AN ABSTRACT OF THE THESIS OF

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The present study attempted to evaluate how background music affected memory and attention. The information-load theory proposes that an interaction between the type of music and the type of task determines what effect music will have on performance. Forty-eight college students completed a low cognitive demanding task of memorizing vocabulary words and a high cognitive demand task of understanding a reading passage, either with or without music. Contrary to expectations, background music did not hinder reading performance or facilitate vocabulary performance. Additional analyses examining musical preferences, study habits, or perceived distraction did not elucidate the reason for a lack of an interaction between music and task. It was concluded that music's effect on memory and attention is of a multifaceted nature.

THE EFFECT OF BACKGROUND MUSIC ON MEMORY FOR DIFFERENT TASKS

A Thesis

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Most of all, I would like to dedicate this thesis to the bravest, strongest, most unique person I know, Mr. Aaron Miller, whose zest for life inspires me. I know you will beat all odds. I'm looking forward to playing with your grandchildren!

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CHAPTER 1

INTRODUCTION

Music has been part of our culture since the beginning of time. The human species danced and sang several thousand years before speech evolved (Portnoy, 1963). Over time, music has been incorporated into all aspects of daily life. In fact, going anywhere without hearing music is nearly impossible. Music is played in grocery stores, restaurants, business offices, beauty salons, dental and medical offices, movie theatres, and sometimes even on the street corner. Music is also present in school to expand knowledge and creativity, to help remember ABCs, to play games, and to pay tribute to the country. The culture uses music to celebrate a person's birthday, to conduct religious services, to relax, to get motivated for exercise, and to celebrate holidays. People associate songs or melodies with events, places, people, and times in their lives. Sometimes just hearing a song can elicit a memory that would not otherwise be remembered (Schulkind, Hennis, & Rubin, 1999).

The field of psychology uses music in a variety of ways to help patients. Graduate programs (e.g., at New York University, University of Miami, and University of Minnesota) now exist that focus entirely on music's beneficial powers. However, one does not need musical therapy to reap the benefits of music. For example, music relaxes adolescents with learning, emotional, and behavioral disorders and reduces the amount of aggressive and hostile behaviors exhibited in the classroom (Montello & Coons, 1998). Music also reduces college students' anxieties before taking an exam (Fudin, Tarakanov, & Klassina, 1996). Music is used at all stages of medical procedures to relax patients before an operation (Reilly, 1999), to help surgeons to concentrate (Allen & Blascovich, 1994), and to speed recovery and healing of patients (Cunningham, Monson, & Bookbinder, 1997). Music can play some role in memory processes when we hear a song and remember what we were feeling, thinking, and doing the first time we heard that song. What contributions could background music have on memory for cognitive processes?

Some controversy exists as to whether studying to-be-learned material in silence, or with music, or with television is best (Crawford & Strapp, 1994). No doubt this is dependent, to some degree, on personal preferences. However, the cognitive effects of music are not only applicable to students and to educators but to businesses and to the working public. Music is often found in the work place, piped into a room or played on personal computers. The impact of music on both memory and attention is important for businesses to consider as it could affect productivity (Fox, 1983).

The present experiment attempted to contribute to the list of potential benefits that music offers by specifically addressing its effect on memory. Because the study addressed whether music is advantageous to memory, the results are useful in a variety of areas, such as education and business. If music enhances memory rather than having a negative effect on concentration, psychology can utilize this information to promote the use of music for similar tasks. For example, students may want to listen to certain kinds of music while memorizing vocabulary words or reading a biology textbook.

To evaluate the role of background music in cognitive processing, two tasks that required varying degrees of mental effort were used. This manipulation allowed the author to test whether music has a facilitative or distracting effect on diverse types of tasks. A brief overview of how memory functions along with different theories about how music is processed was provided. Specific areas addressed include background music's effect on attention and memory while performing various cognitive tasks. The review of literature focused primarily on studies done in the last fifteen years unless findings previous to that time had been unique.

Cognitive Processing Theories

Three terms related to memory are used frequently in the field. The first term, encoding, refers to putting information in memory. As one meets a new person, information about that person becomes encoded into memory. Retrieval or recall refers to previously encoded information being called to mind. If one were asked about the person who was met previously, the memory of that person's appearance, personality, or voice, would be retrieved or recalled. The third term, cue or retrieval cue, is a hint for remembering some bit of information (Klatzky, 1975). A retrieval cue for the person one met at a party could be the name or physical description.

Most people have a concept of what memory is and likely think of it as a process by which one remembers and forgets information. Memory is a complicated process and is defined differently by various experts in the field. In general, memory is considered a processing system comprised of two types of memory systems—short-term and long-term memory. Short-term memory allows people to store information temporarily and also aids in retrieving and utilizing information from long-term memory. For example, short-term memory is demonstrated by looking at a phone number and immediately going to the phone, dialing it, and then not remembering it one minute later. Information becomes lost quickly if it is not rehearsed (Atkinson & Shiffrin, 1971). Long-term memory, in contrast, stores memories on a more permanent basis. Information in this memory system is stored in greater detail and depth and is therefore easier to remember. Long-term memory is demonstrated as one sees a classmate from a course taken two years ago and is able to call the person by name. As important information is encoded, it is transferred from short-term memory to long-term memory but then transferred back to short-term memory during retrieval. Reading a story for a literature course or learning psychology terms both involve short and long-term memory. That is, students must decode to the words at hand, which utilizes short and long-term memory. However, remembering the story requires retrieving information from long-term memory.

Schemas also play a role in memory. A schema is a framework, concept, or knowledge about a particular topic and is often stored as somewhat of a theme (Ashcraft, 1994). For example, for the word "wedding" most people have a general conceptualization or schema of what events occur at a wedding and how these events take place. The word "wedding" may also activate a schema that includes the sights and sounds that are often associated with this event. In addition to event schemas, people also develop story schemas which are mental representations of what occurs in stories, typically fairytales (Rahman & Bisanz, 1986). Story schemas are activated each time one reads a story as a way of helping a person to process the information contained in the narrative. Thus, story schemas enable the reader to anticipate the type of information contained in the passage from beginning to end.

Before reviewing the literature concerning music and memory, the different theories that attempt to explain how extraneous factors, such as background music, affect attention and memory are presented. Some theories purport that music aids in cognitive processing. For example, the Mozart effect has recently come under direct attention of psychologists and educators. Rauscher, Shaw, and Ky (1993) found that playing Mozart music for 10 minutes improved spatial reasoning as measured by the Stanford Binet Intelligence Scale. Since then, attempts to replicate these findings have yielded inconsistent results (Nantais & Schellenberg, 1999; Newman et al., 1995; Rideout & Taylor, 1997; Steele, Brown, & Stoecker, 1999). The idea that music may contribute to mental processing has become a popular idea that has flooded the fields of music, education and psychology alike.

Another theory, context-dependent memory (CDM), assumes that memory is facilitated by music when it is presented during both encoding and recall (Smith, 1985). CDM states that information is best remembered in the context in which it was originally learned. For example, if a person learns information in a particular setting, the information will be recalled best when the person is in the same setting again. When dealing with recall for music, context-dependent memory is referred to as music-dependent memory (Balch & Lewis, 1996). In this situation, information presented with music is best remembered when the same music is present at recall. CDM theory assumes that when music is presented with information to-be-remembered, the melody will serve as a retrieval cue and allow the information to be more accessible to memory. Unlike the Mozart effect, this theory does not dictate that music is contributing something unique to memory. Instead, music's ability to improve memory would be based simply on the idea that music and the to-be-remembered information are encoded together, making the music an effective retrieval cue.

Other theories propose that music hinders cognitive processing. For example, the interference theory predicts that hearing music while learning new information actually interferes with encoding, making remembering that information more difficult (Furnham & Bradley, 1997). By providing additional information to be encoded, music takes away from the resources available to focus on other stimuli. This theory would hold that listening to music would distract from other activities altogether and as the information to-be-remembered becomes more difficult, the music would reduce retention more.

Finally, some theories suggest that music's ability to enhance or hinder memory depends on the complexity of the task and the type of music played. According to Kiger (1989), music has different types of information-loads. Slow and repetitive music has a low information-load. High information-load music, on the other hand, is fast and unique in rhythmic structure. The information-load music theory purports that low information-load music (e.g., a funeral march) is successful in sustaining attention with a cognitive task because it is not distracting and demanding of attention. High information-load music (e.g., a fast rock song), on the other hand, may be distracting because the beat is fast paced and non-repetitive, making it distracting. Thus, high information-load music is not well suited for tasks requiring a great deal of concentration. Rather, this type of music may serve to motivate people to improve simple, repetitive, or non-demanding task performance.

