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The Effect of Chewing Frankincense (Boswellia Sacra) Gum on Recall and Recognition of Stories Presented in Auditory Forms

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

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Educational Psychology

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An Abstract of

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Frankincense is the dried sap of a tree indigenous to the Middle East; the gum derived from the tree has been used in the Arabian Peninsula for more than 5000 years (Michie, 1989). In Arabic culture, there is a belief that frankincense gum increases individuals’ mental abilities (Ali, 2013). To date, no research has examined the effect of frankincense gum on individuals’ recall and recognition abilities.

The current study examines the effect of chewing frankincense gum on students’ ability to recall and recognize stories presented in auditory forms. The purpose of the study is to determine whether there are significant differences in test performance of frankincense gum chewers as opposed to commercially manufactured gum (other gum) chewers and no gum chewers in recognition and recall of the content of oral presentations. Seventy-four undergraduate students from a Midwestern University in the U.S. with approximately 20,000 students ($M_{age} = 20.19, SD = 4.64$; 55 women, 19 men) listened to three recorded stories. The two experimental groups chewed the frankincense or other gum when they listened to stories. However, the control group did not chew gum when they listened to stories. Thereafter, participants took two tests to measure their
performance pertaining to recall and recognition of each story. Both test-1 and test-2 included nine questions alternating between recall and recognition abilities.

In test-1, experimental groups chewed frankincense gum or other gum during the test, and in test-2 they were asked to discard the gum before beginning the test. The researcher hypothesized that participants who chewed frankincense gum would have higher recall and recognition of the information than participants who chewed other gum or no gum. Additionally, the researcher expected to find that participants would have higher scores in test-1 than in test-2.

Results indicated that there was a significant difference between the three conditions, $F(2,71) = 22.16, p < .001$. Findings showed that there was no significant difference between the frankincense gum group and the no gum group $p = .61$. However, there was a significant difference between the other gum group and the no gum group $p < .001$. In relationship to individual participants, results showed there was a significant difference between test-1 and test-2, $F(1, 71) = 18.95, p < .001$. Although this finding was not compatible with the researcher’s expectation, results indicated that participants had lower scores in test-1 than in test-2.

*Keywords:* chewing gum, recalling, recognition, memory, mental abilities, learning, and volatile oil
# Table of Contents

Abstract ........................................................................................................................................ iii

Table of Contents .......................................................................................................................... v

List of Figures ................................................................................................................................. viii

1 Introduction ................................................................................................................................... 1

1.1 Statement of the problem ....................................................................................................... 3

1.2 Significance of the Problem ................................................................................................. 4

1.3 Conditions ............................................................................................................................. 5

1.4 Research Questions ............................................................................................................... 5

2 Research and Literature Review ............................................................................................. 6

2.1 Theoretical Framework ......................................................................................................... 6

2.2 Physiological Impact ............................................................................................................ 7

2.2.1 Increasing the Blood Flow to the Brain ........................................................................ 7

2.2.2 Increasing Glucose in the Blood ................................................................................... 8

2.3 Psychological Impact ............................................................................................................. 9

2.3.1 Reduction of Stress ........................................................................................................ 9

2.4 Learning Impact ................................................................................................................... 11

3 Methodology ............................................................................................................................ 14

3.1 Participants ........................................................................................................................... 14

3.2 Design .................................................................................................................................. 14
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3 Data Collection and Instrumentations</td>
<td>15</td>
</tr>
<tr>
<td>3.4 Procedures</td>
<td>16</td>
</tr>
<tr>
<td>4 Results</td>
<td>18</td>
</tr>
<tr>
<td>5 Discussion</td>
<td>22</td>
</tr>
<tr>
<td>5.1 Limitations</td>
<td>25</td>
</tr>
<tr>
<td>5.2 Recommendations</td>
<td>25</td>
</tr>
<tr>
<td>References</td>
<td>27</td>
</tr>
<tr>
<td>A IRB Approval</td>
<td>34</td>
</tr>
<tr>
<td>B Informed Consent Form</td>
<td>36</td>
</tr>
<tr>
<td>C Stories</td>
<td>38</td>
</tr>
<tr>
<td>C.1 First Story</td>
<td>38</td>
</tr>
<tr>
<td>C.2 Second Story</td>
<td>39</td>
</tr>
<tr>
<td>C.3 Third Story</td>
<td>40</td>
</tr>
<tr>
<td>D Test-1</td>
<td>42</td>
</tr>
<tr>
<td>E Test-2</td>
<td>44</td>
</tr>
<tr>
<td>F Participant Survey</td>
<td>46</td>
</tr>
<tr>
<td>G Debriefing Statement</td>
<td>48</td>
</tr>
</tbody>
</table>
List of Figures

4-1  Mean number of test scores within participants ........................................20
4-2  Mean number of test scores between conditions .......................................21
Chapter 1

Introduction

Boswellia sacra is a tree indigenous to the Arabic region, and it is one of the most prominent plants in Sultanate Oman. Frankincense is the sap of the Boswellia sacra tree that has been used in the Arabian Peninsula and North Africa for more than 5000 years (Michie, 1989). This substance, obtained when Boswellia tree bark is slashed, is also known as luban, bakhor, and kendar in Saudi Arabia and other parts of the Arabic region (Wallis, 1967). Frankincense gum is widely used in the Middle East and North Africa, and consists of 60% resin, 25% gum, and 5% volatile oils, with 10% comprised of a combination of Albyn, Myrrh, oil phellandrene, and Beinin (Mohsen, 2001).

There is a belief in the Middle East and North Africa that there is an association between chewing frankincense gum and high cognitive functions (Ali, 2013). This belief remains essentially untested and, at this time, there is no scientific information about the effect of chewing frankincense gum on recall and recognition. Rose (1993) mentions that the volatile oil in frankincense arouses part of the brain that controls memory and learning. Additionally, Rose suggests that the volatile oil increases cognitive functionality and allows for better mental focus and concentration.
People chew gum for a variety of reasons. For one, chewing gum is used for freshening breath, it serves as a low-calorie snack (Xie, Ba, Zhang, & Liu, 1998), and it increases blood circulation to the mouth and brain (Takada & Miyamoto, 2004). Chewing gum may be able to help with improving concentration and sustaining attention (Wilkinson & Scholey, 2002). Several studies have suggested that the masticatory movements of gum chewing activate the brain (Fisher, Ogoh, Young, Raven, Raven, & Fadel, 2008; Paulson, Strandgaard, & Edvinsson, 1990). Therefore, it has been suggested that learning is improved, or obliviousness is prevented during the act of gum chewing (Kurokawa Nakajima, Maeda, Takeda, & Ishigami, 2008).

