Psychology Internal Assessment

An investigation into the effect of word length on memory recall

Psychology Higher Level

Name: Lakshya Choudhary

Candidate number:

School: Wells International School

Date of Submission: December 8, 2015

Word Count: 1,835
Abstract

The aim of this experiment was to investigate how word length affects short term memory recall. The hypothesis is that words with less syllables, shorter words, would be easier to remember, and shorter words in a smaller cluster, would be the easiest to remember. The null hypothesis was that words with many syllables would be easier to recall especially when in a large group. This experiment aims to replicate an experiment done by Baddeley, Thomson, and Buchanan (1975). The independent variable are the words used and the groups the words were combined into. The dependent variable was the amount of words a participant was able to recall. The repeated measure design had been chosen. There were 25 randomly sampled participants, who went through 4 trials. The method was to get the participants to listen to a recording of the list of words, starting with cluster of 5 monosyllabic words, trial 2 used a cluster of 10 monosyllabic words, trial 3 had list of 5, 5 syllable words, and lastly, trial 4 had a list of 10, 5 syllable words.

The Wilcoxon test is able to show that word length does not influence memory recall, however length of the sequence does influence a participant’s ability to recall. The results were significant at a 0.05 or 5% level of the Wilcoxon Signed-Ranks Test in the ‘one-tailed’ column. The hypothesis for length of the sequence was correct, however the hypothesis for word length was incorrect, therefore making the null hypothesis correct.

Words Count: 249
Abstract
Introduction
Method
  Design
  Participants
  Materials
  Procedure
Results
  Descriptive
  Inferential
Discussion
Resources
Appendix 1
  Consent Form
Appendix 2
  Briefing
Appendix 3
  Debriefing
Appendix 4
Appendix 5
Appendix 6
Appendix 7
Appendix 8
Appendix 9
Appendix 10
Appendix 11
Introduction

Cognitive processes such as memory and encoding are based on schemas. Schemas are an individual’s mental representation of the world. Baddeley and Hitch (1974) suggested the Working Memory Model (WMM), which proved that the short-term memory (STM) deals with the mind’s visual features of an object, such as its size and color.

According to Miller (1965) the capacity of short term memory is constant, only when measured in terms of numbers of chunks, or groups. Craik (1968) performed an experiment to investigate Miller’s hypothesis. Craik used the method of recency effect on memory recall to estimate short term memory capacity. Craik found that word length did not affect free recall of separate groups of words comprising of different numbers of syllables. This experiment was then replicated and extended by Glanzer and Razel (1974). They were able to find that recency effect did influence memory recall by comprising the list of items in groups instead of word length. Glanzer and Razel concluded that the short term memory was capable of storing only two items, no matter what the item and how long it is.

Baddeley, Thomson, and Buchanan (1975) experimented on Word Length and Structure of Short-Term Memory. This study investigated the memory span of participants for sets of short, monosyllabic words, and long, 5 syllable words, and compared it to the common occurrence of the word in the English language.

This experiment is a modification of Baddeley, Thomson, and Buchanan (1975). The modification made was to the word choice. Instead of using everyday words, the words being used in this modification are Standardized Aptitude Test (SAT) vocabulary. Another modification was that there was no time limit, the participant was given as much time as they required to recall. The hypothesis for this investigation is that the longer the words the harder they are to recall, and the longer the list, the harder it is to remember. The null hypothesis is the shorter the words the harder they are to remember, and the shorter the list the harder they are to recall.
Method

Design

The repeated measure in this investigation are the lists of words used, the monosyllabic and 5 syllables word. The words were repeated to get a consistent data and to be able to tell whether the results are the same for all the participants. This experiment did not have a control group, only an experimental group. The controlled items for this experiment were: the website used as the recording of the list, the speed the words were articulated in, the accent of the words, the list of words, the amount of words in each list, and the list of words that was shown to the participants. The independent variable is the word length and list length, the dependent variable is the participant’s recall. Possible ethical consideration may be the fact that participants were not given prior notice regarding when the experiment would be conducted, they were asked to sign the form and the experiment was conducted then and there.

Participants

There were 20 participants, who were students not studying psychology, from ages 16-18, and were randomly selected, according to the time they were available to meet us. Gender did not matter for this experiment, therefore there was an uneven number of male and female participants, 13 male participants, and 7 female participants. Each participant had to go through four conditions. In the first condition, participants were shown a list of 10 monosyllabic word and were given a recording of 5 monosyllabic word to listen to, and were asked to verbally recall the words in the order they were heard. In condition 2 the participants were given a recording of 10 monosyllabic words to listen to, after listening the recording, were asked to verbally recite the words in the order they heard it. Condition 3 and 4 were the same as conditions 1 and 2 but with 5 syllable words.