Music's effect on attention

One concern regarding music being played when studying or working is the possible effect that music may have on a person's ability to pay full attention to the task at hand. It is necessary to be aware of the different effects that music can have on attention because memory processing requires that a person attend to the to-be-remembered material. A review of the research examining the effect of music on attention while performing a variety of cognitive tasks is presented next.

Several researchers have proposed that music neither enhances or interferes with attention, and therefore, task performance (Boyle & Coltheart, 1996; Manthei & Kelly, 2000; Sogin, 1988). Manthei and Kelly (2000) found no difference in scores by college students who took a math exam while listening to popular background music, to classical background music, or to no music. Sogin (1988) also reported that college students who listened to either classical, jazz, popular or no background music while completing numerous eye-hand coordination tasks performed similarly in speed and accuracy.

The effect of four music conditions was tested on reading comprehension for a sample of college students. Boyle and Coltheart (1996) also found no significant differences in accuracy and speed for college students' abilities to rate whether simple and complex sentences were logically and grammatically correct while listening to either instrumental music, acoustic singing, singing with musical accompaniment, speech, or no music. In each of these studies, background music did not have any more effect on attention than did silence.

Despite the absence of effects of various types of music on attention in some studies, some research suggests that music can influence performance. Cockerton, Moore, and Norman (1997) utilized music from a Buddhist tradition to possess a harmonic quality that would ease a person into a state of relaxation. Undergraduate students in the music condition and the control condition (no music) completed a test of general intelligence, AH4. Participants who listened to the relaxing music answered significantly more questions and answered more questions correctly. The researchers proposed that the music relaxed the participants allowing them to focus more efficiently on the task.

One's ability to concentrate on a task may also be enhanced when listening to music of one's choice. Fifty surgeons who usually listen to music during surgery volunteered for a study in which they did mathematical subtraction (Allen & Blascovich, 1994). Each surgeon listened to music of his or her choice, experimenter-selected music, and silence while doing the subtraction task. Results showed that when participants listened to their own music, speed and accuracy were significantly improved. Physiological responses also indicated that the surgeons were more relaxed when listening to music (both self-selected and experimenter-selected) than when not listening to music. Performance was also better during the experimenter selected music sessions than in the no music sessions. Although the results of this study are important to consider, one must keep in mind that the sample utilized in this study were doctors who already used music in the operating room.

The literature is inconsistent as to whether or not music affects attention while performing different tasks. Consistent with the information-load theory, results from a recent study suggest that music's ability to influence cognition may depend on the type of music heard and the type of task performed. Beh and Hirst (1999) asked college students to listen to either low or high intensity music (slow or quick rhythm) or no music while doing high or low demanding driving-related visual tracking or vigilance tasks. Results showed that music intensity did not have an effect on the participants' attention and performances for low demand tracking tasks. Response time to identify centrally located visual signs (locating things in front of the car while driving) was improved for both music conditions under both high and low demand tasks. However, those in both music conditions demonstrated increased response time (i.e., poorer performance) to locate peripheral visual signals (i.e., signs that would appear in one's peripheral vision). This performance decrement was more severe for participants hearing high-intensity music. In this study, hearing music while doing a simple task (i.e., seeing things right in front of a person) increased attention and performance. However, when the task required more resources, background music seemed to decrease attention.

Information-load theory may also explain Mayfield and Moss' (1989) results. Undergraduate business students were trained to collect and calculate closing stock-market prices while listening to fast-paced rock music, to slow-paced music that resembled the sound of a human heartbeat, or to no music. Results showed that the participants listening to rock music and to no music had the best performances, whereas those listening to the heartbeat had significantly lower performances. Although the performances under the rock and no music conditions were the same, participants listening to the rock music reported that they were distracted by the music. Considering these results, it may be possible that the rock music did enhance attention, but caused the participants to experience stress. While performing an advanced cognitive task, such as the participants did in the study, it may not be advisable to play fast-paced music.

Music's Effect on Memory Tasks

Similar to research reported previously, results from studies addressing the relationship between music and memory are also variable. In these experiments, participants listened to music while performing different tasks, such as memorizing a string of digits or reading a story passage. After a distractor task was administered (to ensure the participants are not rehearsing the to-be-remembered information), an assessment was taken to measure memory for the task. A review of the literature on music's effect on memory is presented next.

Music adds a unique aspect to memory tasks which lends support for the Mozart effect (McElhinney & Annett, 1996; Wallace, 1994). Wallace (1994) conducted a study that tested whether information was remembered better when heard as a text or in a song. Sixty-four undergraduate psychology students participated in the study. One group of students heard three verses of a ballad sung with musical accompaniment and the other group of students heard the text spoken. Analysis showed that the text was better recalled when it was heard as a song as opposed to speech. The results were found both immediately after presentation, and two days later. In a second experiment, another group of undergraduate psychology students heard words spoken in a rhythmical intonation with a beat tapped in the background while the second group heard the same words sung as a song. This experiment was done to see if the words were better remembered because they were presented in a rhythmical structure. Results showed higher recall for words in the song than in the rhythmical presentation. This study demonstrated that music was contributing something unique beyond rhythmical structure that allowed for better recall than did a nonmusical environment. Wallace suggests that music strengthens memory by tying portions of the text together, therefore increasing elaboration of the text.

In a similar study, McElhinney and Annett (1996) investigated whether college students would remember more words when sung in a song or spoken as a text. For one group, a song by Billy Joel, which none of the participants reported hearing previously, was played. A second group heard the same lyrics read by a male voice without musical accompaniment, but spoken in the same tempo. The groups underwent three trials of their condition so that each group heard the same song or spoken passage three times. Data from the three trials were analyzed separately. Results from the first trial supported that participants in the spoken group remembered more words than those in the sung condition. Yet, when long-term memory was assessed for the second and third trials, there were no significant differences in the mean number of words the two groups remembered. However, the people in the song condition remembered significantly more groups or chunks of information, as opposed to those in the text condition who remembered sporadic words which appeared in the lyrics. In this situation, it appeared that music added an element to the material that allowed people to retain it in long-term memory as meaningful chunks.

Other research showed music may enhance recall not because of its unique quality, but rather due to its ability to serve as a retrieval cue. That is, some evidence exists to support the context-dependent memory theory. Several studies have tested the effect of playing either the same or different music during encoding and recall (Balch, Bowman, & Mohler, 1992; Balch & Lewis, 1996; Smith, 1985).

Smith (1985) conducted a study to specifically test the ability of background music to serve as a context rich retrieval cue. When presented with a word list, college students heard either a Mozart piano concerto, a jazz selection, or no music at all. No significant differences among groups were found for immediate recall. Participants returned 48-hours later and were asked to recall all of the words they could remember. During this time, they were either presented with the music they had heard originally, a different type of music, or silence. A context-dependent (or music-dependent) effect was found; those tested with the same music at encoding and recall remembered significantly more words than any of the other groups. Long-term memory was enhanced by the original context being reinstated, but only for the music condition. That is, the no music condition did not create a context in which learning was improved when silence was again reinstated. Those who listened to Mozart during the encoding phase of the experiment recalled a significantly higher percentage of words than those who listened to jazz music. This effect was independent of the kind of music that was played during recall. No detrimental effect was found for those participants who originally heard music and then were presented with silence or for those who learned the words in silence and were later presented with music.

Similar findings were reported by Balch, Bowman, and Mohler (1992). They asked college students to listen to either fast or slow tempo music while rating words for "pleasantness." At recall, either the same musical selection or different type (classical or jazz) and tempo was played as participants wrote down any words that they remembered. To be more specific, if a person in the different type condition heard a slow jazz song during encoding, a fast classical song was presented at recall. Those who heard the same music at encoding and recall remembered significantly more words than the other groups. Those who heard a different selection, type, and tempo at recall received the lowest scores. Performance by those in the no music condition fell between that of people in the same and different music conditions. This study suggested that listening to the same type of music facilitated memory more than not listening to music at all. It is also suggested that differential tempos had a negative effect on memory.

In a similar study, Balch and Lewis (1996) asked undergraduate students to listen to music while rating the "pleasantness" of a series of words. Following a distractor task, participants either heard the same music, the same music at a different tempo, or a different selection of music altogether while recording any words that they remembered. Results showed that those who heard the same selection as was encoded, played at the same tempo during recall remembered significantly more words than did those from the other two groups. People who heard music with a different tempo during recall than during encoding did not differ in the amount of words recalled from those who heard a different music selection altogether.

Although some research suggests that music facilitates memory, under certain conditions it appears to be detrimental to performance. Kiger (1989) examined music's effect on reading comprehension by young adults. High school students read a passage while listening to fast-paced instrumental music, slow-paced instrumental music, or no music. Following a distractor task, participants were given a multiple-choice quiz to complete, in silence, over the reading material. Results showed that those students who read the passage while listening to slow paced music had significantly higher scores on a quiz over the reading material than did the students listening to fast paced music or to no music. The fast-paced music may have distracted the readers and decreased the attention available to encode new information, whereas the slow-paced music increased or had no effect.

