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The Effects of Speech Rate on Comprehension

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There is a perception that the rate of speech affects the level of comprehensibility of a listener. If the rate of a speaker during a speech or lecture does in fact affect the level of comprehension, then the speaker would have to modify his/her rate of speech in order to benefit the ears of all his/her listeners. In the present study, 40 participants listened to four passages, taken from www.testpreview.com all recorded at varying speeds, after which they answered 10 questions that corresponded with the passages. Results found that speech rate had no effect on comprehension. However, findings based on one passage suggest that there may be a link between speech rate and content.

When speaking, people speak at a natural rate, and believe their speech to be audible and understood; however, for listeners this may not be the case. Research on the topic of speech rate and comprehension has shown a variety of different findings. It has been found that speech rates vary widely across people. In a study that compared the difference in speech rates for native speakers of English to those who spoke English as a second language, it was found that both groups preferred to hear speech at a slower rate when it was not their native language (Derwing & Munro, 2001). Derwing and Munro also found that slower rates of speaking were preferred, but there was no significant effect on comprehension of these listeners when tested at different speech rates. In this

study, rate was measured in syllables per sentence measures, not by using passages or paragraphs.

Ernest (1966) conducted a study that looked at achievement and listening comprehension; in her study, she used university students and used book excerpts from different materials such as experimental or historical. Ernest used a word per minute measures of 120wpm for slow and 160 wpm for fast; results found that listening comprehension was not affected by the rate at which the excerpts were presented. However, a slight trend was found for historical material to be comprehended at quicker rates. Blosser, Weidner, and Dinero (1976) found in their research that as speech rates decreased, comprehension scores for their participants increased. Differences in this study were that children were the focus of the study and a speech compressor was used to change the rate of the speech samples, not the speaker. In another study that looked at compressed speech compared to normal speech, it was found that normal speech rates were found to be more comprehensible than faster rated compressed speech rates (Beatty, Behnke, & Froelich, 1980). Beatty, Behnke, and Froelich first used a male voice to record their excerpts at 140 wpm as the standard control and then used a machine to compress that speech recording to 210 wpm and 280 wpm. Based upon these studies, speech rate varies in what is considered normal and the measure of rate may also play a link into the end results of a study.

Researchers have demonstrated that comprehension and speech rate was largely combined with cognitive processing. Results of one study showed that regardless of age, speech that was presented at fast speech rates took longer to understand and process

cognitively because slow rates allow people more time, whereas fast rates of talking diminishes this time (Wingfield, Peelle, & Grossman, 2003). In the study, they compressed sentences at 35%-80% using a computerized algorithm with the standard for speech set at 205 wpm. Wingfield, Peelle, and Grossman also found in their study that when tested on comprehension of true/false questions, until rates were very fast at about a 595 wpm rate there was no difference in the comprehension scores between older and younger adults. In a more recent study, by Fallon, Peelle, and Wingfield (2006) the difference between older and younger adults in task demands and self-paced listening was researched. In the study speech rate was used as a condition; speech rates of 124, 155, and 207 wpm were used and were compressed on a machine. Results showed that speech rate did not affect either young or older adults or either task of recall or comprehension. However, the results of this may be attributed to the fact that the adults were able to go at their own pace and pause the recording when necessary. In a study that looked at compressed speech in commercials, Nickell and Pinto's (1984) finding refuted previous research that stated that faster communication on the radio was better; their findings show that people did not really have a preference for faster speech rates on the radio. Nickell and Pinto used compressed speech at 150 wpm for a control, and then compressed speech to rates of 175 wpm, 200 wpm, and 225 wpm. All of the research points to many different findings that, while related, all differ in some degree. The measure of rate differs in several of the studies, as does the method of how to control the speech rate by using either a computerized machine to speed up and slow down the rates or to use an actual human model. Research also differed on what was considered as fast,

slow, and average in speaking. Such factor may indicate the reason for such varied findings.

