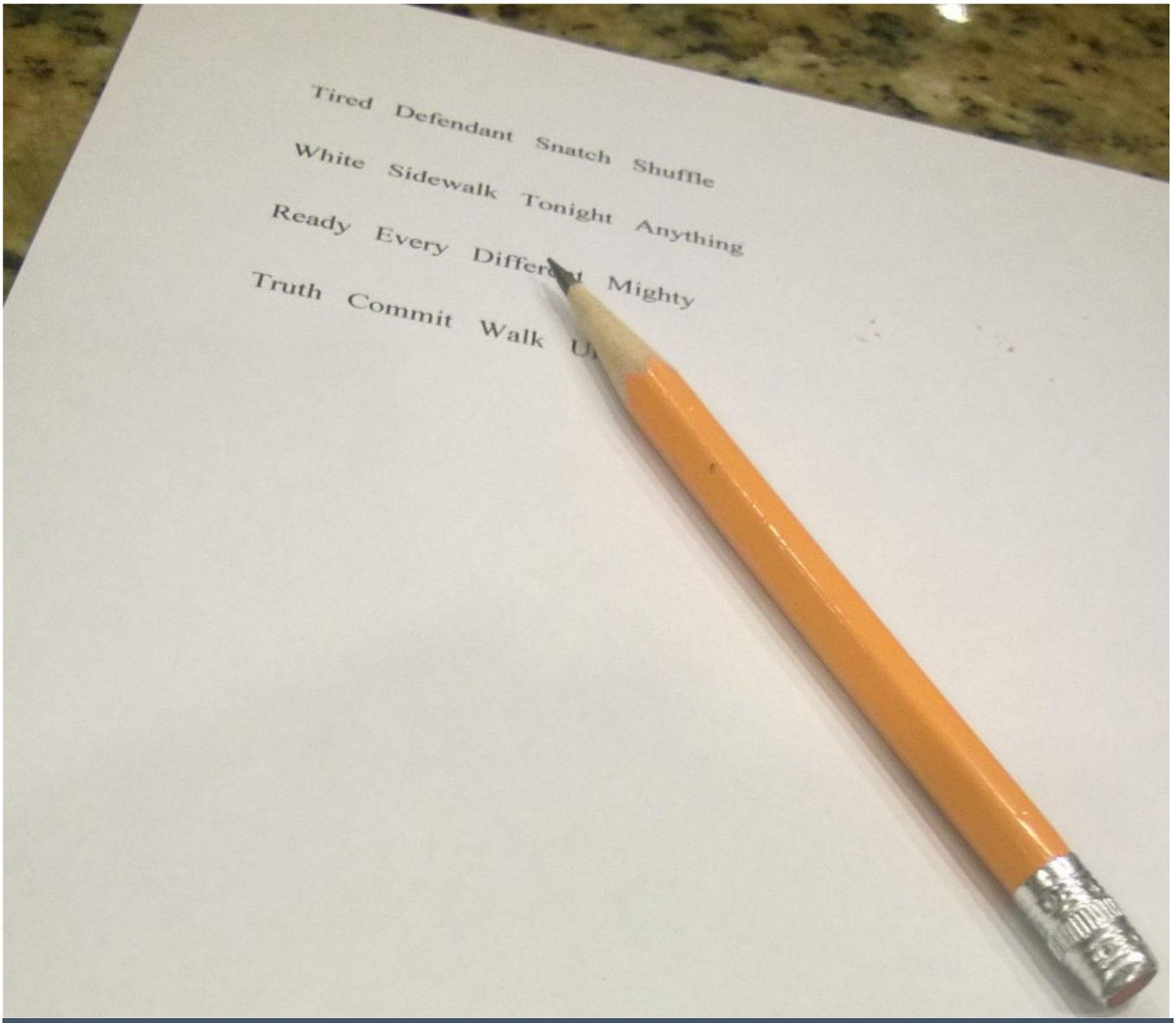

Does the grouping of long strings of words significantly improve memorization?