Martin, Wogalter, and Forlano (1988) had undergraduate students listen to either continuous speech, randomly arranged speech, instrumental music, random tones, white noise, or no music while reading story passages. After a distractor task, they were tested on the passages. Recall was significantly lower when participants heard continuous and random speech than for the other conditions. The verbal information contained in the speech may have distracted the participants from processing the verbal material in the story. Interestingly, differences in comprehension were not found among groups hearing silence, instrumental music, random tones, and white noise.

Experiments using another type of cognitive task, digit recall, have also demonstrated that the information load of background music interacts with task complexity to explain memory performance. Nittono (1997) asked college students to recall a series of nine-digit numbers immediately after being visually presented with them on the computer. This task was performed while listening to instrumental background music in forward or reverse sequence. Results suggested that music played in its normal format led to significantly more errors on the digit recall task than did music played backwards. Reversing the music may allow people to focus on the task because their attention was not diverted by the song.

In a similar study by Salame and Baddeley (1989), college students were presented with vocal music, instrumental music, or silence while recalling a series of nine-digit numbers. Vocal music interfered with performance, whereas instrumental music interfered more than silence but was only slightly more disruptive than was silence. In a follow-up experiment, the same procedure was used but in this trial, participants were allowed to practice the task for one hour. Again, vocal music distracted from the attention to the task at hand, but no significant difference was found in the number of digits recalled by those in the instrumental music condition and those in the silence condition. The results suggest that familiarity with a task mediated how instrumental, but not vocal music, influenced memory.

Summary

Overall, research supported the idea that music may contribute something unique which aided in memory processes and that background music can serve as a contextual cue to enhance recall. However, inconsistency in the findings, including that music sometimes had no effect or a positive effect on attention and memory, and other times interfered with cognitive processing, may be best explained by the information-load theory. That is, variation in memory performance for different tasks may be due to the interaction of the information load of the background music played during encoding along with the complexity of the task.

The Present Study

In this study, two groups of participants, one who listened to music and one who did not, memorized a list of words and definitions and read a passage. This study examined whether there was a difference in the way background music affected memory for two different types of tasks. A reading passage requires more cognitive effort as it demands not only that the person use short-term memory to encode the information at hand and long-term memory to retrieve it, but also that the person understands the information. Memorizing a list of words and definitions also required attention, concentration, and the use of short and long-term memory, but because the information does not necessarily need to be understood to be memorized, it requires less cognitive resources. Thus the reading comprehension task required a high degree of concentration, whereas the words and definition task required low to moderate concentration.

Mozart's Sonata for Two Pianos in D Major was selected as the musical piece for the music group in the present study. The reasons were that it had been shown to render positive cognitive effects, it was instrumental and it was unique in rhythmic presentation making the musical classified it as high information-load (Rauscher, Shaw, & Ky, 1993; Rideout & Taylor, 1997). High information-load music was chosen to isolate the effects of this kind of music on the two tasks. To ensure that the participants were not rehearsing the information to-be-remembered, math quizzes were administered prior to testing. Math was selected as a distractor task as it did not include verbal information that could interfere with the vocabulary words and definitions and the reading passage. The main issue addressed by the present study was whether background music affected performance for the two cognitive tasks differently.

Hypotheses

Three hypotheses were tested to explain the role of background music in the present study.

Hypothesis 1: The number of vocabulary words remembered would be significantly higher than the number of questions correctly answered about the passage.

Hypothesis 2: Adults who listen to background music would have significantly higher scores on the vocabulary/definition quiz than those who do not listen to background music.

Hypothesis 3: Adults who listen to background music would have significantly lower reading comprehension scores than those who do not listen to background music.

CHAPTER 2

METHOD

Participants

Forty-eight predominantly Caucasian undergraduate college students enrolled in introductory psychology courses in a small midwestern city participated in the present study. Students volunteered to participate as part of their course requirements. The sample consisted of 22 men and 26 women ranging in age from 18 to 30 years old (M age = 20 years, 8 months, SD = 2.84). Two participants were dropped from the study because they were not fluent in the English language. Of the remaining participants, all but two were native English speakers; both indicated that they have been speaking English for over 15 years and considered themselves to be fluent. The sample used in the present experiment is assumed to be generalizable to other midwestern undergraduate students residing in a small community due to the similarity of the population make-ups.

Materials

The best method for assessing reading comprehension and definition retention was determined through pilot testing. To avoid ceiling and floor effects, questionnaire styles (i.e., multiple choice, matching) were tested to ascertain which format provided the most variability in answers for the sake of consistency, and based on pilot data results, a multiple choice format was selected for both tasks.

Word list and quiz. The vocabulary list (Appendix A) was composed of 20 words and definitions that were randomly selected from a book published by Kaplan to improve Scholastic Achievement Test (SAT) scores entitled SAT Verbal Workbook (Simon & Schuster, 1998). All of the words on the list were adjectives and appeared in Book

Antiqua, 12-point font. Because the words were obtained from a book that prepares students for a college entrance exam and the students used in the present experiment were already in college, the words were assumed to be challenging but not too difficult. Ten of the 20 words were randomly selected from the word list and were used for the quiz. The quiz was used to test the number of words remembered by the participants and was in multiple choice format requiring participants to select the correct definition from four choices that matched each of the 10 words (Appendix B). Each correct response was worth 1 point making the range of possible points on the test from 0 to 10.

Reading passage and quiz. The reading passage (Appendix C) was selected from the same book as the word list, SAT Verbal Workbook (Simon, & Schuster, 1998). The passage was titled, "Life on Mars" and was a nonfiction account of two Viking landers which were sent to Mars to gather information about potential life on the planet. The passage contained 687 words, was double-spaced, and in Book Antiqua, 12-point font. Fry's Readability Test indicated the passage was at an eighth grade reading level.

The quiz consisted of 10 multiple-choice questions (Appendix D). Five of the questions addressed the reader's comprehension of the passage and were taken directly from the book, SAT Verbal Workbook. The other five questions were constructed by the experimenter and were based solely on facts stated in the passage. Each question was worth one point making the range of the quiz from 0 to 10 points. Answers were placed on a scantron sheet. Permission was granted by Kaplan to use the passage and quiz in the present study.

Distractor task. A math quiz was selected as the distractor task as it did not include verbal information that could interfere with previous learning on the vocabulary and reading tasks. The math quiz included a variety of problems, such as addition, subtraction, multiplication, exponents, division, word problems, and conversion of metric numbers written in a multiple choice format (Appendix E). Two forms (A and B) of this math quiz served as the distractor task and were used between the encoding and testing phase of each task to ensure that the participants did not rehearse the material to-be-remembered. The quiz was taken from the first eight pages of an eighth grade math book, <u>The Mathematical Experience</u> (Haubner, Rathmell, & Super, 1992) to ensure that it was not too difficult or intimidating. Permission was granted by the publisher, Houghton Mifflin, to use the math quizzes in the present study.

<u>Musical selection</u>. Mozart's Sonata for 2 Pianos in D major was chosen as the background musical selection due to its reported abilities to improve performance and its unique and unrepetitive nature, therefore high information-load. Music was played on an Aiwa portable stereo, at a volume of five (as displayed by a digital number). This volume ensured that the music was at a "background" level; that is, the music was not overpowering, but was able to be heard clearly. To minimize visual distraction, the stereo was placed on a table directly behind the participants so that it did not appear in their visual field.

<u>Procedure</u>

Each participant was tested individually. Immediately upon arriving, the participant was asked to complete an informed consent document describing the purpose of the investigation (Appendix F). Next, each participant was given the first of the two tasks. Each task consisted of three phases: encoding, distraction, and testing. For the encoding phase, the participant was asked to memorize vocabulary words or to read the passage. The order of the tasks was determined by random assignment and was counterbalanced across participants. When the vocabulary list was given, the participant was told,

> Here is a list of words and their definitions to memorize using any technique you want. You will have five minutes to complete this task. Later in the session you will be tested on your knowledge of these words. I will wait outside the room until the five minutes have passed and then I will come in and give you the next set of directions. Do you have any questions?

When the reading passage was administered, the participant was told,

> Here is a reading passage. Please read it as quickly and as carefully as you can. You will have five minutes to complete this task. I will wait outside the room until the five minutes have passed. Please wait here until I return even if you have already finished reading the story. Later in the session you will be tested on your knowledge and understanding of this story. Do you have any questions?