---

Materials

- Consent form
- Standardized briefing and debriefing instructions
- List of 10 monosyllabic words
- List of 10 five syllable words
- 3 Laptops
  - to show list of words to participants
  - to open the website used for recording
  - to note down the words they recalled
- Earphones

Procedure

Participants were given the consent form, once the participants signed the forms, they were told the briefing, and instructions of this experiment. Participants allowed to familiarize themselves with the words in the two pools, before the experiment. The two pools were a list of monosyllabic words and a list of 5 syllable words. These lists were available for the participants to view throughout the experiment, these words were shown on a laptop screen. The words in the list given to the participants were mixed, to limit familiarity. Two list lengths were used, list of 5 words and list of 10 words. Two sequences of each length were made from pool of short word and two sequences of each length were made from pool of long words. Random sampling was used to generate the sequences. All participants are tested in both long and short words. Sequences were in an ascending order, starting with sequence of 5 words then sequence with 10 words. The words were read at speed 2 (of the website). When each trial was completed, participants were asked to verbally recall the words in the order they heard it, they were given as much time as they required. Participants were then debriefed about this experiment.

---

2 See Appendix 1
3 See Appendix 2 and 3
4 See Appendix 6
5 See Appendix 6
6 See Appendix 5
7 See Appendix 4
Results

Descriptive

This investigation used various interval data, therefore the descriptive statistics for this experiment is mean and standard deviation. According to table 1, list length influences recall for monosyllabic words more than for 5 syllable words, although the means are very close together, the mean for monosyllabic words is higher (4.2) than the mean of 5 syllable words (3.9), the standard deviation is also close together and is fairly low as well. Table 2 shows that word length does influence recall, given that the mean for 10 words list is higher (4.8) than the mean of 5 words list (3.1), however the standard deviation for short list is much lower (1.1) than that of long list (1.7). Standard deviation for both conditions were fairly low, proving that the results were very close to the mean.

Table 1: List Length Influences Recall

<table>
<thead>
<tr>
<th>List Length Influences Recall</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monosyllabic Words</td>
<td>4.2</td>
<td>1.5</td>
</tr>
<tr>
<td>5 Syllable Words</td>
<td>3.9</td>
<td>1.8</td>
</tr>
</tbody>
</table>

See Appendix 7 for calculations
Table 2: Word Length Influences Recall

<table>
<thead>
<tr>
<th>Word Length Influences Recall</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 words (short list)</td>
<td>3.1</td>
<td>1.1</td>
</tr>
<tr>
<td>10 words (long list)</td>
<td>4.8</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Inferential

This experiment uses the Wilcoxon Signed - Rank Test. Condition 1 tested influence of list length on recall. The hypothesis for condition 1 was that the longer the list length, the harder it is for a participant to recall. The Wilcoxon test revealed that the experimental hypothesis is correct, length of a list does have an influence on memory recall. Condition 2 tested the influence of word length on recall. The hypothesis was that the more syllables the word had the harder it would be to recall. According to the Wilcoxon test, the experimental hypothesis is incorrect, therefore making the null hypothesis correct, in other words, word length does not have an influence in memory recall.

---

9 See Appendix 7 for calculations
Discussion

The experiment has proven that the length of the word itself does not influence recall, however the length of the amount of words does influence recall. This is proven by both descriptive and inferential results. The descriptive results proved that amount of words in a list effects recall, by calculating the mean of monosyllabic words recalled in a list of 5 words and a list of 10 words, showing a higher mean than the mean of 5 syllable words in different lists. While the inferential results, through Wilcoxon test has proved that the experimental hypothesis, list length effects verbal recall, is correct. The descriptive results for word length influences recall showed that the mean for recall of both monosyllabic and 5 syllable words are higher for the long list than the short list, showing that the experimental hypothesis was incorrect. The experimental hypothesis for condition 2 was, word length influences recall. This hypothesis is again proven incorrect by the inferential results. Wilcoxon test proves that the experimental hypothesis is incorrect, resulting in the null hypothesis for condition 2 to be correct. The null hypothesis for condition 2 is that word length does not influence recall. These results are not consistent with the results discovered by Baddeley, Thomson, and Buchanan (1975). They discovered that the word length does have an effect on memory recall. Perhaps one difference would be that they did not test the influence of the amount of words in a list on memory recall. There were separate sequences, but they were not the variables being tested, the independent variable for the original experiment was only word length.