6/1/14

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Section I: Introduction

The short-term memorization of words is central to our daily lives. Our music, reading material, and conversations flood us with phrases and sentences. We remember some of these words but forget many more. What factors influence the retention of these words? History suggests that the length of the word sequence is one such factor.

For many years, psychologists have attempted to understand the details of memorization. Miller's famous 1956 study, "The Magical Number Seven, Plus or Minus Two," stated that we most effectively retain information when it is presented in sets of seven. However, this was a "rough estimate" rather than "a real capacity limit." More recent studies, including Cowan's 2001 paper, "The magical number 4 in short-term memory: a reconsideration of mental storage capacity," insist that in fact, the true "capacity limit" is closer to four.

Evidence of these modern psychological studies can be found throughout our society. Credit card numbers, social security numbers, and telephone numbers are arranged in sets of two, three, and four. Yet, this grouping is typically reserved for digits, not words. For example, in vocabulary books, words are presented in long lists. We are hard pressed to find situations where *words* are grouped in order to aid memorization. Does this indicate that the grouping of information is less effective for words? Or, are we missing a valuable opportunity to improve our short-term retention of words? These questions led to the following hypotheses that we intend to test with a two-sample t-test:

H_0: presenting the words in grouped form does not influence the true mean number of words we can remember after 20 seconds

H_A: presenting the words in grouped form improves word retention

Section II: Data Collection

In order to test these hypotheses, we performed a randomized, comparative experiment.

To begin with, we composed a set of sixteen words. We randomly selected pages from Harper Lee's *To Kill a Mockingbird* using the TI-nspire's "RandInt" function. On each page, we located the first noun, verb, or adjective, disregarding proper nouns and words of fewer than five characters. We changed each word to its "simplest" form (plural to singular, past tense to present, converting gerunds, etc.) and added it to our list. The selected words are included in our appendix.

With the same sequence of sixteen words, we created two different arrangements:

- "Ungrouped"—The sixteen words in a single line across the top of the page
- "Grouped"—The words separated into four lines of four words each

These served as our treatments. For every subject, we used the TI-nspire's "RandInt" to generate either "1" or "2." "1" corresponded to the "ungrouped" treatment while "2" corresponded to the "grouped" treatment.

Then, we gave each student a face-down sheet with the sixteen words in the selected format. When we said "go," the students turned over the sheet and had twenty seconds to memorize as many words as they could. On "stop," they immediately flipped the sheet to the blank back side. Then, they attempted to write all the words they could remember. Afterwards, we collected the paper from the individuals. We assigned each test a score based on the number of words they correctly wrote. Since spelling was a problem for many subjects, we disregarded it

when grading. Additionally, we didn't distinguish between different forms of the same word. For example, if a subject wrote "walking" instead of "walk," we gave them points for it nonetheless.

Section III: Data Analysis

Below are the summary statistics from our experiment, including the size, mean score and standard deviation for each group. We also included histograms for the two distributions to facilitate the comparison of the groups.

Parameters of Interest:

