
| | Female | 15 | 85.733 | 13.014 | 85.600 | 9.140 | |
| DBP | Male | 15 | 68.533 | 7.463 | 67.333 | 8.608 | .662 |
| | Female | 15 | 68.667 | 8.641 | 68.667 | 7.916 | |
| SBP | Male | 15 | 122.933 | 14.180 | 124.933 | 14.420 | .006 |
| | Female | 15 | 113.467 | 13.866 | 110.267 | 12.395 | |
| ART | Male | 15 | 78.090 | 22.097 | 54.288 | 15.821 | .324 |
| | Female | 15 | 60.510 | 13.927 | 48.554 | 15.456 | |
| VRT | Male | 15 | 83.088 | 23.005 | 59.288 | 16.757 | .886 |
| | Female | 15 | 75.979 | 15.319 | 58.467 | 14.152 | |

*SD- Standard Deviation, SBP-Systolic Blood Pressure, DBP-Diastolic Blood Pressure. N=no of students, ART=Auditory reaction time, VRT=Visual reaction time; Level of significance at P<0.05*

**RED BULL**-In **males**, the mean ART decreased (89.500 to 45.524 ms) and the mean VRT decreased ( 96.119 to 57.239 ms). Also, the mean DBP decreased from 68.286 to 64.857mmHg and the mean SBP from 122.143 to 119.143mmHg.In **females**, the mean ART decreased (50.332 to 50.311 ms) and the mean VRT decreased ( 54.378 to 51.244 ms). There was an increase in mean pulse rate from 66.867 to75.267. The mean DBP and SBP increased (73.867 to74.00 mmHg) and (108.000 to 112.133 mmHg) respectively. On comparing the effect of Red Bull between males and females, there was no significant difference between the ART (p=0.514) and VRT (p=0.437).

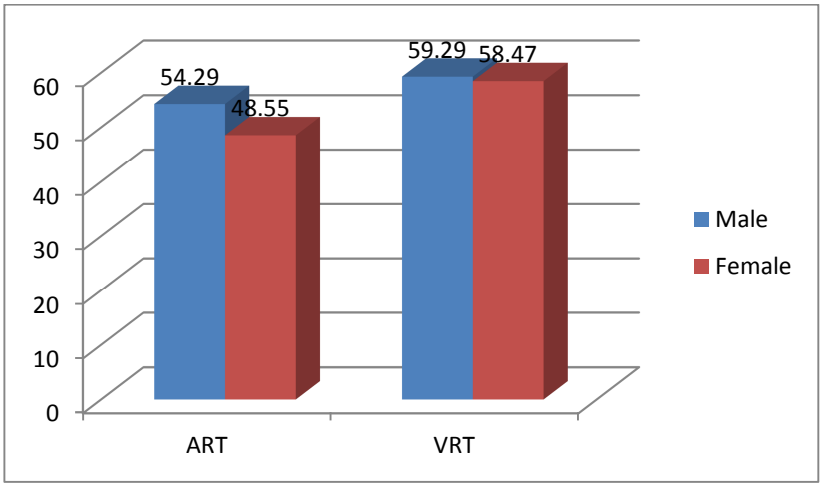
**GLUCON D**- In **males**, the mean ART decreased (78.090 to 54.288 ms) and the mean VRT decreased (83.088 to 59.288 ms). The mean DBP decreased marginally (68.533 to 67.333mmHg) and the mean SBP increased(122.933 to 124.933mmHg). In **females**,the mean ART decreased ( 60.510 to 48.554 ms) and the mean VRT decreased (75.979 to 58.467 ms).