Gum chewing is a practice that is often prohibited in schools around the world. Some teachers believe that gum chewing can impede the learning process and can be noisy and distracting for other students.

Recently, several studies have investigated the possible cognitive benefits of chewing gum. Smith (2009) examined the effect of chewing gum on participants’ performance on intelligence tests. He compared two groups: gum chewing and no gum chewing. Smith gave the two groups an intelligence test, the Alice Heim test, and he found that the group who chewed gum while testing scored higher on the intelligence test.

In contrast, some studies report cognitive dysfunction of gum chewing. Michail, Robert, and Dylan (2011) assert that gum chewing has a negative effect on retrieving information from short-term memory. In their study, participants were presented with lists of letters to be remembered while chewing or not chewing gum. Participants’ performance was measured by whether the list of letters was recalled in its correct serial
position. Michail et al. found that participants who chewed gum during the task performed significantly worse in remembering the lists of letters. They illustrate that gum chewing impairs short-term recall. Michail et al. suggest that gum chewing disrupts students from encoding items their brain has received.

1.1 Statement of the Problem

The problem addressed in this study is that many teachers, based on findings from Michail et al. (2011), prohibit students from chewing gum during class because they believe that gum distracts students from learning. However, other researchers have found that students who chew gum during cognitive activities, such as standardized tests, achieve a higher score than those students who do not chew gum (Johnston, Tyler, Stansberry, Moreno, & Foreyt, 2012; Stephens & Tunney, 2004). The current study focuses on the impact of chewing frankincense gum on students’ retrieval of stories presented in auditory forms. The purpose of this study is to determine if there are significant differences in test performance of frankincense gum chewers as opposed to other gum chewers or no gum chewers in recognition and recall of the content of oral presentations.
1.2 Significance of the Problem

The study has three primary beneficiaries: administrators, teachers, and students who are looking to maximize their cognitive aptitudes. The study can provide evidence to administrators, teachers, and students that there is a natural supplement which improves the learning process by enhancing individuals’ working memory. Some students are trying to improve their cognitive abilities by illegally using non-prescribed cognition-enhancing drugs such as Provigil and Ritalin (Cognitive-enhancing drugs, 2008).

The US National Institutes of Health administered an online survey to investigate if there are a broad range of using illegally cognition-enhancing drugs in people across countries (Maher, 2008). Maher analyzed the survey’s results, which included 1,400 respondents from 60 countries, and he found that there was a wide range of using illegally cognition-enhancing drugs among participants. Maher mentioned that one out of five respondents indicated they had used cognition-enhancing drugs such as methylphenidate and modafinil for non-medical reasons to stimulate their focus, concentration, and memory. In Maher’s study, 62% of stimulant users stated they take methylphenidate for concentration. He reports that 86% of respondents knew these drugs were dangerous for their health, and they indicated that children under the age of 16 should be prohibited from taking these drugs. In addition, several studies reported that some college students used prescription stimulants to help with concentration or to
increase alertness (Low, & Gendaszek, 2002; Kollins, MacDonald, & Rush, 2001; Roehrs, Papineau, Rosenthal, & Roth, 1999). In contrast, the results of the current study provide new information regarding a natural supplement, frankincense, which enhances students’ learning by increasing their cognitive abilities, specifically their abilities to retrieve information presented in auditory forms.

1.3 Conditions

**Condition #1:** Participants listened to three recorded stories and took test-1 while chewing frankincense gum, and then they took test-2 without chewing gum.

**Condition #2:** Participants listened to three recorded stories and took test-1 while chewing other gum, and then they took test-2 without chewing gum.

**Condition #3:** Participants listened to three recorded stories and took test-1 and test-2 without chewing gum.

1.4 Research Question

1. Is there a difference in test performance between participants who chew frankincense gum versus no gum as well as participants who chew other gum versus no gum, and do these conditions have a positive impact on recalling and recognizing the content of oral presentations?
Chapter 2

Research and Literature Review

2.1 Theoretical Framework

The current study is based on two theories: Onyper’s mastication-induced arousal theory and context-dependent memory theory. Mastication-induced arousal is the theory that mastication has a positive, but time-limited, effect on cognition (Onyper, Carr, Farrar, & Floyd, 2011). This theory has been used to conduct research on the effect of gum chewing on cognitive abilities. More specifically, it has been found that chewing gum is a physical activity, which creates a physical response in preparing the body for more action. The act of gum chewing arouses the brain to receive a higher amount of blood and glucose flowing and produces a heightened level of alertness (Hasegawa, Sakagami, Ono, Hori et al., 2009; Smith, 2010). Gum chewing is associated with an increase in heart rate and blood pressure, which also results in the transfer of more blood to the brain; both of these could be causes for the increase in cognitive functions (Wilkinson, Scholey, and Wesnes, 2002).

Context-dependent memory theory supports the premise that memory might be easier to retrieve if an individual is in the same place or condition during both memory encoding and recall (Aggleton & Waskett, 1999; Godden & Baddeley, 1975; Miles &
(Hardman, 1998; Tulving & Thompson, 1973). Baker, Bezance, Zellaby, and Aggleton, (2004) found that context-dependent memory has a positive memory effect in terms of learning and recalling lists during gum chewing. In contrast to Baker et al.’s (2004) study, Tucha, Mecklinger, Maier, Hammerl, and Lange (2004) failed to find such a benefit for context-dependent effects on the recall memory of participants who were auditorially presented word lists while chewing gum. They explain these conflicts may be due to the lack of statistical power in their experiment.