Based on this prior research, it is still not certain as to what speech rate is best for comprehension; upon this basis, one aim of our studying is to further our knowledge about how we communicate with one another. As humans, we rely heavily upon speech to communicate and the more knowledge we gain about communication, the better we become at communication. Our aim by conducting this experiment is to determine what rate of speaking is best for a listener to understand the content of speech. In classroom and university settings, such knowledge would be highly beneficial because speaking is the major means by which professors and teachers try to convey course content to their students. If professors and teachers knew at what rate to modify their speaking voices, they would be better equipped to communicate valuable information to students. Based on prior research findings, we hypothesize that slower speech rates will result in listeners obtaining higher comprehension scores.

In our study, we took four different passages, which were selected to control for different variables, and had a professional speaker record them at different rates: a fast rate (at 200+ wpm under 2 min), a slow rate (120 wpm in over 3 min), and two control rates (160 wpm in 2.15-2.5 min). Then, these selected passages were presented to participants at these different rates. Each participant heard each of the four different passages, but each at a different rate. After hearing each separate passage, participants were asked questions about the passages in order to obtain a measure of comprehension.

Method

Participants

A total of forty-one participants, all college students from Lindenwood University, were recruited in this study. Participants were recruited through the Lindenwood University Human Subject Pool (HSP) or they were recruited on the campus of Lindenwood University. Thirty-three of the participants were recruited from the Lindenwood HSP. Students that were able to participate in the HSP were students currently enrolled in an introductory social science course of the following: Principles of Psychology, Concepts of Sociology, Interactive Psychology, or Cultural Anthropology. Participants that were recruited through the HSP each received one bonus point for their respective courses for their participation in the study. The eight participants that were not recruited through the HSP were recruited on the campus of Lindenwood University. These eight students were all enrolled in classes at Lindenwood University. These participants did not receive any incentives for their participation in the study.

Materials

In our study, four written passages were taken from www.testpreview.com. These four passages were prewritten for help on the reading comprehension section for the ACT exam (see Appendices A-D). Each of the passages was centered on historical figures, the length of each passage was about equal with an average of 426 words per passage, and the level of comprehension was found to be set at a high school level. Mike Wall, Lindenwood University Professor of Mass Communications, recorded the passages onto a Memorex CD using the professional radio station equipment of the university.

Professor Wall recorded each of the four passages four times, with each passage read at a different speech rate each time; the passages were recorded along a time scale for more efficient recording purposes.

The speech rates were recorded as follows. Each passage was recorded at a fast rate of less than two minutes, a medium rate lasting between two minutes and fifteen seconds and two minutes and thirty seconds, a control rate lasting between two minutes, fifteen seconds to two minutes and thirty seconds, and a slow rate of three minutes. The speed rates were based upon a word per minute measure, which was taken from previous studies. Our determination for the speeds were as follows: we found that 120wpm was considered to be a slow rate for speaking so we took that measure and divided it by the average number of words found in our four passages (426) and got a result of 3.55. Taking that result, we determined that each passage should be read at a speed that required about 3 minutes to complete the passage. 160-170 wpm was found as our medium and control group standard and when this was applied to our average number of words we determined that each passage should be read between 2 minutes and 15 seconds to 2 minutes and 30 seconds. 200+ wpm we found to be a standard for fast speech rates and again when applied to our average words per passage we determined that each passage should be read at under 2 minutes.

The passages were first recorded onto one Memorex CD, but were then burned onto four separate Memorex CDs; each CD contained a condition of our variable so when conducting the study the process would be more efficient. Two portable CD players, a Lennox model and Memorex model, both equipped with standard headphones, were used

by the participants to listen to the recordings. Comprehension tests were used to measure the comprehension ability of the participants. These comprehension tests were based on questions that corresponded to the passages that were found at www.testpreview.com (see Appendices A-D). Each test consisted of ten multiple choice questions. Writing utensils and paper were used to fill out the comprehension tests. The study was conducted in a small room in which there was a desk, two chairs and a computer; the room was located at Lindenwood University in the Young building in room 105 in labs A and D. The labs in Young 105 were mostly quiet areas and provided few interruptions or distractions for participants.

