

The Effects of Multitasking on Memory

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Abstract

The purpose of our research was to investigate the effect of multitasking on memory. We executed this investigation using 60 participants with multitasking as our independent variable, and scores on an examination of trivia questions as our dependent variable. The objective was to multitask on a distractor task of Tetris and a recording of trivia questions, or, for the control group, mono-task on only the recording. Afterward, we administered the same questions in a randomized order in the form of a test, asking them to recall the answers. We found a significant difference in the ability to recall the answers to the trivia between the two groups, with the control group scoring significantly higher. We also measured the relationships between gender, exposure to Tetris, and other demographical factors within our results to determine if other significant relationships existed. Our research suggests that multitasking should be avoided when specific recall is needed.

With the ever changing development of technology, the ability to multitask is a skill of great value. Common items are becoming more complex to aid in multitasking. For instance, cellular telephones are not just for communication anymore. They have become miniature computers with built-in cameras, mp3 players, games, and internet capabilities. According to Don Tapscott (2009), author of *Grown Up Digital*, parents from the television generation are raising children in the computer generation, where TV is simply background noise to a constant stream of entertainment and networking from the internet (p. 20). Founder of the Relationship Economy Expedition, Jerry Michalski notes that the people from the Millennial Generation spend much of their time with friends playing multiplayer games online (as cited in Tapscott, p. 104). However, what is the quality of that time spent together? This group may be able to hold all of this information – the game, conversations with friends, and whatever else in the environment – in working memory, but how much will they remember when the game is off and the conversation is over? An article by Steenhuysen (2007) discussed a study in Israel that reported “adults who trained their brains with a computer workout program showed significant improvement in spatial short-term memory, spatial learning, and focused attention” (as cited in Goodfellow & Maino, 2007, p. 69). In a study by Greenfield, DeWinstanley, Kilpatrick, and Kaye (1994), video game players had a lower attentional cost measured by reaction time per stimuli in their visual field than non-players. (as cited in Green & Bavelier, 2005, p. 218) Though this study suggests that they may be able to track information in their visual fields faster, do these video game players have the ability to multitask better, and how does this correspond in other

areas of life? Moreover, does the information they focus on get committed to long-term memory?

These questions helped fuel our experiment, the purpose being to find out how much information can be retrieved after such a situation. To see if multitasking would have an effect on memory, we randomly assigned college-age participants into two groups, one of which was subjected to one stimulus of listening to trivia and were instructed to focus solely on it, while the other group was tasked with two stimuli, playing Tetris and listening to the recording simultaneously. Their ability to remember the trivia was measured on a survey administered after the completion of a distractor task. Our choice to use a video game as the second task was verified by Greenfield (1994, 1999) and Greenfield and Cocking (1994, 1996), describing video game play as “a complex, multirequirement cognitive domain” (as cited in Lawrence, 2001, p. 448).

The operational definition of memory used for this experiment is from *Cognition*, by Mark Ashcraft (2006), which defines memory as “the mental process of acquiring and retaining information for later retrieval” (p. 571). To operationalize multitasking, research by Hambrick, Oswald, Darowski, Rench, and Brou (2009) points to two different definitions. The first, and more traditional, is defined as a time-sharing ability, with the typical mental process of designating “a primary task and the other a secondary task” (p. 1149). On the other hand, Hambrick and colleagues (2009) also describe the alternative definition of multitasking as a situation “in which the performer must make conscious shifts of attention between two or more tasks” (p. 1150). This

definition contrasts the traditional of time-sharing, and seemed more appropriate for our study. In addition, other studies also pointed to this construct of multitasking.

Trick, Jaspers-Fayer, and Sethi (2005) asserted that attentional focus can only be directed to one object at a time (374-75), and Margaret Heffernan (2011) stressed that it is the ability to switch tasks quickly.

Our hypothesis stated that there would be a significant difference between the multitasking group and non-multitasking group on the ability to recall the answers to trivia. The results of the experiment supported this hypothesis in showing that the multitasking group had significantly more difficulty in recalling the answers.