2.2 Physiological Impact

2.2.1 Increasing the Blood Flow to the Brain

Several researchers discovered that chewing gum can improve memory. Wilkinson et al. (2002) use a between-subjects design to associate chewing gum with an increase in heart rate. They suggest that chewing gum can enhance multiple types of memory, such as working memory and episodic memory. These two types of memory are responsible for the learning, storage, and retrieval of information (Vanderaspoilden, Adam, Van der Linden, & Morais, 2007; Indahl, 2016). Wilkinson’s et al. findings show that mastication increased the possibility of differential involvement in the cortical regions. Momose, Nishikawa, and Watanabe (1997) used a positron emission tomography, PET imaging technique, to show the influence of chewing on regional cerebral blood flow. Their study showed a 25% increase in blood flow within brain regions associated with motor function during chewing, including the frontotemporal cortices and the cerebellum.
Takada and Miyamoto (2004) examined human brain activity during mastication using Functional Magnetic Resonance Imaging, FMRI. This technique measures brain activity by detecting changes associated with blood flow. In their study, they determined which cells of the brain are more active during mastication. The study involved 12 participants performing two tasks: chewing gum and imitating chewing gum movements. Results suggest that chewing gum is more effective than merely mimicking mastication. Takada and Miyamoto attribute this difference to specific activations in the dorsolateral prefrontal cortex, ventral prefrontal cortex, and parietal cortex during the gum chewing task. In other words, activities in the prefrontal cortex increase working memory function (Fletcher & Henson, 2001).

2.2.2 Increasing Glucose in the Blood

Due to these brain regions being (i.e., dorsolateral prefrontal cortex, ventral prefrontal cortex, and parietal cortex) connected with cognition, the rise in blood perfusion is present in these areas. Thus, glucose availability, such as that which is present during gum chewing, could benefit relevant cognitive functions (Lezak, 1995). Stephens and Tunney (2004) found that chewing gum leads to cognitive advantages through increasing the delivery of glucose to the brain. They show the possibility that chewing improves memory through the action of insulin, thus promoting further glucose uptake into metabolically active cells. Stephens and Tunney suggest that chewing gum leads to cognitive benefits by increasing glucose in the blood, which will travel to appropriate brain regions. In agreement with Onyper, Carr, Farrar, and Floyd's (2011)
study that chewing gum has a limited time effect on cognition, Stephens and Tunney found that chewing gum improves immediate, but not delayed, recall. Their finding suggests there is another explanation for improvement in the delayed recall observed by Wilkinson et al. (2002).

2.3 Psychological Impact

2.3.1 Reduction of Stress

Changing psychological circumstances are some of the causes that may lead people to chew gum. The positive effect of chewing gum on psychological states has been investigated since the late 1930’s. Hollingworth (1939) examined the effects of chewing gum on mood and performance. He began by separating participants into three groups: not chewing, chewing gum, and sucking candy, and then asked participants to assess how they felt on a 20-point linear rating scale, ranging from extreme strain to extreme relaxation. Participants rated themselves between 10% and 15% more relaxed while chewing gum than not chewing gum or sucking candy. Compared with the no chewing condition, gum chewing was associated with significantly higher alertness and reduced subjective stress and anxiety. Hollingworth suggests that chewing gum has consistent positive effects on mood during an acute stressor. Smith (2010) examined the effect of chewing gum on mood and agreed with Hollingworth’s finding of the positive effects of chewing gum on mood and performance. He asked his participants to rate their mood at the start and end of the memory tasks and reaction time tasks. Smith adds that the
positive effect of chewing gum has an influence on the mood whether participants were stressed or not.

In another study of deliberately heavy gum chewing, Tahara, Sakurai, Ando, Shimada, Miura, and Sato (2007) asked participants to chew at least ten pieces of gum per week. They found that 54% of the participants stated that chewing gum reduced their daily stress, suggesting the possibility that chewing gum may have anti-stress properties. Specifically, the data in the study suggests that chewing gum has beneficial effects on many measures during periods of intense stress. Smith, Chaplin, and Wadsworth (2012) found that chewing gum reduced daily stress, fatigue, anxiety, and depression. They suggest that chewing gum leads to a more positive mood inside and outside of work. In their study, chewing gum was also found to have a positive effect on work performance, a finding reinforced by Smith and Woods (2012).

Scholey, Haskell, Robertson, Kennedy, Milne, and Wetherell’s (2009) study also provides evidence of the stress reduction effect of chewing gum. They experimentally produced stress in forty participants by increasing cognitive workload through a variety of tasks. They used a within-subject design; participants completed the tasks once while chewing gum and again without chewing gum. They found that gum chewers had lower scores on the state-trait anxiety inventory and subjective stress ratings than the control group. Also, they found that chewing gum was associated with better performance on cognitive tasks. In contrast, Torney, Johnson, and Miles (2009) found that chewing gum did not have an effect on self-rated stress; this finding contradicts the finding of Scholey et al. Torney’s et al. study subjected their participants’ periods of stress, which were 25% less than those allotted by Scholey et al. Therefore, it is possible that a greater period of
chewing is required in order to observe stress reductions. Moreover, Freeman’s (1940) study provides a different explanation for the stress reduction associated with chewing gum. He suggests that chewing gum reduces stress in a similar way to other forms of physical activity, such as foot tapping.

In the 1970s and 1980s, chewing gum has become more common among baseball players (Brown, 2014). Oliva, a former baseball player, said that a player has to chew something to amuse him when he plays a game; otherwise, his brain goes insane due to the amount of waiting in the bullpen or the bench (Brown, 2014). Another former baseball player, Morneau, stated that a player obtains nervous energy when he is playing; thus, he needs to reduce stress by mastication (Brown, 2014).