**Table2** shows the group statistics of Glucon D and Red Bull

**Table2 Group Statistics (Glucon D) and Red Bull**

| | GluconD | | | | | Red Bull | | |
|---|---|---|---|---|---|---|---|---|
| | Group | N | Mean | SD | P value | Mean | SD | P value |
| Pulse | Pre-test | 30 | 80.533 | 12.011 | .957 | 69.069 | 7.050 | ***.036*** |
| | Post-test | 30 | 80.700 | 11.555 | | 73.655 | 9.108 | |
| DBP | Pre-test | 30 | 68.600 | 7.933 | .774 | 71.172 | 8.290 | .496 |
| | Post-test | 30 | 68.000 | 8.154 | | 69.586 | 9.326 | |
| SBP | Pre-test | 30 | 118.200 | 14.597 | .876 | 114.828 | 12.542 | .835 |
| | Post-test | 30 | 117.600 | 15.172 | | 115.517 | 12.543 | |
| ART | Pre-test | 30 | 69.300 | 20.231 | ***.000*** | 69.241 | 35.204 | ***.006*** |
| | Post-test | 30 | 51.421 | 15.642 | | 48.000 | 19.299 | |
| VRT | Pre-test | 30 | 79.533 | 19.541 | ***.000*** | 74.529 | 34.561 | ***.008*** |
| | Post-test | 30 | 58.878 | 15.245 | | 54.138 | 20.294 | |

**Figure1**




*ART P=0.457*
*VRT P=0.314*

**Glucon D**-There was no significant change in mean pulse, SBP and DBP before and after administering Glucon D drink. There was a significant decrease in mean ART from 69.3 to 51.4 ms (P=0.000) and mean VRT from 79.5 to 58.88 ms (P=0.000) after taking Glucon D.

**Red Bull**-There was a significant increase in mean pulse rate from 69.069 to73.66 per min (P=0.036) but no significant change in mean SBP(P=0.835) and DBP(P=0.496) after giving Red Bull. There was a significant reduction in mean ART from 69.24 to 48ms (P=0.006) and mean VRT from 74.53 to 54.14ms (P=0.008).

**Figure 1** shows the comparison of the effects of **Red Bull** and **Glucon D** on ART and VRT. The P value of ART between either drinks was 0.457 and the P value of VRT between either drinks was 0.314.Both were statistically not significant.

## DISCUSSION

In the present study, the decrease in the ART and VRT in males and females after consumption of Red Bull was similar to the findings that energy drinks reduce fatigue and improve reaction time[12].Red Bull has also shown to improve driving performance, mood, short term memory and concentration. The decrease was more in males as compared to females but not statistically significant. The difference in the reaction time between males and females is consistent with other studies.

In a study , the simple and choice reaction time in boys was found to be less than that in girls[13]. A number of studies have supported this finding [14,15]. Males generally have a shorter reaction time as compared to females. This could be explained by the varying levels of sex steroids during different phases of the menstrual cycle. But a study by Shenvi and Balasubramaniam had contradictory findings and showed that the ART and VRT was less in males than in females[16].

The effect of Red Bull on reaction time is due to the presence of caffeine. Caffeine is known to improve cognitive function by blocking neurotransmitters. Adenosine is the main neurotransmitter affected by caffeine. The popular hypothesis on the interaction between caffeine and adenosine is that adenosine binds to adenosine receptors which allows the excitatory neurotransmitters dopamine and glutamate to increase activity of the CNS and blocking inhibition from adenosine[17]. The molecular mechanism is by increasing cAMP concentration. Studies have shown that caffeine has an inotrophic effect on the body , improves endurance and increases epinephrine, plasma lactate, cortisol and Beta endorphins[2].

Taurine is naturally produced in the body. It is found in bile, urine,fluid of muscle ,lungs and nerve tissue. It also works in electrically active tissues such as the brain and heart to stabilize cell membranes[18]. Taurine is known to increase force generation by increasing Ca accumulation and release.