After giving instructions for each task, the experimenter exited the room so as not to serve as a distraction to the participant. During the encoding phases, half of the participants were exposed to background music (experimental condition) and half were not (control group).

Following the encoding phases, participants were given the distractor math problems. Regardless of condition, no music was played during this phase. The experimenter removed the vocabulary list or reading passage and gave the participant one of two forms of the 4-page math quiz. Half of the participants were given Form A for the first distractor phase and the other half were given Form B. Order was determined by random assignment and was counterbalanced across participants. The participant was told,

> Solve as many problems as you can in five minutes. If you do not know how to solve a problem, go on to the next one. Please write directly on the test. You may use the back sheet as scratch paper.

The testing phases followed the distractor phases. In order to simulate real life test situations, music was not played for either group. The experimenter collected the math test and then administered the appropriate quiz. The participant was told,

> Please do your best to answer as many questions as possible on this quiz. You have up to five minutes to complete this task. If you complete the quiz before five minutes, open the door and I will come in and give you the next set of instructions.

After completing the testing phases for both tasks, each participant was asked to complete a demographic questionnaire asking information (e.g., if he/she listens to classical music, listen to music while studying, familiarity with vocabulary list, etc.) that served as a manipulation check for the study (Appendix G). Participants in the music condition received a different demographic sheet with three additional questions specifically addressing the music (Appendix H). The experimenter volunteered to answer any questions students had, briefly explained the goal of the study, thanked them for participating, and then gave them a sheet of paper reporting one credit of research participation that fulfilled the requirement for any introductory psychology course.

CHAPTER 3

RESULTS

The vocabulary scores and reading scores were analyzed using separate 2 (Study Condition: music vs. no music) x 2 (Task: vocabulary words vs. reading comprehension) repeated measures analyses of variance. Study Condition was the between-subjects factor and Task served as the within-subject factor. A significant main effect was found for Task, F (1,46) = 65.74, $p < .01$. Consistent with Hypothesis 1, participants performed better on the vocabulary test (M = 9.02, SD = 1.51) than on the reading comprehension task (M = 6.52, SD = 1.85). Thus, participants found the vocabulary task to be easier than the reading comprehension task, which was congruent with the task manipulation. The absence of a main effect of Study Condition, F (1,46) = .43, p = .51, showed that the presence of music did not influence memory performance. There was no significant Study Condition by Task interaction, F (1,46) = .46, p = .50, indicating that the music did not differentially affect memory performance on the two cognitive tasks. Table 1 shows the means and standard deviation for both conditions. Contrary to expectations, those in the music group did not have higher vocabulary scores (Hypothesis 2) or lower reading scores (Hypothesis 3) than those in the control group.

Ad-hoc analyses were conducted to ascertain whether previous familiarity with the vocabulary words or with the story about Mars' landings could have affected performance. A correlation was performed to determine whether students who reported knowing some of the vocabulary words prior to the experiment had higher scores than those who did not report being familiar with any of the vocabulary. Results showed no significant relationship between the number of words students previously knew with their

Table 1

Means and Standard Deviations for Both Tasks for Music and No Music Conditions

	Vocabulary Recall		Reading Comprehension		Total	
	M	SD	M	SD	M	SD
Music Condition	9.25	1.07	6.54	1.64	15.79	1.93
No Music Condition	8.79	1.84	6.50	2.06	15.29	3.18
Total	9.02	1.51	6.52	1.84	15.54	2.62

scores on the vocabulary quiz, $r(48) = .30$, $p = .12$. A correlation was not performed for the presence or absence of knowledge about the Mars' landings with reading performance because only five students indicated previous exposure to this topic.

Additional ad-hoc analyses were conducted to determine whether individual preferences affected performance by students in the music condition. Students who usually listened to classical music may have performed better than those who did not listen to classical music. Comparisons with classical music listeners ($N = 12$) to non-classical music listeners ($N = 12$) on vocabulary and reading scores were conducted separately. No significant effects were found for the vocabulary scores, $t(22) = -1.15$, $p = .26$, or for the reading scores, $t(22) = .61$, $p = .55$, indicating that music preferences did not affect performance on either task. Table 2 lists the means and standard deviations for both tasks by music preference.

Another issue addressed by ad-hoc analyses was to determine whether study preferences of students in the music condition affected performance on the two tasks. It was possible that those who currently studied while listening to music were more comfortable with the music in the experiment because it simulated their usual studying habits. Fifteen students indicated that they listened to music while studying, whereas nine students indicated that they did not. t-test analyses comparing these groups yielded no significant differences for the vocabulary quiz, $t(22) = .10$, $p = .92$, or for the reading quiz, $t(22) = 1.56$, $p = .13$. Table 3 shows the means and standard deviations for tasks by study habits. Thus, neither students' music preferences nor their study habits affected performance on the vocabulary and reading measures.

Table 2

Means and Standard Deviations for Both Tasks by Music Preference

	Classical Music Listeners		Non-Classical Music Listeners	
	M	SD	M	SD
Vocabulary	9.00	.80	9.50	1.28
Reading	6.75	1.82	6.33	1.82

Table 3

Means and Standard Deviations for Both Tasks by Study Habits

	Study with Music		Study without Music	
	M	SD	M	SD
Vocabulary Recall	9.27	1.10	9.22	1.09
Reading Comprehension	6.93	1.79	5.89	1.17

A final possibility existed concerning how music affected students' attention. In order to ascertain whether music disrupted students' concentration, they were asked to rate how distracting the music was when they were trying to read and memorize. A 5-point Likert scale was used with one representing "not distracting at all" and five representing, "very distracting." Students in the music condition did report that the music was more distracting when they were trying to read than when memorizing the vocabulary words. When memorizing vocabulary words, students rated their mean level of distraction lower ($M = 1.83$, $SD = 1.05$) than when reading the passage ($M = 2.58$, $SD = 1.35$), $t(23) = 3.19$, $p < .01$. However, participants' reported level of distraction when memorizing vocabulary words did not significantly correlate with their vocabulary scores, $r(48) = -.39$, $p = .06$. In addition, students' reported level of distraction when reading was not significantly correlated with their reading scores, $r(48) = -.11$, $p = .61$. Consequently, regardless of reported distraction from music, there did not appear to be a relationship with performance on the two tasks.

CHAPTER 4

DISCUSSION

Different theories have attempted to explain the role of background music on cognitive activities. The present study was unique in that it attempted to examine music's effect on two cognitive tasks of varying levels of difficulty. Congruent with the information-load theory, students' performance was expected to differ due to the interaction of high information-load music with the complexity of the task. Consistent with Hypothesis 1, students earned higher scores on the simple task, remembering vocabulary words, than on the difficult task, comprehending a reading passage. Moreover, students' high performance on the vocabulary quiz and low performance on the reading quiz demonstrated the success of the task manipulation. However, the prediction in Hypothesis 2 that students listening to background music would recall significantly more words and definitions than those not listening to music was not confirmed. Thus, contrary to the information-load theory, background music did not appear to have a facilitating effect on the participants' ability to accomplish a simple task. Similarly, the prediction in Hypothesis 3 that students who listened to background music would have significantly lower scores on the reading quiz than those who did not listen to music was not supported. According to the theory, high information-load music should have served as a distractor, making the reading task more difficult because it lessened one's ability to attend to, memorize, and comprehend relevant information. Although performance was not lower in the music group, participants did indicate that they were more distracted by the music when performing the more difficult task, than the simpler task.

Clearly, the information-load theory cannot adequately explain the absence of significant differences between scores of students in the music and control groups. However, the competing theories, the Mozart effect, and the interference theory are also equally deficient. That is, the music did not appear to have a positive effect on memory or attention, as would have been predicted by the Mozart effect (Rauscher, Shaw, Ky, 1993), nor did the music lower performance, as would be predicted by the interference theory (Furnham & Bradley, 1997). Results from the present experiment are consistent with many others that failed to find an effect of music on performance (Boyle & Coltheart, 1996; Manthei & Kelly, 2000; Sogin, 1988). Because the participants in both groups received such similar scores, it can be assumed that music did not significantly facilitate or interfere with the participants' memory in these tasks. However, although the students did not generally indicate that the music was distracting, there was some effect of the high information-load music on students' perceived concentration. As indicated in the ad-hoc analysis, students reported that the music was more distracting to them when they were reading than when memorizing the words and definitions. Yet, it did not appear that high information-load music succeeded in facilitating memory for the simpler task or hindering memory for the more complex task.

Results in the present experiment are similar to those found by Newman et al. (1995) in which the same musical piece rendered null results for a spatial ability task. Congruent with the present experiment, Newman et al. did not find that college students who listened to Mozart performed better than those who completed the task in silence. It may be more beneficial to test the information-load theory with more than one musical piece. Future studies may want to compare high information-load music to low information-load music to ascertain directly the role of load on cognitive tasks. However, it may be difficult to find both high and low-information load music that are comparative in style and type.

