The Effects of Gum Mastication on Alertness in Post-Pubescent Subjects

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Abstract

This experiment was an investigation into the effects of gum mastication on alertness in post-pubescent individuals. Tests were designed to see if gum had a significant effect on alertness by increasing several measurable variables including: reaction time, blood pressure, heart rate and short term memory. This study was carried out by using three separate groups, each consisting of five individuals. Each individual's baseline measurements were first recorded. Subjects were then exposed to their respective variables: sitting in a chair in sensory deprivation, riding on a stationary bike, or chewing gum. The individuals engaging in light cardiovascular activity were the positive control group as it is a well-established fact that exercise will lead to increases in all variables being measuring (Pontifex, et al. 2009). Subjects remaining sedentary between their readings were the negative control group, and no physiological changes were expected. Our testing was unable to establish a significant effect on alertness by chewing gum. However, we were also unable to demonstrate an increase in alertness among those in the positive control group. As this correlation has been previously proven to exist and we could not establish it in our experiment, it is unreasonable to rule gum mastication out as a stimulator of alertness. The biggest setback to obtaining any kind of significant results was the lack of subjects being tested. Even with results leaning towards gum mastication having an effect on alertness, it would be nearly impossible to establish significant findings on the matter with a study of fifteen people.

Keywords: mastication, alertness, gum, memory, reaction time

Introduction

Mental alertness can be defined as the ability to maintain attention, and focus on a given activity. The aim of this experiment was to establish whether gum chewing can have a significant effect on mental alertness; this topic is physiologically relevant due to gum's high accessibility, ease of use and relevance in a classroom setting. If a positive correlation is found between gum chewing and increased mental alertness, students could use it to increase their ability to focus and learn during lectures or other periods of study. Previous research has shown that mental alertness is directly related to cerebral blood flow. Additionally, an increase in blood pressure has also been positively correlated with an increase in cerebral blood flow, suggesting that blood pressure could be used as an indicator of alertness level (Jessell et al., 2000, p. 1305). Several other studies have shown that gum chewing may lead to an increase in mental acuity through enhanced blood flow to the prefrontal neural tissues brought on by the mastication of gum. (Fang et al., 2005) (Onozuka et al., 2002) In addition, Hasegawa and colleagues (2007) found that mastication increased overall cerebral blood flow and heart rate in tested subjects, suggesting that increased heart rate could also indicate a higher level of mental alertness. From these studies, the correlation that chewing gum increases cerebral blood flow and brain activity can be inferred, and therefore the overall mental alertness of the individual.

Mental alertness could also be determined through the use of cognitive tests that measure reaction time and working memory. It was expected that there would be a greater margin of improvement among subjects that have chewed gum than those who have not on cognitive tests. Experiments on negative and positive control and experimental groups will be performed to answer this question. In the positive control group, subjects performed light aerobic exercise by pedaling on an exercise bike. It was expected that positive control subjects will show an increase in alertness, as it is well known that exercise will increase heart rate, and blood pressure. A study in 2009 by Pontifex and Hillman found that exercise is directly correlated to a decrease in reaction time, and a temporary increase in working memory. This suggests that aerobic exercise could be a suitable positive control for mental alertness. For the negative control, sensory deprivation will be used and it is expected that these individuals will show low levels of alertness due to lower overall input to the reticular activating system (RAS) in the brainstem, which normally increases alertness with higher activity (Sherwood, 2006). The experimental group chewed gum and it was expected that these subjects will show test results that correlate with higher mental alertness. Based on the study that was performed, the experimental results show that chewing gum does not significantly improve mental alertness. Overall, there were no significant differences between the control group and the experimental group.

Methods

Before participating in any of the experiments subjects filled out a survey, establishing their baseline gum-chewing, caffeine consumption and athletic/physical activity levels. Subjects also signed a consent form. Subjects were asked not to chew gum for at least 20 minutes before participating.

Our experiment consisted of two sets of five measurements, which included: heart rate, oxygen saturation percentage, blood pressure, a computer based reaction time test (Top End Sports) and a computer based short term memory test. The short term memory test came from the Funbrain website (Pearson Education, 2011) with the settings: animal images, medium difficulty. A collection of baseline data was performed before subjects were exposed to their experimental conditions in order to establish each subject's resting/normal physiology.

After their baseline assessments, subjects were submitted to one of three experimental conditions for 15 minutes; either negative control, experimental or positive control conditions. Subjects undergoing the negative control were submitted to a sensory deprivation treatment by wearing noise cancelling headphones and keeping their eyes closed for the duration of the experiment. Subjects undergoing the experimental control condition were required to chew gum while wearing noise blocking headphones and keeping their eyes closed. Finally, positive control subjects were asked to perform light aerobic exercise on a stationary bike for 15 minutes.

