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Effects of peppermint, chewing gum on memory, cognition, alertness, reaction time, arithmetic skills and athletic performance during laboratory induced stress in undergraduate medical students

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ABSTRACT

Background: Many medical students are dealing with day to day stress in their lives and they need to be both physically and mentally active to counter and overcome their daily problems. In such scenario, a non-pharmacological adjunct could prove useful to counter all of it so that they can work more efficiently. Many universities do recommend the use of peppermints and chewing gums. This study is conducted to see if any of these items actually have an influence on cognitive and physical abilities.

Methods: A non-randomized controlled trial was performed on the undergraduate medical students of N.K.P. Salve Institute of Medical Sciences and Research Centre belonging to the age group of 18-21 years. They were given normal flavoured gum, mint flavoured gum and peppermint. A series of cognitive and physiological tests in both stressful and stress free environments were performed.

Results: Consumption of peppermint in a stressful environment showed increase in attention span of the subjects and it increased the intelligence Wechsler Adult Intelligence Scale-R (WAIS-R) in both stress free and stressful environments. As compared to normal gum, peppermint and peppermint gum proved to be more effective. There was no significant change observed in alertness, reaction time, arithmetic ability, short term memory and fatigue index in any of the subjects.

Conclusions: Peppermint has caused increase in the attention span and intelligence of medical students in a stressful work scenario. Peppermint gum was found to be more beneficial than normal gum.

Keywords: Cognitive skills, Peppermint gum, Psychomotor, Stressful environment

INTRODUCTION

Most students have to undergo a lot of physical and mental strain on a daily basis. Occupational stress is common in medical students both during and after work hours. Considering the health scenario of our country most of the students need to stay alert and attentive all the time. Reliance on pharmacological drugs to counter stress and increase cognitive function has its side effects and is not a long term solution to our problem. Switching to a non-pharmacological adjunct can be beneficial and there are no major side effects and can be used for long durations.

Sucking on gum directly rather than eating will help in its absorption in the superior labial veins that are directly communicating with the venous sinuses in cerebrum.[1] As the major content of drug is glucose so the brain gets a direct supply of glucose bypassing the first pass metabolism of liver. Angiography studies also reveal that mastication improves the circulation in brain and may lead to increase in oxygen supply to brain Thus the brain will function more efficiently if given a proper dose and route of administration.[2-4] Flavouring agents like peppermint do impart a taste and act on the reward centres in the limbic system.[5] A good fragrance and taste also leads to reflex

bronchodilation thus improving exercise potential and physical swiftness of an individual.[6]

In many universities it has been recommended that use of peppermint and chewing gum can be used as a remedy. To this day it remains a point of controversy as many studies have been conducted to study its effects on animals as well as humans but most remain inconclusive.

Studies show that consumption of peppermint gum increases alertness, attention span and lowers reaction time.[7,8] There is also increase in cognitive skills, short term memory and arithmetic skills along with fall in stress due to change in salivary cortisol levels.[9-11] On the contrary some other studies show that there is a decreased attention and increased reaction time.[12] Also subjects had a fall in cognitive skills and short term memory.[13] Some studies also showed fall in basic arithmetic skills and increase in stress levels of subjects.[14, 15]

Effect of peppermint consumption on overall physical fitness was seen in some studies and it had positive results while in some cases it remained unaltered.

As mentioned above most of studies show mixed results. This may be due to inconsistency in study parameters, route, duration and dose of administration and study group. This study focuses on a specific study group and studies all the parameters evenly to compare and calculate the results of action of different substances via a single route, having a fixed dose and duration of administration to conclude a generalized result for the above studies.

METHODS

This is a non-randomized controlled trial conducted at N.K.P. Salve Institute of Medical Sciences and Research Centre, Nagpur. Permission of Institutional Ethics Committee was taken prior to the study and the drug did not show any adverse effects and was perfectly safe for our study group. 10 (5 male and 5 female) undergraduate medical students were selected as it was a pilot study.