Obviously, an individual's musical preferences play a role in performance (Sogin, 1988). For example, participating in a study in which classical music was played when the person did not like this type of music would have either been annoying or could have facilitated performance by allowing students to tune out the music. Because there was a small sample and people's likes and dislikes for classical music was not related to performance, it would be impossible to conclude which possibility was correct. This is one of the limitations of the current research and future studies should use a larger sample to test this idea.

It was also possible that results in the present study were influenced by participants' current studying habits. Although there was not a significant difference between those who reported listening and not listening to music while studying, there has been research suggesting that being exposed to music while participating in an experiment affected one's responses about musical listening habits. Mayfield and Moss (1989) found that participants in the music condition were significantly more likely to minimize whether they listen to music while studying when asked after participating in the music condition. Considering this finding, it is possible that participants underreported the amount of studying done accompanied by music. Another limitation of this study was that only nine participants indicated that they did not listen to music while studying, people who currently study with music or other background noise such as the television, are not distracted by it. Etaugh and Ptasnik (1982) found that people who seldom studied with background music performed better when they learned in silence, whereas those who frequently studied with music performed better when music was played. Future research may wish to assess the current study habits of participants before the experiment to see how habits correlate with individuals' memory performances.

Another variable that may affect one's focus when performing various tasks is personality. Personality differences may be responsible for preferences in studying environment. Certain personality traits may play a role in music's ability to be facilitating or distracting. Davies, Hockey, and Taylor (1969) suggest that introverts are more vulnerable to distraction when presented with extraneous noise, such as music. Extroverts, on the other hand, may be more comfortable with a low level of distraction than silence. Personality factors could also be considered when conducting research of this type.

The current experiment does not indicate a positive or negative effect of music on performance. Performing a task for an extended period of time may be necessary before an affect can be observed. Although most of the experiments on memory and music play music for only 2-10 minutes, playing music for more than five minutes may be necessary to receive a measurable affect. Usually, one reads or studies for more than 5-minute intervals. In addition, when background music is present, as in businesses, it is usually played throughout the day. Perhaps music's affect on attention and memory would best be tested in a longer time interval to more accurately parallel what occurs in reality.

The effect of music on memory may be of a multifaceted nature. Perhaps the best way to test studies of this type would be to assess personality, individual music likes, and current study habits, and then to correlate these factors with performance using different types of music. Future research is necessary to explore and test this area in more detail. Because music is predominant in our culture, its effects on cognitive processes should be explored further.

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Appendix A

winsome—charming, happily engaged

feckless—ineffective, careless, irresponsible

nebulous—vague, cloudy

impassive—showing no emotion

lachrymose—tearful, mournful

clairvoyant—having ESP, psychic

verdant—green with vegetation; inexperienced

sophomoric—immature and overconfident

pandemic—spread over a whole area or country

unimpeachable—beyond question

dogmatic—rigidly fixed in opinion, opinionated

odious—hateful, contemptible

gaunt—thin and bony

mawkish—sickeningly sentimental

lissome—easily flexed, limber, agile

rococo—very highly ornamented

slovenly—untidy, messy

heinous—shocking, wicked, terrible

quixotic—overly idealistic

defamatory—slanderous, injurious to the reputation

Appendix B

Subject #_____ Date ____

For each of the 10 words, please indicate which choice (a, b, c, or d) provides the correct definition. Please record your answers directly on this sheet.

_____ 1. pandemic
a. contagious
b. dangerous
c. spread over a whole area
d. agile

_____ 2. impassive
a. relating to others' feelings
b. showing no emotion
c. determined
d. psychic

_____ 3. mawkish
a. sickeningly sentimental
b. charming
c. have an annoying trait
d. to make fun of

_____ 4. unimpeachable
a. inconsequential
b. beyond question
c. vague
d. presidential offence

_____ 5. defamatory
a. overconfident
b. opinionated
c. hateful
d. slanderous

_____ 6. lachrymose
a. cancerous
b. tearful
c. thin and bony
d. lacking emotion

_____ 7. verdant
a. green with vegetation
b. overgrown
c. truthful
d. rigidly fixed in opinion

_____ 8. rococo
a. prizewinning
b. seasonal
c. immature and overconfident
d. very highly ornamented

_____ 9. heinous
a. messy
b. pertaining to the rear
c. terrible
d. admirable

_____ 10. feckless
a. idealistic
b. persistent
c. optimistic
d. ineffective

Appendix C

Life on Mars

The following passage discusses the possibility that there is life on Mars. Interest in the subject reached a peak when the National Aeronautics and Space Administration sent two unmanned spacecraft to Mars in 1975. After ten months, Vikings 1 and 2 entered orbits around the red planet and released landers.

When the first of the two Viking landers touched down on Martian soil on July 20, 1976, and began to send camera images back to Earth, the scientists at the Jet Propulsion Laboratory could not suppress a certain nervous anticipation, like people who hold a ticket to the lottery they have a one-in-a-million chance of winning. The first photographs that arrived, however, did not contain any evidence of life. What revealed itself to them was merely a barren landscape littered with rocks and boulders. The view resembled nothing so much as a flat section of desert—in fact, the winning entry in a contest at J.P.L. for the photograph most accurately predicting what Mars would look like was a snapshot taken in a particularly arid section of the Mojave Desert.

The scientists were soon ready to turn their attention from visible life to microorganisms. The twin Viking landers carried three experiments designed to detect current biological activity and one to detect organic compounds, because researchers thought it possible that life had developed on early Mars just as it is thought to have developed on Earth, through the gradual chemical evolution of complex organic molecules. To detect biological activity, Martian soil samples were treated with various nutrients that would produce characteristic byproducts if life forms were active in the soil. The results from all three experiments were inconclusive. The fourth experiment

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heated a soil sample to look for signs of organic material but found none, an unexpected result because at least organic compounds from the steady bombardment of the Martian surface by meteorites were thought to have been present.

The absence of organic materials, some scientists speculated, was the result of intense ultraviolet radiation penetrating the atmosphere of Mars and destroying organic compounds in the soil. Although Mars' atmosphere was at one time rich in carbon dioxide and thus thick enough to protect its surface from the harmful rays of the Sun, the carbon dioxide had gradually left the atmosphere and been converted into rocks. This means that even if life had gotten a start on early Mars, it could not have survived the exposure to ultraviolet radiation when the atmosphere thinned. Mars never developed a protective layer of ozone as Earth did.

Despite the disappointing Viking results, there are those who still keep open the possibility of life on Mars. They point out that the Viking data cannot be considered the final word on Martian life because the two landers only sampled two limited—and uninteresting—sites. The Viking landing sites were not chosen for what they might tell of the planet's biology. They were chosen primarily because they appeared to be safe for landing a spacecraft. The landing sites were on parts of the Martian plains that appeared relatively featureless from orbital photographs.

The type of Martian terrain that these researchers suggest may be a possible hiding place for active life has an Earthly parallel: the ice-free region of southern Victoria Land, Antarctica, where the temperatures in some dry valleys average below zero. Organisms known as endoliths, a form of blue-green algae that has adapted to this harsh environment, were found living inside certain translucent, porous rocks in these

Antarctic valleys. The argument based on this discovery is that if life did exist on early Mars, it is possible that is escaped worsening conditions by similarly seeking refuge in rocks. Skeptics object, however, that Mars in its present state is simply too dry, even compared with Antarctic valleys, to sustain any life whatsoever. Should Mars eventually prove to be completely barren of life, as some suspect, then this would have a significant impact on the current view of the chemical origin of life. It could be much more difficult to get life started on a planet than scientists thought before the Viking landings.