Methods

Participants

Participants in the experiment were 60 Olivet Nazarene University students from general education, music, and psychology classes that volunteered for the research in return for extra credit and/or chocolate. Their ages ranged from 18 to 27 years old. There were 25 male participants and 34 female (see figure 1 in the appendix). One demographic response survey was lost. Of the 60 participants, 31 composed the control group and 29 made up the experimental group. Both men and women were tested, as opposed to the method in Green and Bavelier (2005), where only men were used due to women's typically low interest in video games (p. 220). Since female video game players are generally fewer and we wanted female participants for the experiment, we chose Tetris as the distractor task in an attempt for a more gender-neutral game. To control for possible confounds and look for potential relationships among other

variables, we also asked our participants to answer demographic questions such as Tetris score, familiarity with Tetris, and number of hours playing video games per week.

Apparatus

The experiment required two computer labs as each participant needed access to his or her own game of Tetris. The version of Tetris we used was called "Ultimate Tetris Flash Game" found on freetetrisonline.net (see figure 2). This version looked the most average without any abnormal distractions (such as Space Brick Tetris or Prehistoric Tetris, other examples from the same site). All the game settings were kept at the default difficulty level except for the number of lines of blocks on the screen to start, which was reduced to zero to keep the beginning of game identical across participants. All sound settings were turned off to help eliminate distractions.

The trivia was taken from junior varsity Scholastic Bowl questions from the company Questions Galore. The questions we chose to use are called "toss-ups," each containing a one-part question and each yielding one answer. The alternative was called "bonus questions," which contain a broad range of question and answer structure and would ultimately have been more difficult to assess. The toss-ups covered a variety of topics and ranged from long to short in length. Long questions were defined as being over 4 lines long. The questions were put into an alternating order of length for the recording. The recording was made for standardization purposes between the experimental and control groups. Any questions that called for spelling or computation were eliminated because they did not specifically apply to recall.

Playing Tetris while listening to the recording of the trivia was the manipulated, independent variable that differed across the two groups. The control group did not play Tetris while listening to the recording, whereas the experimental group did both, resulting in multitasking. Reflections of this change between groups were seen on the dependent variable, the trivia test scores. See the appendix for the original Scholastic Bowl questions.

Procedure

The participants met in one computer lab where they were numbered off into two groups and were separated into two different labs. A brief explanation of Tetris was given to both groups before playing, and participants played Tetris for 5 minutes to become comfortable with the game.

After the 5 minutes, the control group was asked to stop. The participants in this group were then instructed to sit, relax, and listen to the recording with no distractions, exemplifying mono-tasking, or focusing on only one stimulus at a time. The recording of the 38 trivia questions lasted 14 minutes and 21 seconds. For the experimental condition, the participants continued to play Tetris while also listening to the recording instead, which embodied multitasking, or focusing on more than one stimulus simultaneously. Once the recording was finished, both groups played Tetris for another 5 minutes to control for recency effects.

When the final 5 minutes were over, both groups were administered a survey containing exact copies of the trivia from the recording, except the answers were replaced with blanks. The questions were also put into a randomized order to control

for participants who may have memorized the questions in a sequential order.

Participants were encouraged to guess if they did not remember answers.

Results

The trivia scores showed that the mean score for the control group was 21.77 and the mean for the experimental group was 15.03. To test the significance of this difference, we used an independent samples t-test which yielded the results $t(58) = 3.450, p = .001$. The multitasking group scored substantially lower than the mono-tasking group. The difference between the two groups was significant. Furthermore, our trivia test had a fairly normal distribution (see figure 3).

Demographic information was also analyzed through independent samples t-tests. We were interested to see how much of an impact gender made on hours per week playing video games, experience with Tetris and trivia scores. The results of the impact of gender on hours per week playing video games was $t(57) = 4.435, p = .000$. As expected, the men in our study played more hours of video games per week. Gender also had a slight impact on experience with Tetris in that the men in our experiment were more experienced. However, it was not significant. The results showed $t(57) = 1.853, p = .069$. Though it was marginally significant, this justified our choice in using Tetris as the distractor task since it was somewhat gender-neutral. Gender did not have an impact on the trivia test scores, as demonstrated by the results of $t(57) = .814, p = .419$. Therefore, there were no significant gender biases in the scores on our test.