A limitation of this experiment could be the words used were SAT terms, and were perhaps not the most commonly used words in the English language. The familiarity of the words perhaps also played a role in the recall of words. Another limitation could be that all students were in their senior year, with ages ranging from 16 to 18, therefore generalizing the results. The low numbers of standard deviation show that the participants all performed relatively similarly, perhaps due to the participants belonging to the same age range, the same class, and maybe even due to the friendly competition they had amongst each other.

An improvement for this experiment would be to include a wider range of age in order to base the results for a larger population and not generalize it for one age range. Additionally, the terms used could be made more familiar for the participants, there were a few words in the list of polysyllable words that were very common however there were no words that were commonly used in the English language in the monosyllabic list of words. Another thing that could have been improved would be to give the participants a time limit, as done in the original experiment, to limit second guessing. Participants tend to change their answers often, perhaps giving a time limit would reduce that. The participants were allowed to look at the list of words that they had
to recall, maybe if they were given more time to familiarize themselves with the list of word, they would have performed differently.

In conclusion, this experiment states that recall is influenced by the amount of words that are required to remember as compared to the length of the word itself. Perhaps recall is also influenced by familiarity of the words. This investigation goes against the results of the original experiment by Baddeley, Thomson, and Buchanan (1975). The original research focused more on the word length and its influence on recall and did not focus on the amount of words to remember. Perhaps this could be a factor that should be further studied.
Resources

- Wilcoxon Signed Rank Test. (2013, October 6). Retrieved December 4, 2015, from https://www.youtube.com/watch?v=EFR3NNDGzH0
Appendix 1

Consent Form

INFORMED CONSENT FORM FOR
IB PSYCHOLOGY INTERNAL ASSESSMENT

Please read the following passage carefully.

Greetings, we are students of Wells International School and are replicating and modifying a previous experiment for our internal assessment for our IB Psychology class in the Higher Level. This is a formal request for you to be part of our experiment. Should you to partake in this experiment, the following rules apply:

- No physiological harm would be caused
- No psychological harm would be caused
- All data that is collected would be kept confidential
- Your name would be kept confidential and anonymous
- Once the experiment is over, you would be told the purpose of this experiment
- If you choose to, you would be told the purpose of this experiment
- If you choose to, you would be told the results of the experiment as well
- Once knowing about the experiment, you have every right to withdraw your consent from this experiment

This experiment will take no more than 20 minutes to complete. Should you need assistance, we will be there to aid you.
If you agree to the rules stated above, and will not be offended with the given results, please sign below:

I agree to participate voluntarily as I am aware of the consequences of this experiment. With the signature, I permit the researchers to use my data as part of their study. I am also fully aware that I may withdraw from this experiment at any moment I desire.

Signature: __________________________ Date: __________________________

If you're 16 or younger, please ask your guardian to sign this paper
Appendix 2

Briefing

Thank you for participating in our experiment. This experiment is being conducted for our IB Psychology IA. Once the experiment has ended, you would be informed of the aim of this experiment.

You will be given a list of words to listen to, and those words would also be shown in the screen in front of you. You will first hear a list of 5 words and then 10 words, this will happen twice for each word length. After each trial, you will be asked to recall the words, and verbally recite them in the sequence you heard them, you can use the list of words in front of you as a reference. Are you ready to begin?

Appendix 3

Debriefing

The aim of this experiment was to investigate the effect of word length on memory recall, as well as the effect of sequence length on memory recall. The hypothesis is that there is going to be higher recall when the list is shorter and when the words are short as well. If you would like to know the results, you may contact one of us, and we will provide you with the results once the experiment has been conducted.
Appendix 4

The website used to create the recording: http://www.naturalreaders.com/index.html
Appendix 5