Following their experimental treatment, a second set of measurements was recorded. The difference between the baseline and post-experimental measurements will be used to determine if there is a statistically significant difference physiologically in gum chewers.

Heart rate and oxygen saturation levels were recorded using a digital fingertip monitor. Blood pressure was recorded manually by two people using a teaching stethoscope and sphygmomanometer. The average of ten reaction time measuring trials were recorded based off of the website game. This website measures the time it took participants to click on a button after the screen changes colors at a random time interval. The length of time and number of turns needed to complete the game was recorded. This game is an online version of the children's game memory in which subjects flip over digital card to see if the image on the back side matches. Each flip of a pair of cards was considered a turn. The game is over when all matches have been made.

Results

Results were recorded in tables, as seen in Appendix 1, and entered into Excel. Using Excel we ran single factor ANOVA analysis (Appendix 2) comparing the positive control, experimental and negative control groups for each of the measurements.

There was great variance of results within test groups. Between test groups no statistically significant p-values were found by single factor ANOVA analysis, indicating that any variance was not significant.

Figure 1 (Appendix 1) shows a comparison of the change in the average reaction test time between test groups. Group 1 is the negative control group, group 2 is the experimental group and group 3 is the positive control group. Only the experimental group showed improvement in reaction test times.

Discussion

The first problem we encountered before data collection had even begun was the implementation of the EEG. It was difficult to test overall brain activity because mastication would create artifacts in the readings, making them uninterpretable. It was also very difficult to glean any information from even baseline readings as there were large amounts of background noise, even when subjects were sitting completely still. Also, as no one in our research group was trained in reading EEGs, subtle differences would have been extremely difficult to find. These factors, in addition to the large amount of time a single EEG takes to run, and the discomfort imposed on the subjects by the electrodes led us to decide to remove the EEG test from the experiment. Loss of the EEG is unfortunate, as it would have been the most direct way to measure a change in mental alertness or overall brain activity. Further studies should include a team member who is well versed in the operation and interpretation of EEG.

Another problem was determining whether light aerobic exercise/calisthenics or caffeinated beverages would be best to use as the positive control condition. There was a conflict in the literature researched as to whether exercise or caffeine would serve as the better stimulating agent for a short time period (15 minutes in our experiment). We decided to use exercise in our study, as based on the research, it should have definitively changed the physiological parameters we measured. However, in our results there was not a significant change to these values. More strenuous exercise may have been needed to obtain the results necessary to make exercise a true positive control.

As stated in the results, no significant findings were made during the course of our study. This is likely due to the small sample size available for us to collect data from. As there were only five subjects in each of the three groups tested, a single outlier could have easily skewed any potential findings. Repeating this experiment on a larger scale would be necessary to obtain any kind of meaningful results. Testing a larger group of subjects would diminish the effects of a single outlier and provide a better representation of the general population. The procedure used in this experiment was simple and is easily reproducible. The equipment needed was simple, easy to use and readily available in most laboratory settings.

Although no significant findings indicated that the mastication of gum increases mental alertness, due to the small population tested in this study, it cannot be ruled out either. We believe that researching this question using a much larger sample size would be both more conclusive and potentially beneficial to students.

Appendix 1

Negative Control Group

Before

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Blood Pressure	110/60	130/65	124/82	120/78	114/74
Heart Rate	54	64	72	69	74
Reaction Time (avg.)	.3543	.300	.283	.337	.365
Memory Test	2 min 46 sec (27 turns)	1 min 7 sec (13 turns)	1 min 16 sec (14 turns)	1 min 7 sec (14 turns)	1 min 15 sec (13 turns)

After

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Blood Pressure	100/60	130/80	124/83	124/80	124/70
Heart Rate	61	67	75	57	70
Reaction Time (avg.) sec	.3532	.335	.310	.335	.377
Memory Test	1 min 45 sec (19 turns)	41 sec (11 turns)	56 sec (12 turns)	1 min 4 sec (14 turns)	1 min 11 sec (13 turns)

Experimental Group

Before

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Blood Pressure	120/60	125/90	122/76	112/74	102/62
Heart Rate	61	80	86	77	88
Reaction Time (avg.)	.327	.36	.40	.324	.323
Memory Test	1 min 18 sec (17 turns)	1 min 13 sec (16 turns)	1 min 10 sec (14 turns)	1 min 31 sec (20 turns)	1 min 3 sec (14 turns)

After

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5

Blood Pressure	125/70	120/80	120/76	112/74	104/66
Heart Rate	68	76	84	76	97
Reaction Time (avg.) sec	.30	.38	.339	.334	.29
Memory Test	1 min 13 sec (20 turns)	58 sec (13 turns)	58 sec (12 turns)	1 min 18 sec (16 turns)	55 sec (14 turns)