Appendix D

Please refer to the reading passage, *Life on Mars* to answer the following questions on the scantron sheet

1. The major purpose of the passage was to
   (A) relate an account of an extraordinary scientific achievement
   (B) undermine the prevailing belief that life may exist on Mars
   (C) discuss the efforts of scientists to determine whether Martian life exists
   (D) show the limitations of the scientific investigation of other planets
   (E) examine the relationship between theories about Martian life and evolutionary theory

2. The laboratory involved in analyzing the Viking's findings was
   (A) Aeronautics Administration
   (B) Space Administration Laboratory
   (C) NASA
   (D) Offut Space Laboratory
   (E) Jet Propulsion Laboratory

3. According to the passage, the winning entry of a contest for the photograph most accurately predicting what Mars would look like was a picture of the
   (A) Sahara Desert
   (B) Mojave Desert
   (C) Kalahari Desert
   (D) Navajo Desert
   (E) Gobi Desert

4. The fourth experiment conducted by the second Viking lander heated a soil sample to look for signs of organic material and found:
   (A) nothing
   (B) evidence of meteorites hitting the surface of the planet
   (C) evidence of rock formations
   (D) a flat section of desert
   (E) evidence of organic life

5. The author used the evidence from the four Viking experiments to establish that
   (A) meteorites do not strike the surface of Mars as often as scientists had thought
   (B) current theory as to how life developed on Earth is probably flawed
   (C) there was no experimental confirmation of the theory that life exists on Mars
   (D) biological activity has been shown to be absent from the surface of Mars
   (E) the experiments were more fruitful than was examination of camera images

6. On what bases were the Viking landing sites chosen?
   (A) the area appeared to be mountainous, and therefore more likely to house life
   (B) the area appeared to be the most likely sites for life to exist
   (C) the area appeared to be safe for landing a spacecraft
   (D) the area appeared to be somewhat inverted or indented so that there would be space for the Viking to land
   (E) the area appeared to have the same temperature as places on Earth, such as Antarctica and would therefore be best to evaluate

7. The author suggests that an important difference between Mars and Earth is that, unlike Earth, Mars
   (A) accumulated organic compounds from the steady bombardment of meteorites
   (B) possessed at one time an atmosphere rich in carbon dioxide
   (C) is in the path of the harmful rays of ultraviolet radiation
   (D) has an atmospheric layer that protects organic compounds
   (E) could not have sustained any life that developed

8. The author mentioned the Viking landing sites in order to emphasize which point?
   (A) Although evidence of life was not found by the landers, this does not mean that Mars is devoid of life
   (B) Although the landing sites were uninteresting, they could have harbored Martian life.
   (C) The Viking mission was unsuccessful largely due to poor selection of the landing sites.
   (D) The detection of life on Mars was not a primary objective of the scientists who sent the Viking landers.
   (E) Scientists were not expecting to discover life on the Martian plains.

9. The researchers' argument that life may exist in Martian rock rests on the idea that
   (A) organisms may adopt identical survival strategies in comparable environments
   (B) life developed in the form of blue-green algae on Mars
   (C) life evolved in the same way on two different planets
   (D) endoliths are capable of living in the harsh environment of Mars
   (E) organisms that have survived in Antarctica could survive the Martian environment

10. Which of the following sites on Earth did the authors suggest may be a similar hiding place for active life on mars?
   (A) Northern Sahara desert
   (B) Southern Victoria Land
   (C) Death Valley
   (D) Antibes Peninsula

(E) South Sea Islands

Name ______________________________
Date ______________________
Score ______________________

CHAPTER TEST 1

Form A

Appendix E

DIRECTIONS: Choose the correct answer. Mark A, B, C, or D.

(pp. 2–7, 12–13)

Complete.

1. $3^4 = \_\_ \times \_\_ \times \_\_ \times \_\_$

A. 3; 3; 3 **B.** 3; 3; 4
C. 3; 3; 3; 3 **D.** not given

2. $5^{\_\_} = 5 \times 5 \times 5$

A. 3 **B.** 5
C. 2 **D.** not given

3. $10^{\_\_} = \frac{1}{10 \times 10}$

A. $^-2$ **B.** 10
C. 2 **D.** not given

Find the standard form.

4. $(4 \times 10^3) + (2 \times 10^1) + (3 \times 10^{-1}) + (7 \times 10^{-2})$

A. 402.037 **B.** 4,020.37
C. 40,020.37 **D.** not given

5. 700 + 60 + 0.2 + 0.08 + 0.003

A. 7,600.283 **B.** 7,602.83
C. 762.83 **D.** not given

(pp. 8–9)

Complete.

6. $52{,}800 = 5.28 \times 10^{\_\_}$

A. 4 **B.** $^-4$
C. 3 **D.** not given

7. $0.039 = 3.9 \times 10^{\_\_}$

A. 2 **B.** $^-3$
C. $^-2$ **D.** not given

8. $7{,}130 = 7.13 \times 10^{\_\_}$

A. $^-3$ **B.** 2
C. 3 **D.** not given

Find the standard form.

9. 2.07×10^3

A. 2,070 **B.** 207
C. 20,700 **D.** not given

10. 6.015×10^{-4}

A. 0.00615 **B.** 0.0006015
C. 60,150 **D.** not given

Order from least to greatest. (pp. 10–11)

11. 313; 303; 331

A. 313; 303; 331
B. 331; 313; 303
C. 303; 313; 331
D. not given

12. 2.626; 2.266; 2.662

A. 2.626; 2.266; 2.662
B. 2.662; 2.626; 2.266
C. 2.266; 2.662; 2.626
D. not given

13. 0.075; 0.0057; 0.0075

A. 0.0057; 0.0075; 0.075
B. 0.075; 0.0075; 0.0057
C. 0.0075; 0.0057; 0.075
D. not given

14. 0.080; 0.80; 0.0080

A. 0.0080; 0.080; 0.80
B. 0.80; 0.0080; 0.080
C. 0.080; 0.0080; 0.80
D. not given

15. 3.08; 3.082; 3.0802

A. 3.0802; 3.08; 3.082
B. 3.08; 3.0802; 3.082
C. 3.082; 3.0802; 3.08
D. not given

Name ____________________

CHAPTER TEST 1

Form A (continued)

Round to the value of the underlined place. (pp. 18–19)

16. $5{,}4\underline{3}8.7$
A. 5,430
B. 5,400
C. 5,439
D. not given

17. $6{,}\underline{4}82.9$
A. 6,500
B. 6,400
C. 6,000
D. not given

18. $81.\underline{4}56$
A. 81.4
B. 81.46
C. 81.5
D. not given

19. $0.02\underline{6}09$
A. 0.03
B. 0.0261
C. 0.026
D. not given

20. $\underline{3}3{,}681$
A. 30,000
B. 33,000
C. 3,000
D. not given

Find the expression. (pp. 22–23)

21. n multiplied by 9
A. $n + 9$ **B.** $9n$
C. $n \div 9$ **D.** not given

22. 9 less than x
A. $9 - x$ **B.** $9 + x$
C. $x - 9$ **D.** not given

23. 6 decreased by m
A. $6 - m$ **B.** $6 + m$
C. $m - 6$ **D.** not given

Find a word phrase for the expression. (pp. 22–23)

24. $27 - n$
A. n less than 27 **B.** 27 less than n
C. n decreased by 27 **D.** not given

25. $y \div 2$
A. 2 divided by y **B.** y divided by 2
C. y multiplied by 2 **D.** not given

Complete. (pp. 20–21, 26, 29)

26. 6 m = ______ cm **A.** 60 **B.** 600 **C.** 6,000 **D.** not given
27. 1.75 km = ______ m **A.** 1,750 **B.** 175 **C.** 17.5 **D.** not given
28. 25 kg = ______ g **A.** 2,500 **B.** 250 **C.** 0.25 **D.** not given
29. 2,000 mL = ______ L **A.** 200 **B.** 2 **C.** 20 **D.** not given
30. 4,500 g = ______ kg **A.** 45 **B.** 450 **C.** 4.5 **D.** not given

Solve. (pp. 14–15, 24–25)

31. There are 225 students involved in a regional science fair. About 3 out of 5 students are new to the fair. About how many students are new?
A. 235 students **B.** 375 students
C. 135 students **D.** not given

32. There are 62 schools involved in the science fair. Of this number, 38 are listed as small schools. How many schools are not listed as small schools?
A. 34 schools **B.** 24 schools
C. 100 schools **D.** not given

33. One student reported that about 40,000 pieces of litter are dropped on the beaches each day. About how many pieces of litter are dropped in 365 days?
A. 14,600 pieces **B.** 146,000 pieces
C. 1,460 pieces **D.** not given

34. Students are scheduled to present their research findings every 5 min. If 1 h 30 min is set aside for earth science reports, how many reports are scheduled for this time?
A. 28 reports **B.** 16 reports
C. 18 reports **D.** not given

35. The auditorium where the awards will be presented seats 700. There are 225 students, 75 sponsors, and 60 judges. How many seats are available for parents and other visitors?
A. 440 seats **B.** 340 seats
C. 240 seats **D.** not given

Name ______
Date ______
Score ______

CHAPTER TEST 2

Form A

DIRECTIONS: Choose the correct answer. Mark A, B, C, or D.