Procedure

A within-subjects design was used in this study. Participants were each tested on an individual basis. Four reading comprehension practice ACT tests were selected from the website www.testpreview.com. These four passages were selected upon the basis of being about equal in the areas of length, comprehension level, and interest level (see Appendixes A-D). After selecting these passages, they were recorded at three different speech rates: fast, medium, and slow. These three rates would have left us with twelve conditions, and would have made counterbalancing a cumbersome task; a fourth rate was added so that a Latin Square Design could be implemented. This fourth rate was called the control rate and was the same measure as our medium rate in that it was also recorded at a time between two minutes, fifteen seconds to two minutes and thirty seconds in length. The control rate then was not included in the analysis of the data, for it was equal to our medium rating. Professor Mike Wall, a professional speaker and Dean of the

Communications Department, served as the voice model for all conditions; a professional speaker was chosen to read these passages to help control for the different variables of language, such as tone, consistency in rate, speech errors, etc. He recorded each the four passages at each of the four different rates for a total of sixteen different conditions. Professor Wall was thanked for his help in the study and was offered a gift card.

For each passage, a ten item questionnaire was created that was used to measure the comprehension level of the listener for each passage. The questions were based on questions that were provided with each passage at www.testpreview.com (see Appendices A-D). These questions, like the passages, were chosen so that all would be at on the same level of comprehension and about the same type of questions. This was done again to control for extraneous language variables, such as the wording used to ask the questions.

Each participant was asked to listen to the first passage and then answer the ten item questionnaire about that particular passage. After the participants had completed the first questionnaire they then listened to the next passage. Upon completion, it was then followed by another questionnaire that pertained to that particular passage. This procedure was repeated until the participant had completed each set of four passages and questions. The sequence in which participants heard each of the passages did not vary, but the speech rate for each of the passages varied and was counterbalanced. For example, participant one heard passage one at the slow speech rate, passage two at the medium speech rate, passage three at the medium speech rate, and passage four at the fast speech rate. The second participant then heard the first passage in the medium speech

rate, the second passage in the slow speech rate, the third in the fast speech rate, and the fourth in the medium speech rate. This was done until all registered participants had each heard all four of the passages and answered all four sets of questions. Participants at the completion of the study were then debriefed on the purpose of the study. We then made sure to guide them in the completion of the participant slips to ensure that they received their bonus points.

Results

A multivariate analysis of variance (MANOVA) performed on participants' comprehension scores revealed that there was no significant effect of different speech rates on comprehension, $F(2, 78) = .039, p > .05$. The mean scores on the comprehension by rate were 6.43 for the fast, 6.33 for the medium, and 6.38 for the slow. The maximum score received on each test was ten out of ten and the minimum score was two on the slow and medium conditions and a score of one on the fast condition.

For each individual story, a one-way analysis of variance (ANOVA) was conducted on participant comprehension scores. On passage 1, the ANOVA revealed that there was no significant effect, $F(2, 30) = .170, p > .05$. Passage 2 revealed that scores were not significant, but were approaching the point of significance, $F(2, 30) = 2.668, p < .05$. The ANOVA on passage 3 showed that the results were not significant, $F(2, 30) = .548, p > .05$. Passage 4 ANOVA results displayed that, again, there was no significant effect found, $F(2, 28) = .502, p > .05$. The mean scores when analyzed for each individual passage were all consistent with the medium rate being the rate that received the highest scores, with the exception of passage 2 results. Passage 1 mean

scores were 5.73 (fast), 6.20 (medium), and 5.70 (slow). Passage 3 mean scores were 5.90 (fast), 5.90 (medium), and 5.09 (slow). Scores on passage 4 had a means of 6.90 (fast), 7.67 (medium), and 6.80 (slow). The means on passage 2 show an opposite effect from the other passages. The medium score is the lowest instead of the highest; results showed that the means were 7.50 (fast), 5.90 (medium), and 7.70 (slow).

Discussion

In our study, the results showed that the rate of speech does not have any effect on listeners' comprehension scores. Our hypothesis that a slow speech rate would result in higher comprehension scores must therefore be rejected on this data. The means of the different rates showed that participants scored at a relative consistency, with an average score of six out of ten questions correct. While in the analysis of individualized stories the results of the overall study were supported by passages 1, 3, and 4, passage 2 results indicated an opposite effect from the other test results in which the medium score turned into the lowest score instead of the highest. In passage 2, results were not found to be significant but were approaching significance, which show that the speech rates may have had an effect on the comprehension scores for this specific passage. The overall conclusion that speech rate is not a main influence on comprehension supports the findings of previous research, such as in Fallon, Peele, and Wingfield (2006).