### 2.4 Learning Impact

There are several studies suggesting that gum chewing results in an improvement of memory during specific recognition and sustained attention tasks (Wilkinson et al. 2002; Tucha, Mechlinger, Maier, Hammerl, & Lange, 2004; Scholey et al., 2009; Smith, 2010). Johnston, Tyler, Stansberry, Moreno, and Foreyt (2012) examined the effects of chewing gum on students’ academic performance in a school setting. They used two math classes of eighth-grade students: one class was provided with gum during learning and testing, while the other class was a control condition without gum. They found that students in the gum-chewing group maintained higher grades in math compared to those in the control group.
Smith (2009) shows that chewing gum increased alertness and improved performance on an intelligence test and other tasks that required attention; this result is consistent with the mastication-induced arousal theory. The act of chewing gum increases heart rate and, thus, cognitive performance (Momose et al., 1997; Takada & Miyamoto, 2004). Chewing gum increases activity in several brain regions that are associated with memory and learning (Onozuka et al., 2002, 2003). Smith (2009) also showed that chewing gum increases the speed of encoding new information that could help accelerate the process of learning.

Smith (2010) conducted a comprehensive study on the effect of gum chewing, which included 133 participants. Each participant carried out test activities while chewing gum and while not doing so. He found that when participants chewed gum during activities, their reaction times were quicker, and the effect of gum chewing became more significant as the task became more difficult. Also, he found that chewing gum improved selective and sustained attention, and it was associated with greater alertness.

Tänzer, von Fintel, and Eikermann (2009) studied the chronological time effects of gum chewing on learning. They had two groups in their experiment: one group chewed gum while doing a cognitive task, while the other group completed the cognitive task without gum. They found that the concentration performance of both groups improved during the first 12 minutes of the cognitive task, but that the gum-chewing group continued to improve and maintained performance until the end of the cognitive task. In contrast, the performance of those who did not chew gum decreased markedly toward the end of the cognitive task after 12 minutes. Tucha and Simpson (2010)
investigated the effect of gum chewing on sustained attention over time and found a significant positive effect on learning.

Onyper et al. (2011) examined the effect of the timing of chewing gum on cognitive tasks. They had three groups in their experiment: one chewed gum before testing, another group chewed gum during testing, and the control group did not chew gum. Researchers compared the gum chewers’ group performance to that of the control group. They found that those who chewed gum prior to testing had better performance in cognitive testing. However, this advantage continued only for the first 15–20 minutes of the testing session, and did not extend to all of the cognitive testing, which contrasts with the conclusion of Tänzer et al. (2009). Onyper et al. explain the lack of improvement in cognitive testing during gum chewing by interference effects that divided resources between cognitive and masticatory processes.

In contrast, different studies have failed to demonstrate a benefit of chewing gum on memory (Allen, Norman, & Katz, 2008; Nader, Gittler, Waldherr, & Pietschnig, 2010; Kohler, Pavy, & Van den Heuvel, 2006; Torney, Johnson, & Miles, 2009), Tucha, Mecklinger, Maier, Hammerl, and Lange (2004) examined the effects of chewing gum on memory and attention in two experiments. They found that the gum-chewing group showed improved attention, but not improved memory. Johnson and Miles (2007) examined chewing gum on learning and recalling in a memory task, and they found that chewing gum during learning had a detrimental effect on recalling.
Chapter 3

Methodology

3.1 Participants

Participants were 74 undergraduate students from a Midwestern University in the U.S. with approximately 20,000 students (55 women, 19 men; $M_{age} = 20.19, SD = 4.64$; age range: 17-51 years). Three classes were randomly assigned to one of three treatment conditions (chewing frankincense gum while listening to three stories, chewing other gum while listening to three stories, or not chewing gum while listening to three stories [control group]).

3.2 Design

The study was a 2 X 3 mixed factorial design with repeated measures of recall and recognition of each story within two tests. The within-subjects factor was defined as test conditions (gum chewing during test-1, and no gum chewing during test-2), and between-subjects factor was defined as gum conditions (frankincense gum, other gum, and no-gum [control group]).
3.3 Data Collection and Instrumentations

To recruit participants, multiple emails were sent to several instructors who work at the same university, including my husband. Two instructors and my husband allowed me to utilize their students to conduct my study. Three recorded stories, two tests, and a survey were used to collect the data.

The three stories were adopted from TestPrepReview.com, which provides free Comprehension Practice Tests. These tests were developed by Enoch Morrison, who creates and explains test preparation content (Morrison, 2016). Two stories focused on the subject of history; specifically, the invention of the airplane and Marie Curie’s work with radium. The third story was about the present geography of Mount Vesuvius. The three stories were recorded by an American female voice and were nine minutes long (Appendix C).

The two tests included nine questions alternating between recalling and recognition questions. In test-1 (Appendix D), there were five open-ended questions (e.g., “What was the idea of flying an aircraft to some people?”), and four multiple choice questions (e.g., “The Wrights' interest in flight grew into a ______. A. financial empire, B. plan, C. need to act, D. foolish thought, and E. Answer not available”). In test-2 (Appendix E), there were four open-ended questions (e.g., “How Lilienthal controlled his gliders?”), and five multiple choice questions (e.g., “People thought that the Wright brothers had ______. A. acted without thinking, B. been negatively influenced, C. been too cautious, D. been mistaken, and E. acted in a negative way”). Consequently, higher scores on the tests indicated a greater amount of information being recalled and
recognized in the participants’ memory.

The survey (Appendix F) involved demographic information (e.g., gender, age, and academic status e.g. freshman, sophomore, etc.), one multiple choice question about the participants attitudes towards chewing gum (e.g. “What do you think of chewing gum?  a. Unhealthy habit, b. Healthy habit, c. Impolite habit, and d. I don’t care; ”), five Yes/No personal questions about participants attitudes toward frankincense gum (e.g. “Did you like Frankincense gum?”), and four Likert-scale items (e.g. “I feel that chewing gum relieves my stress,” with 1 = strongly disagree and 4 = strongly agree).

3.4 Procedure

Prior to data collection, approval was received from the IRB (Appendix A). The classes were randomly assigned to three conditions: (1) participants listened to three stories while they were chewing frankincense gum, (2) participants listened to three stories while they were chewing other gum, and (3) participants listened to three stories while they were not chewing gum. At the beginning of the experiment, participants were provided with an Informed Consent form (Appendix B), and I assured participants verbally that their information would be kept confidential. After they signed the consent form, I collected it from them.