The last independent samples t-test we chose to run analyzed the impact of owning Tetris on the scores of the trivia test. The results were $t(57) = -1.303, p = .198$.

These results showed that people who owned Tetris tended to score lower on the trivia test, though the results were not significant.

Implications of Results

The results showed our hypothesis was supported at a significant level. As such, our research implies that focusing on one stimulus at a time, also known as mono-tasking, is more effective than dividing attention between multiple stimuli. The participants in the multitasking group had a more difficult time remembering the trivia on the survey in comparison to the participants that were able to simply focus on the trivia alone. Furthermore, similar research with multitasking by Colom, Martinez-Molina, Shih, and Santacreu (2010) through different media has found that “interference is produced because some mental operations cannot be divided, and, therefore, a bottleneck is generated” (p. 543). This can be applied to our original inspiration for the experiment of multitasking while carrying on a conversation. If an individual is having a conversation while playing video games, our research indicates that he or she would likely have more difficulty recalling details from that conversation at a later time.

Discussion

A popular topic among sociologists is if technology, such as video games, is hindering social interaction. Quoted in *Grown Up Digital*, Michalski states, “We are all bemoaning the so-called decline of social interaction. But kids are growing up with very deep social skills. They still hang out and when playing video games or using the Web, they are interacting socially” (as cited in Tapscott, 2005, p. 104). People growing up in the Millennial Generation may be growing up with very deep social skills, but there is a

good chance that it is not due to the internet or the games they are playing. Through our experiment, we can conclude that though video game players are interacting socially, they should save quality conversations for when they are not playing.

Other results from our experiment showed that gender did not significantly affect experience with Tetris. As was expected, the men in our study spent more hours playing video games than women. However, this did not affect experience with Tetris. Men had slightly more experience, but only marginally so. This finding justified our purpose of choosing Tetris as a gender-neutral game. Also, showing that gender did not pose a potential confound, our trivia test was not significantly affected by it either.

Another interesting statistic is that people that own Tetris did slightly worse on the trivia test than people that did not own the game. The difference was not significant, but it would make for an intriguing study with a larger sample size than was obtained for our experiment. This difference does beg the question, though, as to why these participants would potentially score lower. Could it be because they are more comfortable with the game that they did not focus enough on the trivia? Such a question could be answered in further research.

Further Study

One weakness of this experiment was the process through which we obtained the Tetris scores from each participant. In doing so, the control group played Tetris for a drastically smaller amount time than the experimental group, resulting in a substantial confound for this statistic. We would like to see how the Tetris scores individually impacted the trivia scores, and feel this would be a great avenue by which this study

could be redone. We would like to know if a person who had a high score in Tetris would score lower on the trivia test or vice versa, showing that they paid more attention to one stimulus or another.

Another statistic to take into account would be grade point average. If this study were reproduced, we would like to see how grade point average and affinity for trivia affected the trivia score. Some participants could have simply known the answers some to the trivia because they remembered learning them in school or through other media such as Jeopardy or Trivial Pursuit.

Different age groups could also be tested to see if there is a difference among generations. For example, the Millennial Generation grew up in the late 1980's and early 1990's when computers, game systems, and cell phones were just starting to develop and few households had them. The following generation will be born into a world where all of these technologies are ubiquitous. On the other hand, the Baby Boomer Generation did not have these extraneous technologies to become distracted. Since our sample of participants was only college-age, a cross-sectional study could potentially show a performance difference generationally.

Another study involving different types of video games would be more true to life than playing Tetris. Further research could involve console games or computer games such as first-person shooter, role playing games, and sports games to make the experiment more realistic. Alternatively, a conversational script could be used instead of trivia for the dependent variable if an objective measure were possible to obtain, thereby allowing the mundane realism to be even more applicable. This was our

original research goal and will be the direction we take or would prefer to see other studies take if this research is pursued again in the future.