Inclusion criteria

- Volunteers belonging to age group of 18-21 years
- Volunteers studying in undergraduate medical courses.
- Volunteers willing to take part in this study.

Exclusion criteria

- Volunteers with oral disorders, diabetes, neurological, hematological, respiratory and cardiac disorders.
- Volunteers who have habit of smoking, tobacco, alcohol and caffeine consumption or any other health hazardous habits

Table 1: Drug contents.

Sr. no.	Drug	Energy	Carbohydrates	Fats	Proteins
1	Peppermint	241 kcal	97 g	1 g	0 g
2	Normal flavoured gum	166 kcal	69.3 g	0 g	0 g
3	Mint flavoured gum	165 kcal	68.8 g	0 g	0 g

Procedure

A written consent was taken from all the participants. All the participants were made relaxed and comfortable and given a total of 7 neuropsychological tests each assessing a specific brain function. This involved:

Stanford sleepiness scale

A test providing self-rated alertness by the subject on a rating table where detailed information regarding the predefined levels of alertness as mentioned below.[7]

Click reaction time test

This is a test designed by the Washington University where the subjects had to tap on the screen of their mobile phones as after a visual cue provided on screen.[5] The time interval between appearance of cue and response of subject was recorded in seconds by the computer program.[16]

An average of 3 consecutive readings was considered as the reaction time of the individual.

Arithmetic ability test

The subjects were given software generated random two digit addition/subtraction problems and the accuracy of problem solving was calculated by the program.[11,16]

Standard digit vigilance test

From a list of randomized digits, the subjects were told to cancel out a certain digit from the given list in 30 seconds.

The ratio of frequency of a digit detected by the subjects to the frequency of a digit actually present was calculated.[5,14]

Digit symbol substitution test (Wechsler Adult Intelligence Scale-R)

The subjects were initially given a coding scheme where each digit was designated a specific symbol.[17] They were told to substitute the digit with a symbol according to the given coding scheme. The frequency of the digits they were able to replace within 30 seconds was recorded.

Digit span test

For this, the subjects were shown a series of random digits on their mobile screens for 10 seconds and then were told to recall and arrange the digits in ascending order.[13, 16] If completed successfully, the number of digits in sequence was increased by one and the subjects had to perform this test all over again with increase in the number of digits after every turn. The maximum number of digits they were able to get in a correct was the limit of their immediate number recall and proved as a measure of their short term memory..

Then after taking proper rest to see the changes in exercise physiology they performed

Harvard step test

The subjects had to step up and down on 20 inch (male) and 18 inch (female) tall bench at the rate of 30 times per minute for 4 minutes. Time duration was noted if the person exhausted earlier. The subject was asked to sit immediately and the pulse rate was measured at 1.5, 2.5, 3.5 minute intervals. Then fatigue index was calculated using the formula:

Fatigue index:

$$= \frac{\text{duration of exercise in seconds}}{2 \times (\text{sum of pulse counts during recovery})} \times 100$$

An external noise of 75 dba was introduced in the environment to induce stress in the participants.[7] All the aforementioned tests were repeated in the stressed environment. On the first day, the participants did not consume anything and this served as control. Over next 3 days they were given peppermint, normal flavoured gum and mint flavoured gum one item each day respectively and the changes in the performance of aforementioned tests was noted after allowing the participants to consume the respective item for 5 minutes prior to the beginning of study. Vital signs like pulse rate, pO2 (in left index finger), blood pressure (in left arm in sitting position) was noted daily in stressed and non-stressed condition.[18]

Statistical analysis

Data was analysed with the help of MS Excel and EPI Info Software version 7.2.2.2 and T test was applied and p value less than 0.05 were considered significant. Comparison was done between different groups and before and after drug consumption.

RESULTS

On analysis of the subjects based on the aforementioned cognitive functions, following results were obtained based on each function.

Alertness (Stanford Sleepiness Scale)

There was no significant change observed in the levels of alertness of any of the candidates in each of the groups as compared to control as the p values are >0.05 (Table 2).

Table 2: Alertness.