Compute. (pp. 36–39, 42–43)

1. 3,764 + 6,455 = ______

A. 9,219 **B.** 10,219
C. 10,119 **D.** not given

2. 9,116 − 3,695 = ______

A. 6,421 **B.** 5,321
C. 5,421 **D.** not given

3. $18.65 + $7.28 = ______

A. $25.93 **B.** $25.83
C. $26.93 **D.** not given

4. $74 − $3.80 = ______

A. $70.20 **B.** $71.20
C. $71.80 **D.** not given

5. 176.5 − 35.12 = ______

A. 141.42 **B.** 141.48
C. 140.38 **D.** not given

Compute. (pp. 44–47, 50–51)

6. 11.25 × 7.04 = ______

A. 79.2 **B.** 7.92
C. 79.02 **D.** not given

7. 32,000 ÷ 25 = ______

A. 128 **B.** 12 R 8
C. 1,280 **D.** not given

8. 9.072 ÷ 9 = ______

A. 1.08 **B.** 1.8
C. 1.008 **D.** not given

9. 34.5 × 0.58 = ______

A. 200.1 **B.** 20.01
C. 2.001 **D.** not given

10. 72.6 ÷ 3 = ______

A. 24.2 **B.** 24 R2
C. 2.42 **D.** not given

Use compatible numbers to estimate the quotient. (pp. 54–55)

11. $82\overline{)639}$

A. 80 **B.** 8
C. 9 **D.** 90

12. $4.3\overline{)41.9}$

A. 9 **B.** 100
C. 90 **D.** 10

13. $3.9\overline{)23.9}$

A. 60 **B.** 7
C. 6 **D.** 70

14. 207 ÷ 21

A. 7 **B.** 100
C. 70 **D.** 10

15. 419 ÷ 6.89

A. 60 **B.** 7
C. 6 **D.** 70

Solve the equation. (pp. 60–63, 66–67)

16. $y - 210 = 30$

A. 180
B. 240
C. 510
D. not given

17. $13z = 91$

A. 6
B. 8
C. 7
D. not given

18. $a + 33 = 85$

A. 52
B. 118
C. 53
D. not given

19. $b \div 6 = 15$

A. 9
B. 21
C. 63
D. not given

20. $175 \div h = 25$

A. 8
B. 7
C. 150
D. not given

(pp. 58–59, 64–65)

Simplify each expression.

21. $6 + 2 \times 5 - 12 \div 3$

A. 36 **B.** 12
C. 7 **D.** not given

22. $5 \times 3 + 6^2$

A. 195 **B.** 27
C. 51 **D.** not given

Evaluate. Use the given value for the variable.

23. $16 + n; n = 39$

A. 55 **B.** 45
C. 23 **D.** not given

24. $m \div 5; m = 15$

A. 3 **B.** 75
C. 5 **D.** not given

25. $2(p - 4); p = 9$

A. 14 **B.** 10
C. 26 **D.** not given

Solve if enough information is given. (pp. 40–41, 48–49, 56–57)

26. A city had a population of 375,265 in 1980. The population was 567,304 in 1990. By how much had the population increased in that period of time?

A. 292,039 **B.** 192,039
C. 192,139 **D.** not enough information

27. A city had a population of 163,250 in 1980. The 1980 population was 16,604 more than in 1990. What was the population in 1990?

A. 146,646 **B.** 156,646
C. 179,854 **D.** not enough information

28. A city of 250,075 provides city bus service from 6:00 A.M. to 8:00 P.M. How much does each driver earn each day?

A. \$125 **B.** \$144
C. \$250 **D.** not enough information

29. In a high school baton twirling tournament the judges gave one twirler scores of 8, 7, 5, 8, 9, and 6. The officials eliminated the high and low scores. Find the average of the remaining scores.

A. 7.25 **B.** 7
C. 7.2 **D.** not enough information

30. Find a twirler's average score if the judges gave the twirler scores of 9, 6, 8, 7, 7, and 8, and the officials eliminated the high and low scores.

A. 7 **B.** 8.5
C. 7.5 **D.** not enough information

Name ______________________

Date ______________________

Score ______________________

CHAPTER TEST 1

50

Form B

DIRECTIONS: Choose the correct answer. Mark A, B, C, or D.

(pp. 2–7, 12–13)
Complete.

1. $6^3 = \_ \times \_ \times \_$

A. 6; 6; 3 **B.** 6; 6; 6
C. 6; 2; 3 **D.** not given

2. $10^{-3} = \dfrac{1}{\_ \times \_ \times \_}$

A. 10; 10; 10 **B.** 10; 3; 3
C. 10; 3; 5 **D.** not given

3. $4^{\_} = 4 \times 4 \times 4 \times 4$

A. 8 **B.** 16
C. 4 **D.** not given

Find the standard form.

4. $(3 \times 10^2) + (9 \times 10^0) + (1 \times 10^{-2}) + (2 \times 10^{-3})$

A. 3,090.12 **B.** 309.102
C. 309.0012 **D.** not given

5. 800 + 70 + 0.5 + 0.07 + 0.002

A. 875.072 **B.** 870.0572
C. 870.572 **D.** not given

(pp. 8–9)
Complete.

6. $6{,}170 = 6.17 \times 10^{\_}$

A. $^-3$ **B.** 3
C. 4 **D.** not given

7. $0.0028 = 2.8 \times 10^{\_}$

A. 3 **B.** $^-3$
C. $^-2$ **D.** not given

8. $82{,}400 = 8.24 \times 10^{\_}$

A. 4 **B.** $^-4$
C. 3 **D.** not given

Find the standard form.

9. 8.562×10^5

A. 856,200 **B.** 85,620
C. 8,562,000 **D.** not given

10. 3.77×10^{-4}

A. 37,700 **B.** 0.000377
C. 0.00377 **D.** not given

Order from least to greatest. (pp. 10–11)

11. 443; 404; 434

A. 443; 434; 404
B. 434; 404; 443
C. 404; 434; 443
D. not given

12. 3.535; 3.355; 3.553

A. 3.355; 3.535; 3.553
B. 3.535; 3.355; 3.553
C. 3.355; 3.553; 3.535
D. not given

13. 0.070; 0.70; 0.0070

A. 0.0070; 0.070; 0.70
B. 0.070; 0.0070; 0.70
C. 0.0070; 0.70; 0.070
D. not given

14. 0.089; 0.0089; 0.0098

A. 0.0089; 0.089; 0.0098
B. 0.089; 0.0098; 0.0089
C. 0.0098; 0.0089; 0.089
D. not given

15. 6.07; 6.071; 6.0701

A. 6.07; 6.071; 6.0701
B. 6.07; 6.0701; 6.071
C. 6.0701; 6.07; 6.071
D. not given

Name ______________________________

CHAPTER TEST 1

Form B (continued)

Round to the value of the underlined place. (pp. 18–19)

16. $7{,}65\underline{4}.8$
A. 7,654
B. 7,655
C. 7,650
D. not given

17. $8{,}\underline{3}61.2$
A. 8,300
B. 8,400
C. 8,360
D. not given

18. $60.\underline{8}37$
A. 60
B. 60.83
C. 60.84
D. not given

19. $0.37\underline{0}8$
A. 0.37
B. 0.38
C. 0.4
D. not given

20. $\underline{4}5{,}671$
A. 45,000
B. 50,000
C. 40,000
D. not given

Find the expression. (pp. 22–23)

21. n divided by 12
A. $12 \div n$ **B.** $12n$
C. $n \div 12$ **D.** not given

22. 9 less x
A. $9 - x$ **B.** $9 + x$
C. $x - 9$ **D.** not given

23. d increased by m
A. $d + m$ **B.** $d - m$
C. dm **D.** not given

Find a word phrase for the expression. (pp. 22–23)

24. $n - 27$
A. 27 less n **B.** n less 27
C. 27 decreased by n **D.** not given

25. $2y$
A. 2 increased by y **B.** y increased by 2
C. y multiplied by 2 **D.** not given

Complete. (pp. 20–21, 26–29)

26. 3,000 cm = ______ m	**A.** 3	**B.** 300	**C.** 30	**D.** not given
27. 2.35 km = ______ m	**A.** 2,350	**B.** 235	**C.** 23.5	**D.** not given
28. 55 kg = ______ g	**A.** 55,000	**B.** 5,500	**C.** 550	**D.** not given
29. 8 L = ______ mL	**A.** 80	**B.** 8,000	**C.** 800	**D.** not given
30. 6,200 g = ______ kg	**A.** 62	**B.** 620	**C.** 0.62	**D.** not given

Solve. (pp. 14–15, 24–25)

31. There are 245 students involved in a regional science fair. About 2 out of 5 have been involved in this fair before. About how many students have been involved in this fair before?
A. 98 students **B.** 612 students
C. 88 students **D.** not given

32. There are 61 schools involved in this year's science fair. Of this number, 43 have their own local science fair. How many schools do not have their own local science fair?
A. 28 schools **B.** 18 schools
C. 104 schools **D.** not given

33. One student reported that in his city about 20,000 aluminum cans are recycled each day. About how many aluminum cans are recycled in 325 days?
A. 650,000 **B.** 65,000
C. 6,500,000 **D.** not given

34. The judges allow 5 minutes for each of the students to report their findings. How many students could report in 2 h 30 min?
A. 46 students **B.** 28 students
C. 40 students **D.** not given

35. The auditorium where the awards will be presented seats 650. There are 248 students, 62 sponsors, and 75 judges. How many seats are available for parents and other visitors?
A. 256 seats **B.** 340 seats
C. 265 seats **D.** not given

Name ______________________________

Date ____________________

Score ____________________

CHAPTER TEST 2

Form B

DIRECTIONS: Choose the correct answer. Mark A, B, C, or D.