List of the words that were used in this experiment

<table>
<thead>
<tr>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>tome</td>
<td>tome</td>
<td>abolitionist</td>
<td>abolitionist</td>
</tr>
<tr>
<td>cringe</td>
<td>cringe</td>
<td>conscientiousness</td>
<td>conscientiousness</td>
</tr>
<tr>
<td>gaffe</td>
<td>gaffe</td>
<td>lackadaisical</td>
<td>lackadaisical</td>
</tr>
<tr>
<td>bilk</td>
<td>bilk</td>
<td>diabolical</td>
<td>diabolical</td>
</tr>
<tr>
<td>lance</td>
<td>lance</td>
<td>assimilation</td>
<td>assimilation</td>
</tr>
<tr>
<td>poised</td>
<td>poised</td>
<td>rife</td>
<td>deleterious</td>
</tr>
<tr>
<td>blight</td>
<td>blight</td>
<td>rife</td>
<td>photosynthesis</td>
</tr>
<tr>
<td>rife</td>
<td>rife</td>
<td>laud</td>
<td>abolition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>conscientiousness</td>
</tr>
</tbody>
</table>

Appendix 6

List of words given to participants for reference

<table>
<thead>
<tr>
<th>Monosyllabic Words</th>
<th>Polysyllabic Words (5 syllables)</th>
</tr>
</thead>
<tbody>
<tr>
<td>poised</td>
<td>photosynthesis</td>
</tr>
<tr>
<td>bilk</td>
<td>abolitionist</td>
</tr>
<tr>
<td>hone</td>
<td>abomination</td>
</tr>
<tr>
<td>lance</td>
<td>incredulity</td>
</tr>
<tr>
<td>tome</td>
<td>pediatrician</td>
</tr>
<tr>
<td>laud</td>
<td>conscientiousness</td>
</tr>
<tr>
<td>gaffe</td>
<td>deleterious</td>
</tr>
<tr>
<td>blight</td>
<td>diabolical</td>
</tr>
<tr>
<td>cringe</td>
<td>assimilation</td>
</tr>
<tr>
<td>rife</td>
<td>lackadaisical</td>
</tr>
</tbody>
</table>
Appendix 7

Screenshot from calculator

\[ \overline{x} = \text{mean} \]
\[ \sigma = \text{standard deviation} \]

Monosyllabic words with different list length (list length influences recall)

\[
\begin{array}{l}
\overline{x} = 4.15 \\
\Sigma x = 166 \\
\Sigma x^2 = 784 \\
S_x = 1.561557408 \\
\sigma x = 1.541914395 \\
n = 40 \\
\min X = 1 \\
\downarrow Q_1 = 3
\end{array}
\]

5 syllable words with different list length (list length influences recall)

\[
\begin{array}{l}
\overline{x} = 3.9 \\
\Sigma x = 156 \\
\Sigma x^2 = 732 \\
S_x = 1.780233347 \\
\sigma x = 1.757839583 \\
n = 40 \\
\min X = 0 \\
\downarrow Q_1 = 3
\end{array}
\]

Short list length, different word length (word length influences recall)

\[
\begin{array}{l}
\overline{x} = 3.1 \\
\Sigma x = 124 \\
\Sigma x^2 = 430 \\
S_x = 1.081309747 \\
\sigma x = 1.067707825 \\
n = 40 \\
\min X = 0 \\
\downarrow Q_1 = 2
\end{array}
\]

Long list length, different word length (word length influences recall)

\[
\begin{array}{l}
\overline{x} = 4.825 \\
\Sigma x = 193 \\
\Sigma x^2 = 1047 \\
S_x = 1.722959588 \\
\sigma x = 1.701286278 \\
n = 40 \\
\min X = 1 \\
\downarrow Q_1 = 4
\end{array}
\]
Appendix 8

Participant responses in each condition

<table>
<thead>
<tr>
<th>Participant</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>7</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
## Appendix 9

*List length effects recall*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial1 - Trial 2</th>
<th></th>
<th>[Trial1 -Trial2]</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>6</td>
<td>-3</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>7</td>
<td>-3</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>5</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>7</td>
<td>-4</td>
<td>4</td>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>8</td>
<td>-4</td>
<td>4</td>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>5</td>
<td>-1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6</td>
<td>-3</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>4</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>5</td>
<td>-3</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>6</td>
<td>-3</td>
<td>3</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>6</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>5</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>6</td>
<td>-2</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Sum of all positive differences = 2+7+2 = 11

Sum of all negative differences = 13+13+7+7+16.5+16.5+2+13+7+13+13+7+7+7 = 142
\( T = 11 \) (smaller of the two values) \( (n = 17) \) one tailed test = 41  