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	3	3	2	3	2	2	3	3
2	F	2	1	1	1	2	2	2	1
3	M	3	3	2	2	2	2	2	2
4	F	3	4	3	5	3	3	6	6
5	M	3	2	2	2	2	2	3	2
6	F	3	2	4	3	5	2	6	4
7	M	8	1	1	2	5	3	3	4
8	F	5	3	7	9	6	6	6	7
9	M	2	1	3	5	3	2	1	1
10	F	2	2	6	6	3	6	6	5
P value				0.819101	0.072971	1	0.151749	0.646541	0.093115

Table 3: Reaction time.

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	0.421	0.421	0.361	0.389	0.387	0.354	0.378	0.406
2	F	0.479	0.391	0.418	0.386	0.424	0.447	0.417	0.362
3	M	0.301	0.318	0.273	0.824	0.241	1.924	0.93	0.31
4	F	0.517	0.448	0.429	0.404	0.362	0.505	0.316	0.455
5	M	0.365	0.363	0.399	0.4	0.95	0.358	0.382	0.343
6	F	1	0.95	0.401	0.383	1.209	1.045	0.357	0.354
7	M	0.631	0.338	0.399	0.38	0.37	0.418	0.363	0.387
8	F	0.413	0.421	0.414	0.429	0.415	0.402	0.415	0.439
9	M	0.35	0.32	0.372	0.36	0.393	0.337	0.337	0.369
10	F	0.491	0.77	0.449	0.513	0.523	0.427	0.44	0.513
p value				0.146371	0.738737	0.770978	0.402902	0.496511	0.266

Reaction time (in seconds according to click reaction time test)

The reaction time taken according to Washington click reaction test showed no significant change when compared to control in both normal and stressed conditions (p>0.05) (Table 3).

Attention span (Standard Digit Vigilance Test)

There was a significant rise in attention span of the subjects on consumption of peppermint in a stressful environment (p<0.05). But no such change was observed in other scenarios when compared to control (p>0.05) (Table 4).

Table 4: Attention span.

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	0.1925	0.926	0.1	0.1334	0.1875	0.1852	0.1956	0.1852
2	F	0.2021	0.2407	0.1334	0.2	0.2447	0.3823	0.2282	0.2037
3	M	0.2021	0.1852	0.1	0.1334	0.1808	0.1273	0.163	0.2234
4	F	0.2765	0.3889	0.2625	0.1563	0.1945	0.4629	0.7059	0.2362
5	M	0.1915	0.1852	0.1	0.2021	0.1597	0.1481	0.1956	0.1852
6	F	0.2276	0.4445	0.2	0.2592	0.4118	0.2872	0.3152	0.4259
7	M	0.2234	0.3518	0.1667	0.2553	0.1945	0.2037	0.2065	0.2778
8	F	0.1702	0.1852	0.1334	0.1915	0.1702	0.2353	0.1848	0.2234
9	M	0.2253	0.2407	0.1667	0.2	0.1945	0.2592	0.2174	0.2778
10	F	0.2659	0.4259	0.3125	0.2687	0.5	0.2078	0.3529	0.2014
P value				0.061765	0.043895	0.502162	0.186259	0.276306	0.145282

Table 5: Intelligence (WAIS-R).

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	9	13	18	22	22	20	22	20
2	F	14	22	21	26	26	27	26	30
3	M	15	20	17	20	18	19	20	25
4	F	12	14	18	19	20	19	21	19
5	M	17	20	18	16	23	20	23	22
6	F	14	19	17	17	20	15	16	20
7	M	11	12	15	15	18	13	18	29
8	F	11	15	18	19	26	20	28	18
9	M	16	17	18	21	24	20	23	23
10	F	12	21	21	21	20	21	15	18
P value				0.000232	0.341866	0.533218	0.384114	0.000274	0.020351

Intelligence (Digit Symbol Substitution Test WAIS-R)

On consumption of peppermint gum there was a significant increase seen in the intelligence of the subjects in a stress free environment and stressful environments but peppermint only increased it in stress free environment (p<0.05).