The results of our study compared to prior studies may be contributed to several factors. As in the Fallon, Peele, and Wingfield (2006) study, a word per minute measure (wpm) was used to control speech rate speeds instead of a syllable per second (sp/s) measure. The difference in the use of the way speech rate is measured may be a factor in

the variety of results. In the studies previously reviewed a range of speech rates were used, from a rate of 160 wpm to a rate as high as 207 wpm. This was indicated in different studies as the average rate at which a person would normally speak. The wide range may be a result of other extraneous factors that would dictate speech, such as the area in which the study took place or outside cultural influences. There was no standard rate publicized at what is definitely an average speech rate it may be that our results are skewed to the ratings at which we chose. This suggests that our study may have yielded different results if our standardized rates had been on a broader scale and not on what now seems to be a moderate difference in speech rate comparisons. Another way in that the study could have been altered would be to use a more intricate scale of syllables per second and test on sentences rather than passages.

A more detailed look at the passages in the study suggests that the results may also be linked to the content and wording of the passages, rather than on speech rate. As Ernest (2003) suggested, it may be that the content or wording style of the passages that influenced the results of the study. The four passages were all selected to be about historical people and should all be about at the same interest and content level for people. However, this may not have held true. Passage 1 was an excerpt about the life of Sojourner Truth, passage 2 told the story of Anna Anderson who believed herself to be Anastasia, passage 3 presented information about the life of Charles Lindbergh, and passage four was about the Wright brothers and building the first model airplane. Passages 1, 3, and 4 contained information that was presented in what could be considered a more factual manner, with dates and events listed and told, while passage 2

was presented in more of a story type manner. It contained events and dates it was of a more recent event. Passage 2 was more recent than any of the other passages and could have been of more interest to listeners than the other passages.

A post hoc assumption of the results of passage 2 then may be indicative of passage content or perhaps a listener's interest relationship when compared with speech rate and comprehension. Ernest (2003) found that historical material had a trend of being better understood when at a slightly faster rate than other material. When that finding is related to individualized results of the passages, it can be said that passages 1, 3, and 4, which were perhaps of more historic content than passage 2, were showing comprehension results that may have been influenced by their content and wording styles. Passages 1, 3, and 4 all had results that showed that scores were better, though only slightly when heard at either the medium or fast rates, which is supportive of Ernest's conclusion. Passage 2 results act differently and may be reflecting the listener interest or the fact that though somewhat historical the passage was more recent than any of the other passages. Passage 2 was scored better on at a fast rate or a slow rate, but not at the medium rate. If this content hypothesis could be assumed as true, it may then be said that passage 2 was then considered by listeners as either a historical story and if that was the case did better when given in at a faster rate. Perhaps listeners perceived it as more complex sort of story that intertwined recent events with historical background. Also it could be due to the complexity it needed to be heard, for some, at a slower rate so that more time for cognitive processing was allowed.

This study, on the whole, only suggests that more research in the field of speech rate is needed to better understand its effects on comprehension. Results show that speech rate itself may not be an effective influence on comprehension, but with more research it may be found that the content of what is being heard and listener interest may play a role in what speech rate is more preferable and beneficial in regards to comprehension.

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Author Note

Jamilah Adams and Michelle Weber, both undergraduate students at Lindenwood University

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Appendix A

Passage 1

“Old woman,” grumbled the burly white man who had just heard Sojourner Truth speak, “do you think your talk about slavery does any good? I don’t care any more for your talk than I do for the bite of a flea.”

The tall, imposing black woman turned her piercing eyes on him. “Perhaps not,” she answered, “but I’ll keep you scratching.”

The little incident of the 1840s sums up all that Sojourner Truth was: utterly dedicated to spreading her message, afraid of no one, forceful and witty in speech. Yet forty years earlier, who could have suspected that a spindly slave girl growing up in a damp cellar in upstate New York would become one of the most remarkable women in American history? Her name then was Isabella, many slaves had no last names and by the time she was fourteen she had seen both parents die of cold and hunger. She herself had been sold several times. By 1827, when New York freed its slaves, she had married and borne five children.