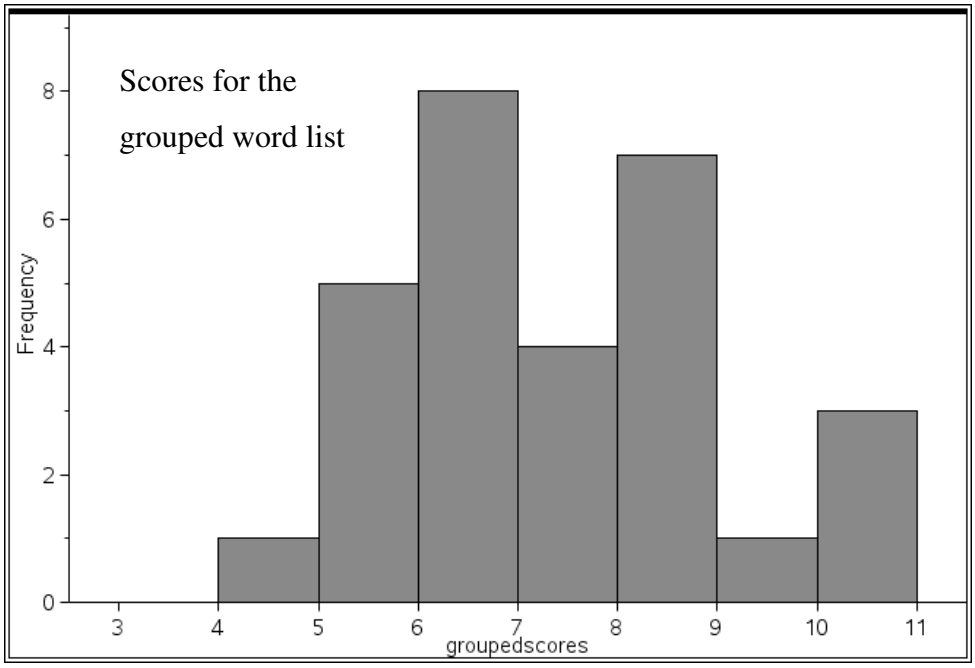
μ_1: the true mean number of words we can memorize in 20 seconds when the string of words is presented in a line of 16 words

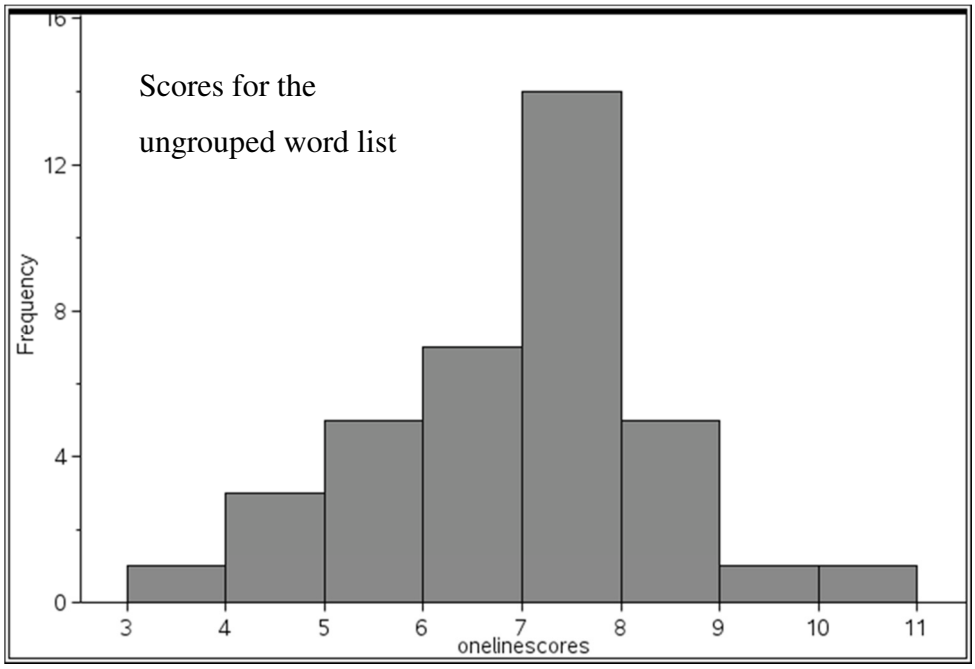
μ_2: the true mean number of words we can memorize in 20 s when the string of words is presented in four lines of four words

Summary Statistics:

s_1	1.46429
s_2	1.633245
$\bar{x}_1$	6.459459
$\bar{x}_2$	6.896552
n_1	37
n_2	29

Histograms:





Both distributions appear to be approximately Normal. However, the "grouped" distribution is bimodal, with peaks at 6 and 8 words, while the "ungrouped" distribution is unimodal, with a peak at 7. The sample mean for the "ungrouped" treatment (6.459) is slightly lower than that of the "grouped" treatment (6.897). The sample standard deviation for the

"ungrouped" treatment (1.464) is also lower than that of the "grouped" treatment (1.633). It appears that on average, the students with the "grouped" treatment scored higher and were more varied than those with the "ungrouped" treatment.