Normal gum has no effect whatsoever on the results of WAIS-R test (Table 5).

Table 6: Arithmetic ability.

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	1	1	1	0.8	1	0.916	1	0.909
2	F	1	0.936	0.937	1	1	0.934	0.889	0.882
3	M	0.723	1	1	0.857	1	0.909	0.909	1
4	F	1	0.9123	0.8125	0.9231	0.8823	0.9473	0.7418	0.7727
5	M	1	0.889	0.945	0.909	0.933	0.923	0.916	0.846
6	F	0.387	0.353	0.85	0.8667	1	0.875	1	0.9473
7	M	0.875	0.857	1	1	1	1	0.909	1
8	F	1	0.923	1	1	1	0.846	0.857	0.937
9	M	1	1	1	0.928	0.928	0.913	0.789	0.619
10	F	0.889	0.923	0.928	1	1	0.947	1	1
P value				0.372658	0.281539	0.188366	0.422302	0.84067	0.769501

Table 7: Short term memory.

Sr No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	11	9	11	10	10	7	11	12
2	F	11	12	10	11	10	9	12	12
3	M	7	5	6	8	9	8	9	9
4	F	6	7	7	10	8	10	8	9
5	M	10	9	10	10	10	10	10	9
6	F	10	11	7	7	8	7	9	9
7	M	9	8	11	11	13	9	11	8
8	F	1	9	10	10	9	10	12	9
9	M	9	9	9	6	5	7	5	5
10	F	10	9	7	8	7	9	8	8
P value				0.715219	0.810074	0.60731	1	0.351707	0.904286

Table 8: Fatigue index.

Sr. No.	Gender	Control		Peppermint		Normal Gum		Peppermint Gum	
		No Stress	Stress	No Stress	Stress	No Stress	Stress	No Stress	Stress
1	M	52.8	45.6	49.2	58.2	45.4	48.6	42.2	56.2
2	F	38	40.4	43.2	37.4	31.8	42.4	36.2	40
3	M	58.4	43.2	47.6	14.8	57.4	50.2	41.2	38
4	F	44	47.2	43	37.2	40	44.2	42.6	36
5	M	48.4	56.2	55.2	43.6	40	45.8	38	52.8
6	F	51	42.6	45.4	48.6	43.8	41.6	50	42.6
7	M	51.8	55.6	38.4	40	43.2	51.2	41.6	42.4
8	F	38.6	37.4	42.4	41.2	38.4	35.2	38	43
9	M	45.6	51.2	43.8	54.6	51.6	45.2	51.8	55.4
10	F	41.2	43.6	44.2	40	36.6	39	46.6	34.4
P value				0.580994	0.224777	0.284745	0.38104	0.251701	0.278685

Arithmetic ability

The arithmetic ability of the subjects did not change significantly under any scenarios when compared with control (p>0.05) (Table 6).

Short term memory (Digit Span Test)

The short term memory as determined by digit span test showed no significant increase or decrease when compared to control in any of the subjects (p>0.05) (Table 7).

To determine the fatigue index of the subjects Harvard step test was conducted and following results were obtained.

Fatigue index

None of the items consumed had any effect on the fatigue index of the individuals when compared to control (p>0.05) in both stressful and stress free conditions (Table 8).

On comparing the findings of different test drugs, we found the p values to be:

The intelligence of the person increases significantly on consumption of peppermint as compared to consumption of normal gum or peppermint gum(p<0.05) in a stress free environment. As compared to normal gum, peppermint gum caused more increase in the arithmetic ability of the subjects (p<0.05) in a stress free environment. The relative changes seen in other parameters were not significant (p>0.05) (Table 9).

Table 9: Comparative findings of different drugs.