Compute. (pp. 36–39, 42–43)

1. $5{,}483 + 3{,}166 =$ ______

A. 8,549 **B.** 8,649
C. 8,639 **D.** not given

2. $8{,}226 - 4{,}587 =$ ______

A. 4,639 **B.** 3,639
C. 3,638 **D.** not given

3. $\$19.50 + \$6.17 =$ ______

A. $24.67 **B.** $13.33
C. $25.67 **D.** not given

4. $\$72 - \$3.60 =$ ______

A. $69.60 **B.** $69.40
C. $68.60 **D.** not given

5. $76.12 - 8.3 =$ ______

A. 67.82 **B.** 77.82
C. 67.8 **D.** not given

Compute. (pp. 44–47, 50–51)

6. $10.15 \times 6.04 =$ ______

A. 61.306 **B.** 6.1306
C. 613.06 **D.** not given

7. $2{,}400 \div 25 =$ ______

A. 86 **B.** 9 R6
C. 96 **D.** not given

8. $6.042 \div 6 =$ ______

A. 1.7 **B.** 1.07
C. 1.007 **D.** not given

9. $42.5 \times 0.64 =$ ______

A. 27.02 **B.** 27.2
C. 2.72 **D.** not given

10. $82.5 \div 5 =$ ______

A. 165 **B.** 1,650
C. 1.65 **D.** not given

Use compatible numbers to estimate the quotient. (pp. 54–55)

11. $8\overline{)739}$

A. 90 **B.** 80
C. 9 **D.** 8

12. $6.8\overline{)40.8}$

A. 6 **B.** 7
C. 60 **D.** 70

13. $0.59\overline{)35.9}$

A. 6 **B.** 60
C. 7 **D.** 70

14. $149 \div 15$

A. 100 **B.** 90
C. 9 **D.** 10

15. $322 \div 7.77$

A. 4 **B.** 50
C. 5 **D.** 40

Solve the equation. (pp. 60–63, 66–67)

16. $y - 260 = 40$

A. 220
B. 200
C. 400
D. not given

17. $23z = 92$

A. 4
B. 5
C. 3
D. not given

18. $a + 22 = 75$

A. 97
B. 43
C. 53
D. not given

19. $b \div 4 = 15$

A. 70
B. 60
C. 65
D. not given

20. $175 \div n = 35$

A. 140
B. 5
C. 15
D. not given

(pp. 58–59, 64–65)

Simplify each expression.

21. $9 + 3 \times 5 - 12 \div 4$

A. 21 **B.** 12
C. 20 **D.** not given

22. $6 \times 2 + 3^2$

A. 18 **B.** 66
C. 21 **D.** not given

Evaluate. Use the given value for the variable.

23. $15 + n; n = 29$

A. 54 **B.** 44
C. 14 **D.** not given

24. $m \div 8; m = 16$

A. 128 **B.** 4
C. 2 **D.** not given

25. $3(p - 3); p = 8$

A. 15 **B.** 12
C. 27 **D.** not given

Solve if enough information is given. (pp. 40–41, 48–49, 56–57)

26. A city had a population of 485,320 in 1980. The population was 631,945 in 1990. By how much had the population increased in that period of time?

A. 246,625 **B.** 146,625
C. 146,525 **D.** not enough information

27. A city had a population of 124,160 in 1980. The population in 1990 was 12,324 less than in 1980. What was the population in 1990?

A. 111,836 **B.** 110,836
C. 136,484 **D.** not enough information

28. A city of 250,081 provides curbside pick-up bags for recyclable items. How many bags does the city need to buy each month?

A. 250 bags **B.** 250,081 bags
C. 81 bags **D.** not enough information

29. In a high school baton twirling tournament, the judges gave one twirler scores of 7, 6, 9, 7, 8, and 7. The officials eliminated the high and low scores. Find the average of the remaining scores.

A. 7.2 **B.** 7.25
C. 6.25 **D.** not enough information

30. Find a twirler's average score if the judges gave the twirler scores of 8, 5, 7, 6, 6, and 9, and the officials eliminated the high and low scores.

A. 6.7 **B.** 7.75
C. 6.75 **D.** not enough information

Appendix F

Participant Consent Form

Please read this consent form. If you decide to participate, please sign and date below. If you have any questions, please ask.

You are invited to participate in a study investigating the effect of environment on memory. You will be asked to read a passage, and a list of words and definitions. You will also be asked to complete a simple math test. You will then be asked to recall certain information.

Information obtained in this study will be identified only by code number. You name will be used only to indicate that you participated in the study and received credit for participating.

Your participation in this study is completely voluntary. Should you wish to terminate your participation, you are welcome to do so at any point in the study. There are no risks or discomforts involved in completing the study.

If you have any questions or comments about this study, feel free to ask me. If you have additional questions, please contact, Candice Lindberg, 342-8711.

Thank you for your participation.

I, ________________________________, have read the above information and have
(please print name)
decided to participate.

I understand that my participation is voluntary and that I may withdraw at any time without prejudice after signing this form should I choose to discontinue participation in this study.

____________________________________ ________________
(signature of participant) (date)

THIS PROJECT HAS BEEN APPROVED BY THE EMPORIA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD FOR THE TREATMENT OF HUMAN SUBJECTS FOR THE PROTECTION OF HUMAN SUBJECTS.

Appendix G
Demographics

Please circle the appropriate response:

1. Male Female

2. Age ___________

3. Year in School
Freshman Sophomore Junior Senior

4. Is English your native language? Yes No
If not, how long have you been speaking English? _____________

5. Did you already know any of the words and definitions presented on the word list? If so, which ones?_______________________________________

6. a. Do you like classical music? Yes No Other______________
b. Do you listen to classical music? Yes No Sometimes

7. Do you usually listen to music while studying?
No (If you answer no, you have finished the questionnaire)
Yes (go on to #8)
Sometimes (go on to #8)

8. If you listen to music while studying, do you only listen to music while studying for certain subjects?

Yes Which subjects do you study for with the music on?
____
Which subjects do you not study for with music on?
____

No, I usually study with the music on regardless of what (subject, course, area) I am studying for.

Other? (please explain)____

9. If you do study while listening to music, what kind of music do you listen to?
Indicate what subject(s) you study for next to the type of music.
Circle as many as apply.
a. top 40____
b. hard rock____
c. country____
d. jazz____

e. classical____
f. alternative____
g. r & b/Soul____
h. rap____

Please feel free to provide comments.

____
____
____
____

Appendix H
Demographics

Please circle the appropriate response:

1. Male Female

2. Age ___________

3. Year in School
Freshman Sophomore Junior Senior

4. Is English your native language? Yes No
If not, how long have you been speaking English? _____________

5. Did you already know any of the words and definitions presented on the word list? If so, which ones?_______________________________________

6. a. Do you like classical music? Yes No Other______________
b. Do you listen to classical music? Yes No Sometimes

7. Do you usually listen to music while studying?
Yes (go on to #8)
No (If you answer no, go on to #9)
Sometimes (go on to #8)

8. If you listen to music while studying, do you only listen to music while studying for certain subjects?

Yes Which subjects do you study for with the music on?
____
Which subjects do you not study for with music on?
____

No, I usually study with the music on regardless of what (subject, course, area) I am studying for.

Other? (please explain)_______________________________________

9. If you do study while listening to music, what kind of music do you listen to? Indicate what subject you study for next to the type of music.
Circle as many as apply.
i. top 40
j. hard rock
k. country

l. jazz
m. classical
n. alternative
o. r & b/Soul
p. rap

10. Had you heard the music you heard today previously?
Yes No Not Sure

11. How did you feel distracted by the music when you were trying to read?

1	2	3	4	5	6	7
Not distracted			Somewhat distracted			Very Distracted

12. Did you feel distracted by the music when you were trying to memorize the words and definitions?

1	2	3	4	5	6	7
Not distracted			Somewhat distracted			Very Distracted

Please feel free to provide comments.

____
____
____
____

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Candice Lindberg
Signature of Author

5/11/01
Date

The Effect of Background Music on Memory for Different Tasks
Title of Thesis

Mary Cooper
Signature of Graduate Offices Staff Member

May 14, 2001
Date Received

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