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Appendix A

Figure 1

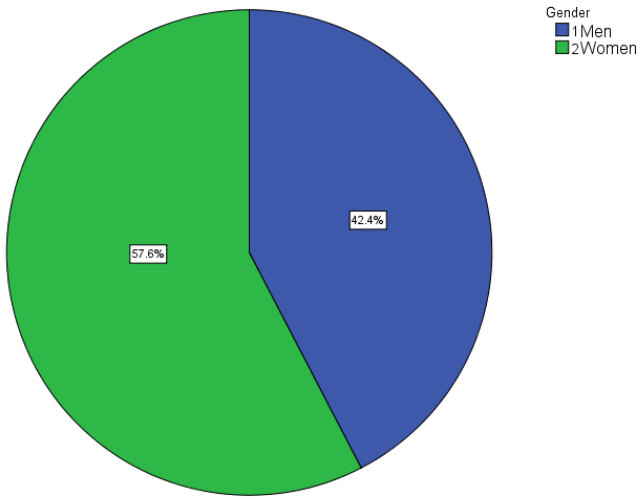


Figure 2

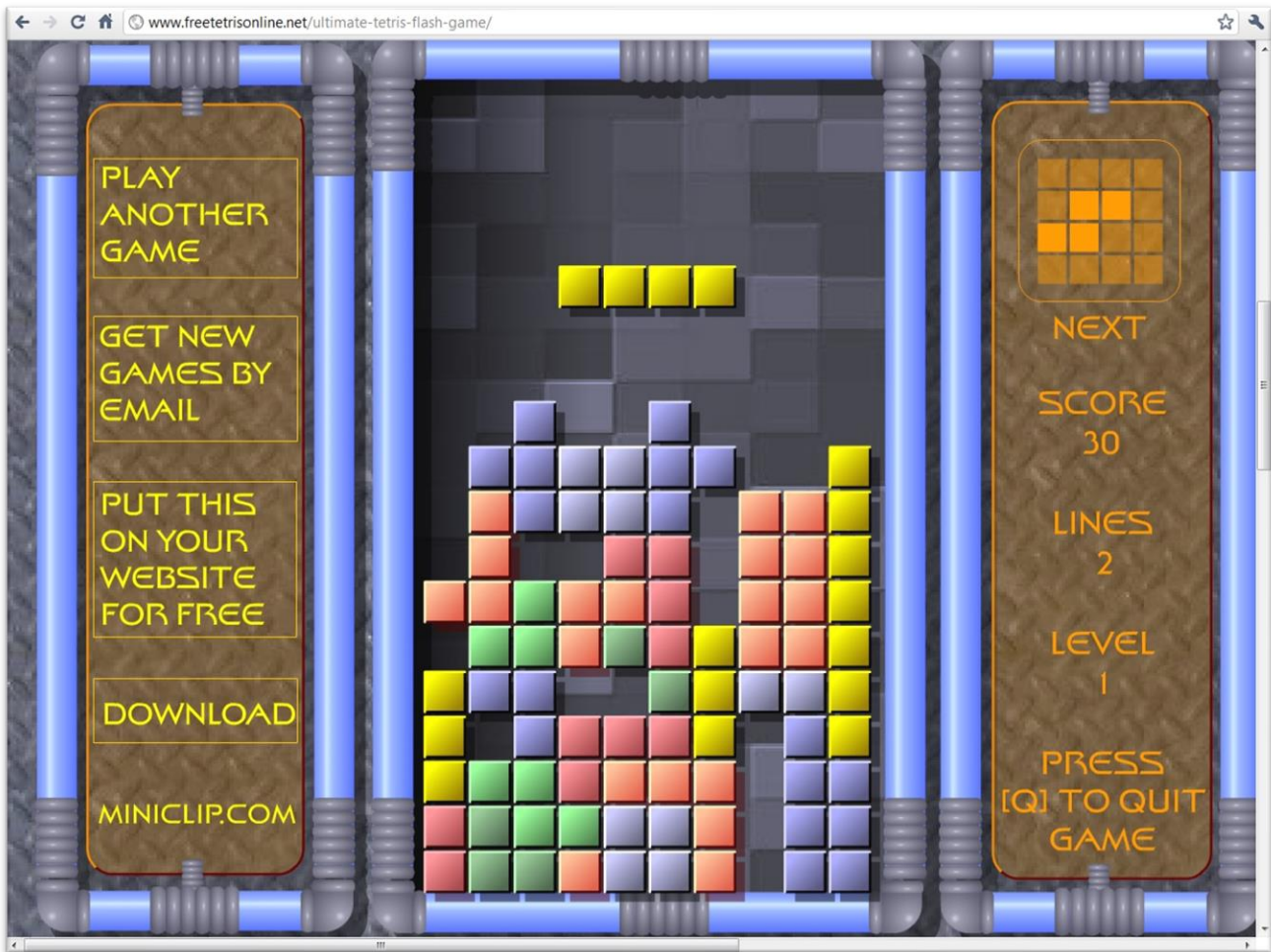
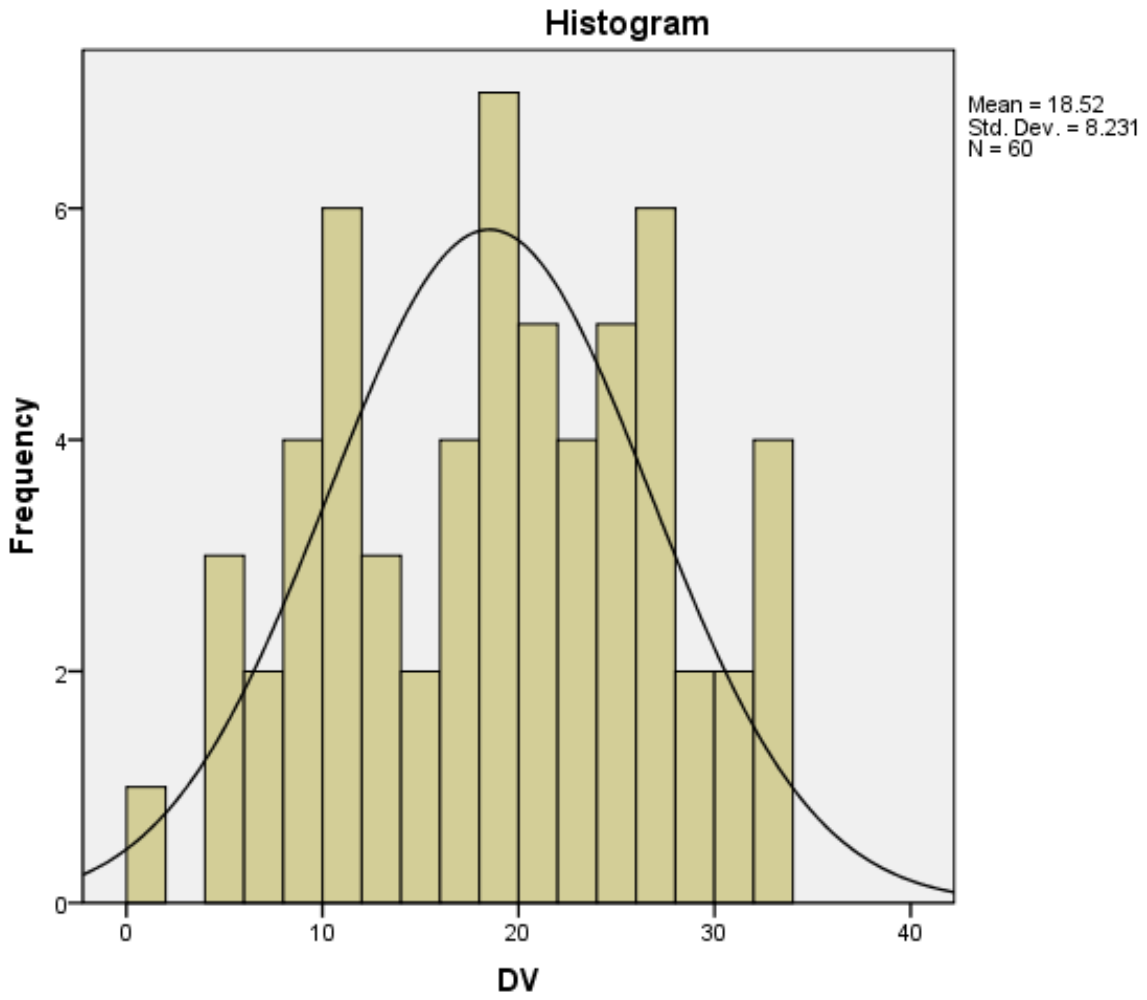