The first hint of Isabella’s fighting spirit came soon afterwards, when her youngest son was illegally seized and sold. She marched to the courthouse and badgered officials until her son was returned to her.

In 1843, inspired by religion, she changed her name to Sojourner Truth, meaning “one who stays briefly” and, with only pennies in her purse, set out to preach against slavery. From New England to Minnesota she trekked, gaining a reputation for her plain but powerful and moving words. Incredibly, despite being black and female, for at the time only white males were expected to be public speakers, she drew thousands to town halls, tents, and churches to hear her powerful, deep-voiced pleas on equality for blacks-and for women. Often she had to face threatening hoodlums. Once she stood before armed bullies and sang a hymn to them. Awed by her courage and her commanding presence, they sheepishly retreated.

During the Civil War she cared for homeless ex-slaves in Washington. President Lincoln invited her to the White House to bestow praise on her. Later, she petitioned Congress to help former slaves get land in the West. Even in her old age, she forced the city of Washington to integrate its trolley cars so that black and white could ride together.

Shortly before her death at eighty-six, she was asked what kept her going. “I think of the great things,” replied Sojourner.

Passage 1 Questions

1. The imposing black woman promised to keep the white man-
 - A searching
 - B crying
 - C hollering
 - D scratching
 - E fleeing

2. This incident occurred in the-
 - A 1760s
 - B 1900s
 - C 1840s
 - D 1920s
 - E 1700s

3. In what city was Sojourner Truth raised in a damp cellar?
 - A New York
 - B Georgia
 - C New Jersey
 - D Idaho
 - E Maryland

4. Isabella lost both parents by the time she was what age?
 - A 27
 - B 2
 - C 7
 - D 14
 - E 19

5. When New York freed its slaves, Isabella had-
 - A problems
 - B no children
 - C five children
 - D an education
 - E three children

6. Isabella's name change was inspired by?
 - A a fighting spirit
 - B religion
 - C her freedom
 - D officials
 - E friends

7. She traveled from New England to-
 - A Canada
 - B California
 - C Minnesota
 - D Alaska
 - E Virginia

8. What did Sojourner force the city of Washington to do?
 - A integrate its trolleys
 - B give land grants
 - C care for ex-slaves
 - D provide food for ex-slaves
 - E clean its trolleys

9. What did Isabella preached against?
 - A smoking
 - B slavery
 - C alcohol
 - D hoodlums
 - E women having no rights

10. What age was Sojourner Truth when she died?
 - A 48
 - B 72
 - C 63
 - D 86
 - E 88

Appendix B

Passage 2

One of the most intriguing stories of the Russian Revolution concerns the identity of Anastasia, the youngest daughter of Czar Nicholas II. During his reign over Russia, the Czar had planned to revoke many of the harsh laws established by previous czars. Some workers and peasants, however, clamored for more rapid social reform. In 1918 a group of these people, known as Bolsheviks, overthrew the government. On July 17 or 18, they murdered the Czar and what was thought to be his entire family.

Although witnesses vouched that all the members of the Czar's family had been executed, there were rumors suggesting that Anastasia had survived. Over the years, a number of women claimed to be Grand Duchess Anastasia. Perhaps the best-known claimant was Anastasia Tschaikovsky, who was also known as Anna Anderson.

In 1920, eighteen months after the Czar's execution, this terrified young woman was rescued from drowning in a Berlin river. She spent two years in a hospital, where she attempted to reclaim her health and shattered mind. The doctors and nurses thought that she resembled Anastasia and questioned her about her background. She disclaimed any connection with the Czar's family.

Eight years later, though, she claimed that she was Anastasia. She said that she had been rescued by two Russian soldiers after the Czar and the rest of her family had been killed. Two brothers named Tschaikovsky had carried her into Romania. She had married one of the brothers, who had taken her to Berlin and left her there, penniless and without a vocation. Unable to invoke the aid of her mother's family in Germany, she had tried to drown herself.