In the experimental groups, the frankincense gum group was provided with three grams of frankincense gum prior to listening three-recorded stories from the class computer. I had them chew the frankincense gum while listening to the three stories. After participants finished listening to the three stories, they took two tests. They
completed test-1 while chewing frankincense gum. Then, I asked them to discard the
frankincense gum and gave them test-2. Next, the participants received a short survey; it
was used to describe the sample in greater detail. At the end of the experiment, the
participants were debriefed (Appendix G). The same procedures were applied to the
other gum group, but rather than chewing frankincense gum, participants chewed other
gum that had the same natural taste as frankincense gum. Regarding the control group,
participants listened to the stories without chewing gum. Then, they took the two tests
(test-1 and test-2) followed by the survey.
Chapter 4

Results

This study examined the differences in test performance of frankincense gum chewers as opposed to other gum chewers in recognition and recall of the content of oral presentations. The first independent variable was the test conditions (gum chewing during test-1, and no gum chewing during test-2). The second independent variable was gum types (frankincense gum, other gum, and control [no-gum]). The dependent variable was the two test scores measuring comprehension of the stories. To analyze the experiment’s data, I performed the mixed factorial repeated-measures ANOVA. To analyze the survey data, I used descriptive analysis to obtain the participants’ perceptions of chewing gum. I expected to find that participant who chewed frankincense gum have higher memory recall and recognition than participants who chewed other gum. In addition, I expected to find that the score of test-1 during chewing frankincense or other gum would be higher than the score in test-2. I calculated all the participants’ means and standard deviations for the two test scores (see Figure 4-1) for the test-1 ($M = 2.42$, $SD = .14$, $n = 74$), while test-2 ($M = 3.19$, $SD = .14$, $n = 74$).

Regarding the test of within-subject effect for the frankincense gum condition, the result showed that chewing gum during test-1 condition does not significantly differ from...
no gum chewing during test-2 condition, in which there was no gum chewing $F(1, 71) = 1.08, P = .30$. For the test of within-subject effect for the other gum group, chewing gum during test-1 condition resulted in lower scores than no gum chewing during test-2 condition, $F(1, 71) = 11.87, P < .001$. In addition, the test of within-subject effect for the control group indicated that test-1 condition had lower scores than test-2 condition, $F(1, 71) = 11.01, P < .001$. Overall, the test of within-subject effect for all three groups showed there was a significant difference across the two tests’ conditions, $F(1, 71) = 18.95, p < .001$.

Regarding the test of between-subject effect, results indicated there were significant differences between all conditions, $F(2,71) = 22.16, p < .001$. Results indicated there was no significant difference between the control group and the frankincense gum group $p = .61$. However, there was a significant difference between the other gum group and the frankincense gum group $p < .001$. In addition, there was a significant difference between the control group and the other gum group $p < .001$. Regarding the interaction effect, results showed there was no significant effect between tests’ conditions and gum conditions, $F(2,71) = 1.28, p = .28$.

I calculated the mean and standard deviation for test-1 in all groups (see Figure 3-2): the frankincense gum group ($M = 3, SD = 1.49, n = 20$), the other gum group ($M = 1.30, SD = .95, n = 27$), and the control group ($M = 2.98, SD = 1.25, n = 27$). In addition, I calculated the mean and standard deviation for test-2 in all groups (see Figure 3-2): the frankincense gum group ($M = 3.35, SD = 1.27, n = 20$), the other gum group ($M = 2.30, SD = 1.35, n = 27$), and the control group ($M = 3.93, SD = 1.04, n = 27$).
Survey results showed that 62% of participants disagreed that chewing gum during listening increased their listening ability, and 67% of participants disagreed that chewing gum distracted their attention. However, results showed that 49% of participants agreed that chewing gum increased their reading ability, and 61% of participants agreed that chewing gum relieved stress. Finally, I found that 80% of participants believed they could perform simultaneous tasks; however, 52% of participants did not prefer chewing gum while studying.

Figure 4-1: Mean number of test scores for participants who either chewed gum during test-1 (n = 47) or did not chew gum during test-2 (n = 47). Error bars show standard deviations.
Figure 4-2: Mean number of test scores for participants who either chewed frankincense gum during test-1 (n = 20), chewed other gum during test-1 (n = 27), or did not chew gum during test-1 (control group). Also, the mean number of test scores for participants who took test-2 after discarding frankincense gum (n = 20), took test-2 after discarding other gum (n = 27) or did not have gum at all from the beginning (control group). Error bars show standard deviations.
Chapter 5

Discussion

The aim of the present study was to assess if there were differences in test performance of frankincense gum chewers as opposed to other gum chewers in recognition and recall of the content in oral presentations. Findings did support the study’s first expectation that participants who were assigned to the frankincense gum condition had significantly higher scores on the two tests compared to participants assigned to the other gum condition. The current study supports findings of Rose (1993), which suggests the frankincense gum consists of 5% of volatile oils, also supporting Hamilton’s (2000) finding that volatile oil enhances student learning and information recall. Rose (1993) suggests that volatile oil in the frankincense gum could be used to clarify thoughts and develop greater focus.

A similar effect was found between the control group and the other gum group. To illustrate, the control group condition receives significantly higher scores on the two tests compared to the other gum condition. In this study, the control group had the highest mean test scores across all conditions, and the other gum group had the lowest mean test scores; this demonstrates that frankincense gum does contribute to greater recall and recognition comparing to the other gum. The mastication of the other gum
group did not have any positive effect on participants’ recall and recognition abilities.

There are several studies providing strong evidence, which suggests a negative effect of chewing gum on cognitive performance (Johnson & Miles, 2008; Nader, Gittler, Waldherr & Pietschnig, 2010; Tucha, Mecklinger, Maier, Hammerl & Lange, 2004). For example, Michail et al. (2012) found that chewing gum had a negative effect on recalling information from memory. They mentioned that when students simultaneously perform several memory tasks, the result was poor ability in performing one or more of the memory tasks.

Onyper et al. (2011) explained the lack of improvement in cognitive performance when gum is chewed during testing may be due to interference effects between two tasks. They mentioned that participants who chew gum throughout testing would split their focus between cognitive and masticatory processes. Therefore, in the current study, when participants chew other gum, the physical activity of mastication disrupts participants from encoding the information to memory.