Figure 3



Appendix B

Scholastic Bowl Questions

1. This U.S. president has a long line of political ties, with his great-grandfather signing the Declaration of Independence and his father being a U.S. president as well. He served in the Civil War as a Brigadier General and proceeded to run for governor of Indiana following his service. Senate appointment became his next venture as he was elected to serve beginning in 1881. He ran for the presidency and ultimately defeated incumbent Grover Cleveland, taking office in 1889. Six states were admitted to the Union during his term but his bid for reelection was stymied when Cleveland returned to office the following term. What is the name of this president who presided over the "Billion Dollar Congress?" **Answer: Benjamin Harrison**
2. Other than neon, how many electrons do all noble gases have in their outer shells? **Answer: 8**
3. The scientific revolution in the sixteenth and seventeenth centuries may not have been what it was without this Italian scientist. He began his studies at the University of Pisa in medicine, but physics and mathematics caught his attention quickly. His first, true experiment dealt with the pendulum and its consistency. Other discoveries included the center of gravity, bodies in motion, and support of the Copernican theory. The first complete, modern telescope was developed by this man, and he became the first to study sunspots through that telescope. Who was this Italian astronomer and physicist who first suggested heliocentrism? **Answer: Galileo**
4. What is the 10-letter word that describes a picture of a person in which certain distinctive features are greatly exaggerated or distorted for comic effect? **Answer: caricature**
5. What is the 10-letter word that describes a picture of a person in which certain distinctive features are greatly exaggerated or distorted for comic effect? **Answer: caricature**

This Canadian singer expanded his influence when he purchased a stake in a major, junior ice hockey team, the Vancouver Giants, in 2008. His big-band style of music caught on all over the world with hits, "Everything," "Feelin' Good," and "Home." He released a new album in 2009 entitled Crazy Love. Who is this crooner who won a Grammy in 2008 for Best Traditional Pop Vocal Album, with his release, Call Me Irresponsible? **Answer: Michael Bublé**
6. How many unfilled electron shells are present in the transition elements? **Answer: 2**
7. Despite being born in Corsica, this leader's influence lied primarily in France. He began his military career during a Parisian assault when he quickly eliminated the insurgent troops. With this and many other quick victories, he quickly spread his influences all over Europe, desiring to invade Britain and Egypt and wipe out all British influence. Coincidentally, he then proclaimed himself emperor of the French, a type of impulse that would ultimately prove his downfall. Who was this French emperor who

also tried to occupy Mexico in 1862, but was defeated by Mexican troops in a battle that is celebrated on Cinco de Mayo? **Answer: Napoleon Bonaparte**

8. What country, that straddles the equator, is one of only two South American countries that does not border Brazil, and also owns the Galapagos Islands? **Answer: Ecuador**

9. Existing in the years between 1900 and 1904, this monochromatic, artistic period encompassed a famous, Spanish artist's work. All his pieces created during this period contain only one to two colors and generally depict somber instances, such as prostitutes, drunks, and beggars. What is the name of this period of Picasso's artistic work that represents the mourning over his deceased friend, Casagemas, where Picasso's paintings express human misery and sadness? **Answer: Blue Period**