Section IV: Inferential Procedures

We are performing a 2-sample t-test for $\mu_1 - \mu_2$ at $\alpha = 0.05$

H_0: $\mu_1 - \mu_2 = 0$

H_A: $\mu_1 - \mu_2 < 0$

Conditions:

Random: We randomly assigned the treatments ("grouped" and "ungrouped") to the chosen students.

Normal: The sample sizes for both groups are large enough to meet the Normal condition. Although our sample size for the "grouped" treatment (29), is below the traditional cut-off at 30, we felt that the sample size was large enough to ensure that the sampling distribution is approximately Normal.

Independent: As a result of random assignment, the two groups were independent of each other. However, we suspect that the individual responses may not have been independent. We collected our data over many separate testing periods. The delivery of instructions differed slightly for each testing period. Since many people participated in our study, it is also possible that information about our experiment had spread to certain subjects before we administered the experiment. Thus, we will proceed with caution.

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}}}$$

$$= \frac{(6.459459 - 6.896552) - 0}{\sqrt{\frac{1.46429^2}{37} + \frac{1.633245^2}{29}}}$$

$$= -1.1288$$

$$df = 29 - 1$$

$$= 28$$

$pvalue = P(t < -1.1288)$ at 28 degrees of freedom

$$= 0.13428$$

Section V: Conclusion

Since our pvalue of 0.13428 is greater than our significance level of 0.05, we fail to reject the hypothesis that the grouping of words does not improve word retention. In other words, we do not have enough evidence to conclude that breaking a string of words into groups significantly improves the ability of subjects like these to remember the words.

Section VI: Reflection

Although the data are not significant, both of us still suspect that the grouping of words influences our short-term ability to memorize words. In our test, we suspect that a variety of factors led to our lack of significance. By analyzing these factors, we can develop strategies to improve future studies about the same topic. First, we think the memorization period in our study was too long. Since each group had twenty seconds to memorize, the subjects with the "ungrouped" treatment had enough time to read across the page. As a result, the "grouped" treatment lost the initial advantage that comes with the methodical organization of words.

Second, there was a lack of uniformity over the individual testing periods. As a result of practical difficulties, we had to administer the test in many separate locations and times. The responses were undoubtedly affected by their surroundings and the specific instructions we gave. Third, the treatments were too inherently similar. Only four presses of the "Enter" key separated the two treatments. We should have devised a way to amplify the effects of grouping the words and/or leaving them ungrouped. Fourth, our sample size was not large enough to detect the small difference between the sample means. Ultimately, we did not have enough power to conclude that there was a significant difference between the two groups. A larger sample size may have given us the power to make this conclusion. Moving forward, we are confident that with improvements to studies like this one, strategies will eventually emerge to help short-term word retention.

Section VI: Appendix

Distribution of Quiz Scores:

Score	3	4	5	6	7	8	9	10
Count for "Grouped"	0	1	5	8	4	7	1	3
Count for "Ungrouped"	1	3	5	7	14	5	1	1

Word List:

Page Number	*Word*	*Simplified Word*
236	Tired	Tired
175	Defendant	Defendant

60	Snatched	Snatch
277	Shuffled	Shuffle
204	White	White
87	Sidewalk	Sidewalk
72	Tonight	Tonight
266	Anything	Anything
261	Ready	Ready
14	Every	Every
34	Different	Different
197	Mighty	Mighty
179	Truth	Truth
90	Committed	Commit
26	Walking	Walk
281	Unhooked	Unhook

Section VII: Sources

Cowan, Nelson. "The magical number 4 in short-term memory: a reconsideration of mental storage capacity." *PubMed*. National Institute of Health, 24 Feb. 2001. Web. 30 May 2014. <http://www.ncbi.nlm.nih.gov/pubmed/11515286>.

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