*Experimental hypothesis is correct*

**List length effects recall**

| Participant | Trial 3 | Trial 4 | Trial 3 - Trial 4 | \(|\text{Trial 3 - Trial 4}|\) | Rank |
|-------------|--------|--------|------------------|-----------------|------|
| 1           | 3      | 6      | -3               | 3               | 15.5 |
| 2           | 4      | 6      | -2               | 2               | 13.125 |
| 3           | 4      | 7      | -3               | 3               | 15.5 |
| 4           | 0      | 2      | -2               | 2               | 13.125 |
| 5           | 5      | 8      | -3               | 3               | 15.5 |
| 6           | 4      | 1      | 3                | 3               | 15.5 |
| 7           | 4      | 5      | -1               | 1               | 2 |
| 8           | 2      | 2      | 0                | --              | -- |
| 9           | 3      | 5      | -2               | 2               | 13.125 |
| 10          | 2      | 4      | -2               | 2               | 13.125 |
| 11          | 2      | 4      | -2               | 2               | 13.125 |
| 12          | 2      | 4      | -2               | 2               | 13.125 |
| 13          | 3      | 6      | -3               | 3               | 15.5 |
| 14          | 4      | 7      | -3               | 3               | 15.5 |
| 15          | 3      | 5      | -2               | 2               | 13.125 |
| 16          | 3      | 6      | -3               | 3               | 15.5 |
| 17          | 1      | 3      | -2               | 2               | 13.125 |
| 18          | 3      | 4      | -1               | 1               | 2 |
| 19          | 2      | 5      | -3               | 3               | 15.5 |
| 20          | 3      | 4      | -1               | 1               | 2 |

Sum of all positive differences = 15.5

Sum of all negative differences =

\[
15.5 + 13.125 + 15.5 + 13.125 + 15.5 + 2 + 13.125 + 13.125 + 15.5 + 13.125 + 15.5 + 13.125 + 15.5 + 2 + 15.5 + 2 = 206.375
\]
T= 15.5 (smaller of the two values) (n = 19)
one tailed test = 53  
Experimental hypothesis is correct

**Appendix 10**

*Word length effects recall*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Trial 1</th>
<th>Trial 3</th>
<th>Trial 1 - Trial 3</th>
<th></th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>-2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
<td>-2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
Sum of all positive differences = 13+5+5+5+5+11+5+5+5=69
Sum of all negative differences = 11+11 = 22
T = 22 (smaller of the two values) (n = 13) one tailed test = 21  Null hypothesis is correct
Word length effects recall

<table>
<thead>
<tr>
<th>Participant</th>
<th>Trial 2</th>
<th>Trial 4</th>
<th>Trial 2 - Trial 4</th>
<th></th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>7</td>
<td>-3</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>8</td>
<td>-1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>2</td>
<td>-1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>7</td>
<td>-1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>5</td>
<td>-1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>6</td>
<td>-2</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>3</td>
<td>-1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>19</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

Sum of all positive differences = 4+12.5+12.5+12.5+9+4+9 = 63.5
Sum of all negative differences = 12.5+4+4+4+4+9+4 = 41.5
T = 41.5 (smaller of the two values)
null hypothesis is correct

Appendix 11

Table of critical values for the Wilcoxon test can be retrieved from:  http://www.stat.ufl.edu/~winner/tables/wilcoxon_signrank.pdf

Critical Values of the Wilcoxon Signed Ranks Test

<table>
<thead>
<tr>
<th>n</th>
<th>Two-Tailed Test</th>
<th>One-Tailed Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>α = .05</td>
<td>α = .01</td>
</tr>
<tr>
<td></td>
<td>α = .05</td>
<td>α = .01</td>
</tr>
<tr>
<td>5</td>
<td>--</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>12</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>13</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>14</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>16</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>17</td>
<td>34</td>
<td>41</td>
</tr>
<tr>
<td>18</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>19</td>
<td>46</td>
<td>53</td>
</tr>
<tr>
<td>20</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>21</td>
<td>58</td>
<td>67</td>
</tr>
<tr>
<td>22</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>23</td>
<td>73</td>
<td>83</td>
</tr>
<tr>
<td>24</td>
<td>81</td>
<td>91</td>
</tr>
<tr>
<td>25</td>
<td>89</td>
<td>100</td>
</tr>
<tr>
<td>26</td>
<td>98</td>
<td>110</td>
</tr>
<tr>
<td>27</td>
<td>107</td>
<td>119</td>
</tr>
<tr>
<td>28</td>
<td>116</td>
<td>130</td>
</tr>
<tr>
<td>29</td>
<td>126</td>
<td>140</td>
</tr>
<tr>
<td>30</td>
<td>137</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>109</td>
<td>120</td>
</tr>
</tbody>
</table>