In contrast, the findings of this study did not support the second expectation that the scores of test-1 within the subject would be higher than the scores in test-2. In the other gum group, the scores of test-1 were lower than the scores of test-2. This finding is consistent with the Onyper et al. (2011) findings that suggest chewing gum has a positive, but time-limited, effect on cognitive performance. Researchers found that chewing gum had a positive effect on cognitive performance when gum was chewed for 5 minutes before, but not during, cognitive testing. They suggested that the positive effect persisted only for the first 15-20 minutes of the tasks before it started to decline. In the current study, participants chewed gum for more than 15 min before starting test-2. Therefore, it
is possible that because of chewing gum prior to the test, participants had a significantly higher score in test-2 than test-1, but this cannot be definitively concluded. However, the chewing of frankincense gum prior to test-2 did not have any effect on participants’ test-2 scores. In the frankincense gum condition, there was no significant difference between participants’ scores in test-1 and test-2.

The current study did not find a benefit for context-dependent effects on recall and recognition memory in experimental groups. One difference between the current study and Baker et al. (2004) was that the current study engaged direct recall and recognition after listening to stories; however, Baker et al. presented a delay of 24 hours between learning and recall. Moreover, Miles, Charig, and Eva (2008) found a context-dependent effect of chewing gum without delay of 24 hours between learning and recall. Miles et al. gave participants a distracter task between learning and recall. The current study conceivably could find a context-dependent effect if there were a break between listening to stories and recalling information.

In conclusion, the current study addresses an important aspect of chewing gum’s relationship to cognition: the frankincense gum effect. This study suggests that frankincense gum has a positive effect on cognitive performance. In addition, this study finds that context-dependent effects do not exist in the current study. Several past studies did not support that chewing gum has an effect on context-dependent memory (Johnson & Miles, 2007, 2008; Miles & Johnson, 2007; Tucha et al., 2004).
5.1 Limitations

The fact that the three groups were in different rooms was a potential limitation of the study. The changing of the environmental context may have had some effects on participants’ recalling and recognition. Smith (2001) mentioned that different contexts or physical states could influence individuals’ learning of information. In future studies, researchers could prevent this limitation by doing the study in a single place.

Moreover, the differences between students’ Intelligence Quotient (IQ) and Scholastic Assessment Test (SAT) were another potential limitation of the study. The lack of information about participants SAT or IQ scores may have had an affect on results of the study. Ebrahimi and Abdollahi (2013) found that the total capacity of working memory in high IQ students was higher than in low IQ students. In addition, Ebrahimi and Abdollahi’s results indicated that high IQ students have a greater level of verbal memory than low IQ students. In future studies, researchers could prevent this limitation by asking participants in the survey about their IQ or SAT scores. Then, researchers can divide participants’ results based on level, high IQ or low IQ students, and compare how IQ levels affect performance.

5.2 Recommendations

The study provides several recommendations for four beneficiaries: administrators, teachers, students, and future researchers. Regarding administrators and teachers, the study results should be interpreted to signify the importance of allowing
students to chew frankincense gum during any cognitive activity related to recall. Regarding students, the findings signify that students can use a natural supplement, frankincense gum, instead of prescription medication (e.g., Adderall) to improve the learning process by enhancing their working memory. Regarding future research, adding more demographic variables, such as students’ Intelligence Quotient (IQ) and Scholastic Assessment Test (SAT), will help in making sure that all conditions have the same cognitive ability level. In addition, future researchers may study the effect of frankincense gum on students’ relaxation during performing tests.
References


Fisher, J. P., Ogoh, S., Young, C. N., Raven, P. B. and Fadel, P. J. (2008) Regulation of


Smith, A. P. (2009). Effects of chewing gum on cognitive function, mood and physiology in stressed and non-stressed volunteers. *submitted*


Appendix A

IRB Approval
To: Lisa Kovach, Ph.D. and Afniu Alrashed
Department of Foundations of Education

From: Walter Eisinger, PhD., Chair
Kamala London Newton, Ph.D., Vice Chair
Patricia Case, Ph.D., Chair Designee

Signed: ___________________ Date: 05/10/16

Subject: IRB #201371
Title: The Effect of Chewing Frankincense (Boswellia sacra) Gum on Students' Learning and Retrieving Educational Materials

On 05/10/16, the above research was reviewed and approved as Exempt (Categories, #1, 2b and 6) by the Chair and Chair Designee of the University of Toledo (UT) Social Behavioral & Educational Institutional Review Board (IRB). The requirement to obtain a signed consent form has been waived as this research is determined to be minimal risk and a signed consent document would be the only record linking the subject to the data. It was determined that this waiver for signed consent will not adversely affect the rights and welfare of the participants. This action will be reported to the committee at its next scheduled meeting.

Please Note: A consent form is not required for this study. However an information sheet regarding the study should be distributed to potential participants. This Information Sheet should include the name and telephone number of a contact person in case the subjects need additional information. It is also strongly encouraged that the study be explained verbally to potential subjects.

Items Reviewed: IRB Application Requesting Exempt Review
Consent Form/Information Sheet
Reading Tests 1 & 2
Audio Stories
Debriefing Statement
Stories

Designated as EXEMPT RESEARCH on: 05/10/16

Please read the following attachment detailing Principal Investigator responsibilities.
Appendix B

Informed Consent Form
ADULT RESEARCH SUBJECT - INFORMED CONSENT FORM

The Effect of Chewing Frankincense Gum on Students' Learning and Retrieving Educational Materials

Principal Investigator: Dr. Lisa A Kovach, Associate Professor, phone # 419.530.2048

Purpose: You are invited to participate in the research project entitled, The Effect of Chewing Frankincense (Boswellia sacra) Gum on Students' Learning and Retrieving Educational Materials, which is being conducted at the University of Toledo under the direction of Dr. Lisa A Kovach. The purpose of this study is to determine if there are significant differences in test performance of Frankincense gum chewers as opposed to participants who chew a regular gum in absorbing oral presentations.