Sr. No	Factor	Peppermint vs. Normal Gum		Peppermint vs. Peppermint Gum		Peppermint Gum vs. Normal Gum	
		No stress	Stress	No Stress	Stress	No stress	Stress
1	Alertness	0.804419289	0.400267356	0.445572646	0.667298712	0.53305428	0.555985167
2	Reaction Time	0.181389019	0.302499058	0.482225899	0.283783465	0.412058702	0.171289258
3	Attention Span	0.09424674	0.188884799	0.068152829	0.128783514	0.610356888	0.884659804
4	Intelligence	0.004242237	0.898429696	0.043035831	0.118662569	0.759907566	0.11357607
5	Arithmetic Ability	0.303984136	0.782741967	0.206550007	0.41486871	0.029732677	0.47157282
6	Short Term Memory	0.912518524	0.469967117	0.450447227	0.90611086	0.540912648	0.599521064
7	Fatigue Index	0.390469183	0.977348248	0.282256955	0.958333495	1	0.93128221

DISCUSSION

In our study the attention span of a person increases on consumption of peppermint in a stressful environment. Madan N et al also found similar findings during their review on the overall benefits of consumption of peppermint in both young and old subjects.[9] In another study by Zoladz PR et al who concluded that peppermint has no action whatsoever in increasing the attention span after conducting the study on their cognitive performance software.[10] This is not in accordance with our study.

The results on assessment of subjects on Wechsler Adult Intelligence Scale-R showed a significant increase in the ratings on consumption of peppermint in a stress free environment and peppermint gum in a stress free as well as stressful environment which was parallel to the findings of Madan N., et al confirmed that consumption of gum and a specific flavour do play a major role in increasing the intelligence for a short span of time.[9] This was quite opposite to the results obtained by Stephens R et al which concluded that there was no change observed on consumption of peppermint or gum during their study

using similar tests but a varied route of delivery which may have caused the variation in the outcome.[14]

The attention span remains the same on consumption of normal gum and peppermint gum in both stressful and stress free condition in our study. This is largely supported by a study conducted by Smith A et al who found similar results of action of chewing gum on human cognitive skills.[19] This was not in congruence with the results obtained by Baker J et al discovered a rise in attention span on chewing of gum in student population.[20]

Consumption of normal gum had no significant effect on any of the candidates in our study. This was similar to the observations made by Allen AP et al who also conducted their study in similar scenarios but had varied the tests that were performed.[21] Opposite to those findings, another study conducted by Wilson A et al concluded that normal flavoured gum does increase spelling acquisition.[20]

The study also proved that there was no significant change seen in fatigue index on consumption of any of the test products in both stressed and stress free environment. Similar to this, the fatigue index did remain the same in

similar study conducted by Considine S et al who performed the treadmill test on their subjects.[8] This was unlike the study conducted by Raudenbush B et al who proved that consumption of peppermint did increase the levels of physical fitness in most subjects.[6]

Our study also showed no major change in alertness or reaction time. The level of alertness and reaction time also remained unchanged in studies conducted by Stephens R. et.al who also conducted similar tests on university students.[14] But the levels of alertness and reaction time did improve in another study conducted by Allen AP et al during his study on chewing gum only.[22]

Our study also proved that arithmetic ability and short term memory remain the same. The results of study conducted by Smith A. et al showed no change in arithmetic ability or short term memory when they conducted their study using similar drugs.[21] Madan N et al showed an increasing arithmetic ability on consumption of chewing gum. Baker JR et al also came to an output unparallel to ours as his results showed increase in short term memory of the subjects.[9,22]

These contradictions can be because of variations in study parameters, sample population, laboratory settings, types of tests done, dose, duration and route of administration of drug.

CONCLUSION

The attention span of the subjects increased on consumption of peppermint in a stressful environment. The intelligence also increased on consumption of peppermint and peppermint flavoured gum in stress free environment. Peppermint gum was also effective in a stressful environment. There has also been relatively better effect of peppermint gum as compared to normal gum and peppermint in increasing the intelligence and arithmetic ability in a stress free environment. Consumption of peppermint, normal gum and peppermint gum had no action on alertness, reaction time, arithmetic ability, short term memory and fatigue index of any of the subjects in both stressful and stress free conditions when compared to control.

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