10. Used in both chemical and industrial practices, this solution carries a faint yellow to colorless appearance. It is corrosive and carries an unpleasant odor. Found in gastric acids, what type of acid is found in human stomachs and works with enzymes to digest food? **Answer: hydrochloric acid**

11. The accession of William III and Mary II were a direct result of this English uprising. The uprising was a response to the ruler's tolerance of the Catholic ideals, ignorance to Parliament, and convergence with Catholic alliances. What was the name given to the revolution that took place in 1688-1689 that dethroned Catholic King James II and enthroned Protestant rulers of the Netherlands that included the daughter of James II? **Answer: The Glorious (or Bloodless) Revolution**

12. Bach, Berg, and Schoenberg all excelled in this musical form that featured a soloist amongst a large orchestra. Piano, cello, and violin remain the primary instruments featured as soloists, and three-part pieces became the standard through the work of Handel and Mozart. What is the name for this genre of music, from the Italian word meaning coming together, that is displayed by Bach's dedications to the margrave of Brandenburg-Schwedt? **Answer: concerto**

13. What is the common name for the Aurora Borealis? **Answer: Northern Lights**

14. By becoming engaged in litigation regarding proper patents, production of this industry may have stalled if it weren't for the refusal to accept George Selden's ideas. What followed was a booming industry that saw the manufacturing of countless units, as well as the production of the first highways. In the 1920s, which industry, including petroleum, rubber- and steel-related jobs, dominated the American economy? **Answer: automobile**

15. This perennial herb is generally found in tropical and subtropical forests. They are a highly prized, economic flower and have been farmed for their benefits for their entire existence. What is the name of this Mexican flower, from which vanilla is extracted? **Answer: orchid**

16. This extension of the Indian Ocean was a prime focus of the Iraq-Iran War of the 1980s. It was also set as the background for the Gulf War of the early 1990s. Despite its involvement in multiple conflicts, this marine area is home to abundant areas of pearl oysters, coral reefs, and prime fishing ground. Multiple oil spills have put this extensive

marine life in jeopardy in recent years. What is the name of this body of water on which the country Bahrain is located? **Answer: Persian Gulf**

17. What adjective beginning with the prefix “un-” describes any document or written material that is complete and has not been shortened or condensed? **Answer: unabridged**

18. Similar to porridge, this dish can be served hot or cold and is derived from the European dish of gruel. It is served at both breakfast and as a dessert and is considered a main course south of the Mason-Dixon Line. What is this southern dish that is made from dried corn or hominy and is available in the regular, quick cooking, and instant variety? **Answer: grits**

19. Named after a famous scientist, what unit of length equal to 10-15 meters is used in both atomic and nuclear physics? **Answer: Fermi**

20. This painter first forayed into art when he was sent into Civil War battles as a correspondent for Harper’s Weekly. His work during these battles earned him acclaim and offered him the ability to start a painting career. He focused primarily on lithographs and illustrations early in his career, but soon took to watercolors, the work for which he is best known. Notable watercolors of his include, Eight Bells, The Hurricane, and Breaking Storm. Who was this American artist that painted “Breezing Up,” which shows three boys and an adult sailing on a choppy sea? **Answer: Winslow Homer**

21. What do George Balanchine, Jerome Robbins, Kenneth MacMillan, and Marius Petipa have in common? **Answer: ballet choreographers**

22. The eldest daughter of Thutmose I, this ruler gained power by relegating her own husband during his reign. Despite being a woman, she was still referred to as a king, and not a queen, and even dressed and was portrayed as a male with a long beard. Her time as a ruler saw a reconstruction of Thebes and a long period of peace. After her death, every object commemorating her was ordered to be destroyed. Who was this female pharaoh that seized power in the early 16th century B.C.? **Answer: Hatshepsut**

23. This Roman was often equated with the Greek, Athena. She is viewed as a symbol of wisdom and was displayed with an owl. Despite being the goddess of handcrafts and arts, who was this Roman goddess that Arachne enraged when she defeated her in a weaving contest? **Answer: Minerva**