During the next few years, scores of the Czar's relatives, ex-servants, and acquaintances interviewed her. Many of these people said that her looks and mannerisms were evocative of the Anastasia that they had known. Her grandmother and other relatives denied that she was the real Anastasia, however.

Tired of being accused of fraud, Anastasia immigrated to the United States in 1928 and took the name Anna Anderson. She still wished to prove that she was Anastasia, though, and returned to Germany in 1933 to bring suit against her mother's family. There she declaimed to the court, asserting that she was indeed Anastasia and deserved her inheritance.

In 1957, the court decided that it could neither confirm nor deny Anastasia's identity. Although we will probably never know whether this woman was the Grand Duchess Anastasia, her search to establish her identity has been the subject of numerous books, plays, and movies.

Passage 2 Questions

1. Anastasia is the grand duchess of-
 - A Russia
 - B Spain
 - C Ukraine
 - D Germany
 - E Romania

2. Anastasia is the daughter of-
 - A Ferdinand IV
 - B Phillip V
 - C Tchaikovsky
 - D Nicolas II
 - E Charles I

3. What group overthrew the government and murdered the Czar's family?
 - A Mutineers
 - B Bolsheviks
 - C Czarists
 - D Communists
 - E Revolutionists

4. How many years did Anna Anderson spend in the hospital?
 - A 3
 - B 4
 - C 5
 - D 2
 - E 1

5. The brothers that rescued Anna were-
 - A sailors
 - B doctors
 - C soldiers
 - D princes
 - E lawyers

6. What city was Anderson left penniless?
 - A Rome
 - B Romania
 - C St. Petersburg
 - D Paris
 - E Berlin

7. What year did Anderson migrate to the United States?
 - A 1956
 - B 1930
 - C 1928
 - D 1940
 - E 1925

8. In 1933 Anderson returned to Germany to do what?
 - A find her real family
 - B look for her husband
 - C start a new life
 - D prove she was Anastasia and file suit against her mother's family
 - E collect her inheritance

9. Who in particular claimed that Anderson was not Anastasia?
 - A the grandmother of Anastasia
 - B The court
 - C hospital nurses
 - D Anna Anderson
 - E Nicolas II

10. The court claimed that-
 - A Anastasia's identity could not be confirmed or denied
 - B Anderson was Anastasia
 - C Anderson was not Anastasia
 - D Charged Anderson for Fraud
 - E a movie should be made about Anderson

Appendix C

Passage 3

Charles Lindbergh is remembered as the first person to make a nonstop solo flight across the Atlantic, in 1927. This feat, when Lindbergh was only twenty-five years old, assured him a lifetime of fame and public attention.

Charles Augustus Lindbergh was more interested in flying airplanes than he was in studying. He dropped out of the University of Wisconsin after two years to earn a living performing daredevil airplane stunts at country fairs. Two years later, he joined the United States Army so that he could go to the Army Air Service flight-training school. After completing his training, he was hired to fly mail between St. Louis and Chicago. Then came the historic flight across the Atlantic. In 1919, a New York City hotel owner offered a prize of \$25,000 to the first pilot to fly nonstop from New York to Paris. Nine St. Louis business leaders helped pay for the plane Lindbergh designed especially for the flight. Lindbergh tested the plane by flying it from San Diego to New York, with an overnight stop in St. Louis. The flight took only 20 hours and 21 minutes, a transcontinental record.

Nine days later, on May 20, 1927, Lindbergh took off from Long Island, New York, at 7:52 A. M. He landed in Paris on May 21 at 10:21 P. M. He had flown more than 3,600 miles in less than thirty-four hours. His flight made news around the world. He was given awards and parades everywhere he went. He was presented with the U. S. Congressional Medal of Honor and the first Distinguished Flying Cross. For a long time, Lindbergh toured the world as a U. S. goodwill ambassador. He met his future wife, Anne Morrow, in Mexico, where her father was the United States ambassador.

During the 1930s, Charles and Anne Lindbergh worked for various airline companies, charting new commercial air routes. In 1931, for a major airline, they charted a new route from the east coast of the United States to the China.