Endogenous taurine levels are crucial to maintain muscle contraction. However, there is no definitive study showing the increase in taurine level following absorption and intracellular taurine level is critically regulated. Studies in rat brain indicate that Na Cl dependent taurine transporters exist in the blood brain barrier which are in turn dependent on the degree of cell damage, osmolarity. Therefore, under normal circumstances, taurine levels within brain are maintained at stable level. An increase in dietary taurine plasma level is unlikely to cause sudden influx of taurine into the brain. Hence, while caffeine can readily diffuse across blood brain barrier, taurine entry is a stringently controlled process[19]. Glucoronolactone is a normal human metabolite formed from glucose. It is a precursor to taurine and is physiologically inactive. It is converted to taurine through a chemical process. When glucoronolactone is administered to humans it is rapidly absorbed, metabolized and excreted as glucaric acid , xylitol and L-xylulose. Rodents can synthesize vitamin C from glucoronic acid but primates including man do not possess this metabolic pathway[20].

A number of studies also prove that the effect of ART and VRT is due to the result of the reversal of the caffeine withdrawal in habitual coffee drinkers[21]. But in the present study, this theory doesn't explain the decrease in reaction time as we had excluded habitual coffee drinkers. Tolerance to caffeine develops easily. When this occurs, one is tempted to consume more of these drugs in order to enjoy the positive effects[22].Red Bull contains the same amount of caffeine as a cup of coffee(80mg)but coffee is ingested over a long period than Red Bull. Drinking Red Bull brings large doses of caffeine in a short time thereby sharply increasing plasma caffeine concentration along with the pscychomotor effect of having consumed an energy drink.

Students should be counseled regarding the consumption of energy drinks like Red Bull and Monster energy drinks which contain a high amount of caffeine and have poor nutritive value.This increased caffeine consumption serves as a gateway for drug abuse later in life.In the present study, the increase in BP after consumption of Red Bull was more in females than in males.

Caffeine increases heart rate and blood pressure through the release of epinephrine. Energy drinks generally contain more than the recommended amount of potentially harmful chemicals. The Food and Drug Administration (FDA) regulates the amount of caffeine in sodas and other caffeinated drinks but not in energy drinks. Energy drinks are often combined with alcohol. They improve only response execution and not response inhibition. This explains the hazards of combining an energy drink with alcohol as the energy drinks counteract the sedation associated with drinking. They contain a high amount of caffeine and have poor nutritive value.

In this study the ART and VRT reduced after consumption of glucose. The increase in blood level of glucose is generally observed 30 minutes after ingestion. Glucose is known to stimulate the release of insulin from the pancreas. Elevated blood glucose levels and consumption of food is also associated with increase in Acetyl CoA which is a precursor of acetylcholine. Acetylcholine is known to stimulate the central nervous system as well peripheral nervous system thus affecting the reaction time. Glucose is also known to improve cognitive function and memory through increase in acetylcholine levels[17].A study by Owen and Sunram –Lea, showed that even 25gms of glucose is sufficient to improve working memory[23]. This shows that even the 26.75gms of glucose present in a 250ml can of Red Bull is sufficient to cause an improvement in cognition and reaction time. However, Glucon D does not produce an increase in blood pressure.

On comparing the effects of Red Bull with Glucon D, the effect on VRT was same with both drinks. The effect on ART was more with Red Bull than Glucon D but not significant. This could be because of the combined effect of caffeine and glucose in Red Bull.

In a study by Scholey and Kennedy, the combined effects of caffeine and glucose had a greater effect on reaction time than either constituent alone[24].In this study, Glucon-D did not cause a significant increase in pulse and blood pressure .Thus energy drinks with only glucose have an edge over Red Bull as it is free from the effects on the cardiovascular and nervous system.

One has to outweigh the benefits and hazards of consuming an energy drink before consuming it in high amounts which raises concerns about its safety. Energy drinks also contain taurine and glucuronolactone which do not directly affect reaction time but may alter it in combination. Therefore consuming these ingredients in excess also raises concern regarding their toxicity. An ideal energy drink should have the lowest amount of caffeine and sugar while still accomplishing the needed results without addiction. Further research needs to be done to evaluate the effects of the individual components of energy drinks like taurine and glucuronolactone. Well designed randomized placebo controlled studies are needed to assess the benefits of an energy drink.

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