Description of Procedures: This experiment will take place in three different classes. The experiment has 3 sessions (1 session 20 participants, 2 session 20 participants, and 3 session 20 participants) 60 participants is the total for the whole experiment. Each session is expected to last about 20 minutes. You will listen to three general stories while you chewing different types of gum or not chewing gum. Then, you will take two tests about the stories. After that, you will complete a brief survey about chewing gum.

After you have completed your participation, the research team will debrief you about the data, theory and research area under study and answer any questions you may have about the research.

Potential Risks: There are minimal risks to participation in this study, including loss of confidentiality.

Potential Benefits: The direct benefit to you if you participate in this research may be that you will learn about how psychology experiments are run and may learn more about the effect of chewing Frankincense gum on learning and retrieving educational materials. Others may benefit by learning about the results of this research (or some credit if it is offered by your instructor).

Confidentiality: The researchers will make every effort to prevent anyone who is not on the research team from knowing that you provided this information, or what that information is. The consent forms with signatures will be kept separate from responses, which will not include names and which will be presented to others only when combined with other responses. Although we will make every effort to protect your confidentiality, there is a low risk that this might be breached.

Voluntary Participation: Your refusal to participate in this study will involve no penalty or loss of benefits to which you are otherwise entitled and will not affect your relationship with The University of Toledo or any of your classes. In addition, you may discontinue participation at any time without any penalty or loss of benefits.

Contact Information: Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation you should contact a member of the research team Dr. Lisa Kovach and Afshan Airshed E-mail: Afshan.Airshed@rockets.utoledo.edu

University of Toledo IRB Approved

Approval Date: 05/05/10
Expiration Date: 05/05/10
IRB #: 821371  
ICF Version Date: ____________

If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, the Chairperson of the SBE Institutional Review Board may be contacted through the Office of Research on the main campus at (419) 530-2844.

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

SIGNATURE SECTION – Please read carefully

You are making a decision whether or not to participate in this research study. Your signature indicates that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research.

The date you sign this document to enroll in this study, that is, today’s date must fall between the dates indicated at the bottom of the page.

Name of Subject (please print)  Signature  Date

Name of Person Obtaining Consent  Signature  Date

This Adult Research Informed Consent document has been reviewed and approved by the University of Toledo Social, Behavioral and Educational IRB for the period of time specified in the box below.

Approved Number of Subjects: 60

University of Toledo IRB Approved
Approval Date: ______________
Expiration Date: ______________

Adult Informed Consent  Revised 11.05.10  Page 8 of 8
Appendix C

Stories

C.1 First Stories

Many great inventions are initially greeted with ridicule and disbelief. The invention of the airplane was no exception. Although many people who heard about the first powered flight on December 17, 1903 were excited and impressed, others reacted with peals of laughter. The idea of flying an aircraft was repulsive to some people. Such people called Wilbur and Orville Wright, the inventors of the first flying machine, impulsive fools. Negative reactions, however, did not stop the Wrights. Impelled by their desire to succeed, they continued their experiments in aviation.

Orville and Wilbur Wright had always had a compelling interest in aeronautics and mechanics. As young boys they earned money by making and selling kites and mechanical toys. Later, they designed a newspaper-folding machine, built a printing press, and operated a bicycle-repair shop. In 1896, when they read about the death of Otto Lilienthal, the brothers' interest in flight grew into a compulsion.

Lilienthal, a pioneer in hang-gliding, had controlled his gliders by shifting his body in the desired direction. This idea was repellent to the Wright brothers, however, and they searched for more efficient methods to control the balance of airborne vehicles. In 1900 and 1901, the Wrights tested numerous gliders and developed control techniques. The brothers' inability to obtain enough lift power for the gliders almost led them to abandon their efforts.

After further study, the Wright brothers concluded that the published tables of air pressure on curved surfaces must be wrong. They set up a wind tunnel and began a series
of experiments with model wings. Because of their efforts, the old tables were repealed in time and replaced by the first reliable figures for air pressure on curved surfaces. This work, in turn, made it possible for the brothers to design a machine that would fly. In 1903 the Wrights built their first airplane, which cost less than $1,000. They even designed and built their own source of propulsion—a lightweight gasoline engine. When they started the engine on December 17, the airplane pulsated wildly before taking off. The plane managed to stay aloft for 12 seconds, however, and it flew 120 feet.

By 1905, the Wrights had perfected the first airplane that could turn, circle, and remain airborne for half an hour at a time. Others had flown in balloons and hang gliders, but the Wright brothers were the first to build a full-size machine that could fly under its own power. As the contributors of one of the most outstanding engineering achievements in history, the Wright brothers are accurately called the fathers of aviation.

C.2 Second story

Marie Curie was one of the most accomplished scientists in history. Together with her husband, Pierre, she discovered radium, an element widely used for treating cancer, and studied uranium and other radioactive substances. Pierre and Marie's amicable collaboration later helped to unlock the secrets of the atom.

Marie was born in 1867 in Warsaw, Poland, where her father was a professor of physics. At an early age, she displayed a brilliant mind and a blithe personality. Her great exuberance for learning prompted her to continue with her studies after high school. She became disgruntled, however, when she learned that the university in Warsaw was closed to women. Determined to receive a higher education, she defiantly left Poland and in 1891 entered the Sorbonne, a French university, where she earned her master's degree and doctorate in physics.

Marie was fortunate to have studied at the Sorbonne with some of the greatest scientists of her day, one of whom was Pierre Curie. Marie and Pierre were married in 1895 and spent many productive years working together in the physics laboratory. A short time after they discovered radium, Pierre was killed by a horse-drawn wagon in
1906. Marie was stunned by this horrible misfortune and endured heartbreaking anguish. Despondently she recalled their close relationship and the joy that they had shared in scientific research. The fact that she had two young daughters to raise by herself greatly increased her distress.

Curie's feeling of desolation finally began to fade when she was asked to succeed her husband as a physics professor at the Sorbonne. She was the first woman to be given a professorship at the world-famous university. In 1911 she received the Nobel Prize in chemistry for isolating radium. Although Marie Curie eventually suffered a fatal illness from her long exposure to radium, she never became disillusioned about her work. Regardless of the consequences, she had dedicated herself to science and to revealing the mysteries of the physical world.