24. This actor was originally born Ramon Estevez, but changed his name to honor a Catholic archbishop. He has four children, all who have parlayed their own careers into acting. Notable roles of his include Captain Willard, 1st Lieutenant Dobbs, and Robert E. Lee. Who is this actor who also starred as President Bartlett on “The West Wing”? **Answer: Martin Sheen**

25. To avoid lung damage, scuba divers must surface very slowly. If they rise too quickly, gas bubbles form in their bodies, causing severe pain. What is this serious condition called? **Answer: bends (decompression sickness)**

26. Most often made of clay, marble, or stone, this bowl-shaped object was first used in medicine to grind pharmaceutical tablets. It is also frequently seen in culinary ways,

as a way to prepare guacamole and pesto. What is the name of this bowl that is used in the science lab with a pestle to grind up solids? **Answer: mortar**

27. What is the only number that has the same number of letters as its name?

Answer: four

28. The etymology surrounding the name of this form of dance comes from the description of alcoholics, and the various moves they would exhibit after intoxication. The dance itself can be divided into many different forms of swing-dancing, including the Lindy Hop, Jive, and West and East Coast Swing. Out of control movements, and movement without any knowledge of a particular dance make this dance what it is. What is the name of this American jazz dance, popular during the 1940s, that consists of acrobatic swings, twirls, splits, and somersaults? **Answer: jitterbug**

29. The English language uses word order to indicate word relationships. What term refers to the sequence in which words are put together to form sentences? **Answer: syntax**

30. This European monarch holds claim to the longest tenured reign of any European head. His leadership, that lasted over 72 years, began when his prime minister was pronounced dead. This king believed strongly in the divine right of kings and ruled as such. His lavish Palace of Versailles represented his personal admiration of himself and his kingdom. Who was this French king that called himself the Sun King and claimed that he "was the state"? **Answer: Louis XIV**

31. Bordered by the Caribbean Sea to the north, and the Pacific Ocean to the west, this country also shares ties with many Central American countries. What is this country that, along with Peru, borders Ecuador? **Answer: Columbia**

32. This popular, Scottish poet wrote the poem that begins with the lines "How do you like to go up in a swing, Up in the air so blue." He suffered for most of his life with a case of tuberculosis and was mildly handicapped as a result of it. Because of this, he traveled greatly to attempt to find a climate that suited his affliction. The traveling enabled him to use multiple cultures in his writing, including *The Bottle Imp* and *The Master of Ballantrae*. What was the name of this author who wrote the famous stories, *Kidnapped*, *Treasure Island*, and *The Strange Case of Dr. Jekyll and Mr. Hyde*?

Answer: Robert Louis Stevenson

33. What 6th century B.C. Greek slave is believed to have authored many Greek fables and stories? **Answer: Aesop**

34. Since the end of World War II in 1945, this island nation has been under control by China. It is also known by the name Formosa and spans across the Tropic of Cancer. It has both tropical and subtropical regions and lies southwest of Japan. What is this East Asian island that is known as the Republic of China? **Answer: Taiwan**

35. Which gas composes approximately 83% of the atmosphere of the planet, Uranus? **Answer: hydrogen**

36. This town in the southeastern United States was the first to hold a Christian worship service in a permanent settlement. It was first colonized by Spanish travelers in 1565, on a day commemorated for a philosopher from Hippo. The travelers subsequently named the city after this philosopher, one that stays to this day. What is

the name of this Florida city where the Spanish built the first permanent European settlement in the United States? **Answer: Saint Augustine**

37. What "a" word is a synonym for greed? **Answer: avarice**

38. This famous poet was named Poet Laureate Consultant to the Library of Congress in 1985. Her first book of poetry, *A Street in Bronzeville*, was a great success. Her second published collection, *Annie Allen*, won her the Pulitzer Prize in Poetry in 1950. Who was this American poet who also wrote *The Mecca*, a story about a mother searching for her lost child? **Answer: Gwendolyn (Elizabeth) Brooks**