Positive Control Group

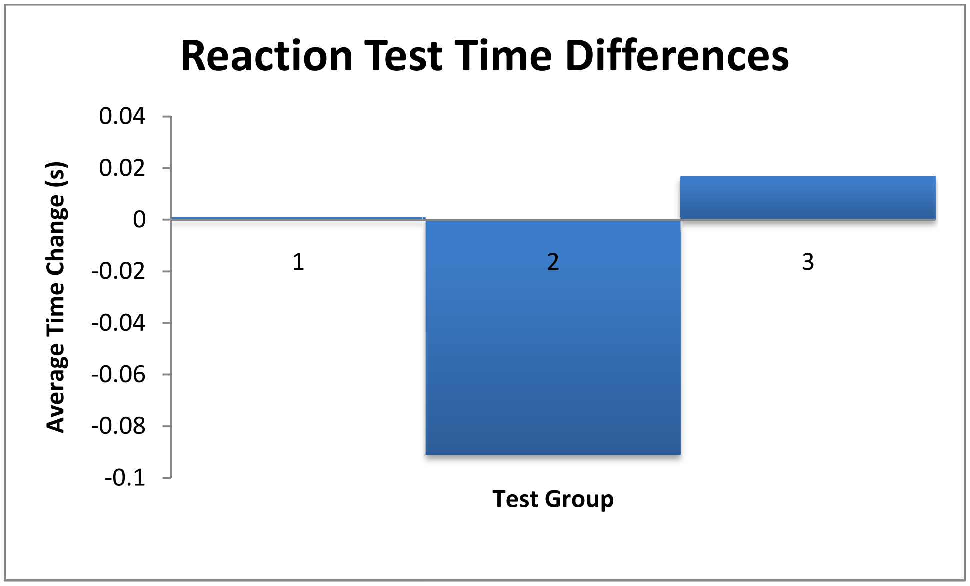
Before

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Blood Pressure	132/90	134/76	124/86	124/80	134/66
Heart Rate	85	78	95	65	82
Reaction Time (avg.)	.286	.282	.340	.306	.289
Memory Test	1 min 48 sec (18 turns)	1 min 28 sec (22 turns)	1 min 24 sec (17 turns)	2 min 18 sec (30 turns)	1 min 9 sec (16 turns)

After

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
Blood Pressure	134/84	128/86	128/82	124/80	140/82
Heart Rate	86	74	124	73	88
Reaction Time (avg.) sec	.285	.304	.369	0.295	.335
Memory Test	1 min 24 sec (13 turns)	1 min 8 sec (19 turns)	1 min 36 sec (21 turns)	1 min 32 sec (21 turns)	56 sec (15 turns)

Figure 1


Reaction Test Time Differences
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
Average Time Change (s)
1
2
3
Test Group

Appendix 2

Anova: Single Factor Systolic BP

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	5	4	0.8	53.2
Column 2	5	0	0	14.5
Column 3	5	6	1.2	21.2

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.733333	2	1.866667	0.062992	0.939259	3.885294
Within Groups	355.6	12	29.63333			
Total	359.3333	14				

Anova: Single Factor Diastolic BP

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	5	14	2.8	51.7
Column 2	5	4	0.8	53.2
Column 3	5	16	3.2	89.2

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	16.53333	2	8.266667	0.127769	0.881238	3.885294
Within Groups	776.4	12	64.7			
Total	792.9333	14				

Anova: Single Factor Heart Rate

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	5	-3	-0.6	56.3
Column 2	5	9	1.8	33.7
Column 3	5	40	8	159.5

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	196.9333	2	98.46667	1.183968	0.339407	3.885294
Within Groups	998	12	83.16667			
Total	1194.933	14				

Anova: Single Factor Reaction Time Average

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	5	0.0009	0.00018	0.00052 6
Column 2	5	-0.091	-0.0182	0.00109 6
Column 3	5	0.085	0.017	0.00053

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.0031	2	0.00155	2.16156 4	0.157858	3.885294
Within Groups	0.008604	12	0.00071 7			
Total	0.011703	14				

Anova: Single Factor Memory Test Time

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	5	-114	-22.8	555.7
Column 2	5	-53	-10.6	16.3
Column 3	5	-91	-18.2	437.2

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	379.6	2	189.8	0.56420 9	0.583194	3.885294
Within Groups	4036.8	12	336.4			
Total	4416.4	14				

	Memory Test
Anova: Single Factor	Turns

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	-12	-2.4	10.8
Column 2	5	-6	-1.2	7.7
Column 3	5	-14	-2.8	23.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6.933333	2	3.46666 7	0.2494	0.783208	3.885294
Within Groups	166.8	12	13.9			
Total	173.7333	14				

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