C.3 Third Story

Mount Vesuvius, a volcano located between the ancient Italian cities of Pompeii and Herculaneum, has received much attention because of its frequent and destructive eruptions. The most famous of these eruptions occurred in A.D. 79.

The volcano had been inactive for centuries. There was little warning of the coming eruption, although one account unearthed by archaeologists says that a hard rain and a strong wind had disturbed the celestial calm during the preceding night. Early the next morning, the volcano poured a huge river of molten rock down upon Herculaneum, completely burying the city and filling the harbor with coagulated lava.

Meanwhile, on the other side of the mountain, cinders, stone and ash rained down on Pompeii. Sparks from the burning ash ignited the combustible rooftops quickly. Large portions of the city were destroyed in the conflagration. Fire, however, was not the only cause of destruction. Poisonous sulfuric gases saturated the air. These heavy gases were not buoyant in the atmosphere and therefore sank toward the earth and suffocated people.

Over the years, excavations of Pompeii and Herculaneum have revealed a great deal about the behavior of the volcano. By analyzing data, much as a zoologist dissects an animal specimen, scientists have concluded that the eruption changed large portions of
the area's geography. For instance, it turned the Sarno River from its course and raised the level of the beach along the Bay of Naples. Meteorologists studying these events have also concluded that Vesuvius caused a huge tidal wave that affected the world's climate.

In addition to making these investigations, archaeologists have been able to study the skeletons of victims by using distilled water to wash away the volcanic ash. By strengthening the brittle bones with acrylic paint, scientists have been able to examine the skeletons and draw conclusions about the diet and habits of the residents. Finally, the excavations at both Pompeii and Herculaneum have yielded many examples of classical art, such as jewelry made of bronze, which is an alloy of copper and tin. The eruption of Mount Vesuvius and its tragic consequences have provided everyone with a wealth of data about the effects that volcanoes can have on the surrounding area. Today, volcanologists can locate and predict eruptions, saving lives and preventing the destruction of other cities and cultures.
Appendix D

Test-1

1. What was the idea of flying an aircraft to some people?

2. The Wrights' interest in flight grew into a ______.
   A. financial empire
   B. plan
   C. need to act
   D. foolish thought
   E. Answer not available

3. Why Wright brothers changed the old tables and replaced them by the first reliable figures for air pressure on curved surfaces?

4. The Curies' ________ collaboration helped to unlock the secrets of the atom.
   A. friendly
   B. competitive
   C. courteous
   D. industrious
   E. chemistry

5. What did Marie Curie feel when she learned that she could not attend the university in Warsaw?
6. _______ she remembered their joy together.
   A. Dejectedly
   B. Worried
   C. Tearfully
   D. Happily
   E. Irefully

7. What did Marie Curie do about her work when she became fatally ill from working with radium?
   ________________________________

8. The poisonous gases were not _______ in the air.
   A. able to float
   B. visible
   C. able to evaporate
   D. invisible
   E. able to condense

9. Who have concluded that the volcanic eruption caused a tidal wave?
   ________________________________
Appendix E

Test-2

1. People thought that the Wright brothers had _____.
   A. acted without thinking
   B. been negatively influenced
   C. been too cautious
   D. been mistaken
   E. acted in a negative way

2. How Lilienthal controlled his gliders?
   ______________________________________________________

3. The Wrights designed and built their own source of ________.
   A. force for moving forward
   B. force for turning around
   C. turning
   D. force for going backward
   E. None of the above

4. In one word, describe Marie personality?
   ______________________________________________________

5. Marie ________ by leaving Poland and traveling to France to enter the Sorbonne.
   A. challenged authority
   B. showed intelligence
C. behaved  
D. was distressed  
E. Answer not available  

6. When Curie’s feeling of wretchedness began to fade?

7. Herculaneum and its harbor were buried under _________ lava. 
   A. liquid  
   B. solid  
   C. flowing  
   D. gas  
   E. Answer not available  

8. What did scientists conclude after analyzing the eruption of Mount Vesuvius data?  

9. Scientists have used _________ water to wash away volcanic ash from the skeletons of victims. 
   A. bottled  
   B. volcanic  
   C. purified  
   D. sea  
   E. fountain
Appendix F

Participant Survey

- Please, answer the following questions:
  1. Age _______
  2. Gender: Man   Woman   Other ____________________
  3. Classification:  Freshman   Sophomore   Junior  Senior   Other____________
  4. What do you think of chewing gum?
    a. Unhealthy habit
    b. Healthy habit
    c. Impolite habit
    d. I don’t care
  5. Do you prefer chewing gum while studying?   Yes   No
  6. Are you multi-tasking person?   Yes   No
  7. Do you like Frankincense gum?   Yes   No
  8. Do you have ever used Frankincense gum before? Yes   No
  9. What did you feel when you start to chew Frankincense gum?

Please, circle the number on the scale indicating whether you agree or disagree with each statement.

I feel that …
7. …Chewing gum relieves my stress.

1  2  3  4
Strongly Disagree  Disagree  Agree  Strongly Agree

8. …Chewing gum increases my reading comprehension ability.

1  2  3  4
Strongly Disagree  Disagree  Agree  Strongly Agree

9. …Chewing gum increase my listening comprehension ability
10. …Chewing gum distracts my attention.
Appendix G

Debriefing Statement

Chewing Gum & Retrieving Educational Material

Thank you so much for your participation in this study. The purpose of this study is to examine if there are significant differences in recalling and recognizing stories presented in auditory forms. The study compares the differences in Frankincense gum groups' comprehensive tests score with other gum groups' comprehensive tests score. Several research finds that chewing gum improves students' performance in the intelligent tests. In addition, they find that chewing gum increased alertness at the end of the test session in his study (Wilkinson, Scholey, & Wesnes, 2002; and Stephens & Tunney, 2004; Smith, 2009).

I want to assure you once again that all information from you will be kept strictly confidential. Please do not talk about this experiment with anyone for doing this could influence the behaviors of the other students that will also be participating in this study. If you have questions, please feel free to contact me, Afnan Alrshed. My email address is Afnan.Alrshed@rockets.utoledo.edu.

Thank you once again for your involvement.