Even while actively engaged as a pioneering flier, Lindbergh was also working as an engineer. In 1935, he and Dr. Alexis Carrel were given a patent for an artificial heart. During World War I in the 1940s, Lindbergh served as a civilian technical advisor in aviation. Although he was a civilian, he flew over fifty combat missions in the Pacific. In the 1950s, Lindbergh helped design the famous 747 jet airliner. He died August 1974, having lived through aviation history from the time of the first powered flight to the first steps on the moon and having influenced a big part of that history himself.

Passage 3 Questions

1. What is Charles Lindbergh's middle name?
 - A Augustus
 - B Adolf
 - C Al
 - D Albert
 - E Adam

2. What is Lindbergh remembered for?
 - A building the first airplane
 - B being given the patent for an artificial heart
 - C making a nonstop solo flight across the Atlantic
 - D flying in the military
 - E being a goodwill ambassador

3. What city's business leaders helped pay for Lindbergh's plane?
 - A Paris
 - B St. Louis
 - C San Diego
 - D Los Angeles
 - E Long Island

4. What happened after Lindbergh crossed the Atlantic?
 - A he flew the mail between St. Louis and Chicago
 - B he left college
 - C he attended the Army flight-training school
 - D he was given the Congressional Medal of Honor
 - E he married Anne Morrow

5. Who was Anne Morrow?
 - A a US Goodwill Ambassador
 - B a doctor
 - C a friend of Lindbergh
 - D recipient of the Congressional Medal of Honor
 - E wife of Lindbergh

6. When did the Lindberghs map an air route to China?

- A before they worked for an airline
- B before Charles worked with Dr. Carrel
- C after World War II
- D while designing the 747
- E when he was thirty

7. Who was Lindbergh's artificial heart patent partner?

- A Anne Morrow
- B Alexis Carrel
- C Averil Bennett
- D Paris Bloomberg
- E he did not have a partner

8. Lindbergh received what award?

- A Purple Heart
- B National Medal of Honor
- C Flying Aces
- D Distinguished Medal of Honor
- E Congressional Medal of Honor

9. What did Lindbergh help design?

- A an airplane
- B the 747 airline
- C the map of where to cross the Atlantic
- D Map from St. Louis to Paris
- E the award for Distinguished Flying Cross

10. What month did Lindbergh die?

- A April
- B May
- C January
- D August
- E December

Appendix D

Passage 4

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

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

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

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

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

Passage 4 Questions

1. The inventors of the first flying airplane were?
 - A Wilbur Sloane and Otto Sloane
 - B Otto Lilienthal and Wilbur Wright
 - C Orville Wright and Wilbur Wright
 - D Orville Lilienthal and Wilbur Keystone
 - E Orville Wright and Otto Lilienthal

2. What year was the first powered flight?
 - A 1907
 - B 1917
 - C 1920
 - D 1913
 - E 1903

3. How did the Wright brothers earn money as young boys?
 - A selling paper airplanes
 - B making and selling kites and mechanical toys
 - C performing imaginary air shows for the neighborhood children
 - D selling lemonade
 - E pick-pocketing

4. Otto Lilienthal was a pioneer in-
 - A flying
 - B creating wings for balance
 - C in selling kites
 - D hang-gliding
 - E building air planes

5. What type of shop did the Wright brothers run?
 - A a bicycle-repair shop
 - B a hang-gliding shop
 - C a flying shop
 - D a kite shop
 - E a printing press

6. What problem almost made the brothers give up trying to invent an airplane?
 - A finding a place to test their gliders
 - B getting a permit for building
 - C finding out how to make the machine turn
 - D finding materials to build the machines
 - E obtaining enough lift power in the gliders

7. How far did the first airplane go on its first flight?
 - A 1,000 feet
 - B 100 feet
 - C 120 feet
 - D 350 feet
 - E 1 mile

8. How much did the first airplane cost to make?
 - A less than \$1000
 - B more than \$500
 - C more than \$1500
 - D less than \$500
 - E less than \$10000

9. How long could the first plane stay aloft by the Wright brothers?
 - A third of an hour
 - B two hours
 - C one hour
 - D quarter of an hour
 - E half an hour

10. The Wright brothers are commonly called-
 - A the fathers of flying
 - B the first hang-glidings
 - C the Wright flyers
 - D the fathers of aviation
 - E pioneers of aviation