A recent mass e-mail circulating online claimed that the correctness of letter order in a word did not matter and stated that as long as the first and last letters were in their original position, one could read it with no problems (personal communication, October, 2003).

This email did not operationally define “no problem,” resulting in confusion about what problematic was intended to mean. The concept that letter scrambling did not matter was demonstrated with a sample paragraph consisting of 79 simple words, most of which consisted of two to three syllables. This e-mail also suggested that people do not actually look at each individual letter in every word, but rather decode a word as a whole (personal communication, October, 2003). This explained how an individual could read scrambled words as long as the first and last letters were in their original position. Because the original paragraph contained only simple words, this study questioned the likelihood that the lack of difficulty in reading scrambled words in a paragraph would broadly generalize to other reading samples.

Similar studies of letter order and word manipulation found that reading time and comprehension worsened due to the manipulation of letters in words (Jordan, Thomas, Patching, & Scott-Brown, 2003). Jordan et al. manipulated approximately 1 in every 10 words to one of three settings: initial, exterior, and interior pairs. Using the word castle as an example, Summer 2006 /box2

This research examined the effects of reading a passage when the letters in words were scrambled. It was conducted as a class project in response to an anonymous mass e-mail that claimed there was no effect on reading as long as the first and last letters of a word were properly placed (i.e., placed). The hypotheses of this experiment were that the scrambling of letters in words would: (a) increase latency, (b) increase frustration, (c) decrease comfort, and (d) reduce comprehension (perceived and actual). Participants read 1 of 4 paragraphs that varied in length and whether they were scrambled, then completed a short survey. The findings suggested that scrambling a word influenced reading latency, frustration, and comfort with the message, but not comprehension. Theoretical implications of these findings were discussed.

Can You Raed This Srcmabeld Msesgae? Testing a Mass E-mail Assertion

This research examined the effects of reading a passage when the letters in words were scrambled. It was conducted as a class project in response to an anonymous mass e-mail that claimed there was no effect on reading as long as the first and last letters of a word were properly placed (i.e., placed). The hypotheses of this experiment were that the scrambling of letters in words would: (a) increase latency, (b) increase frustration, (c) decrease comfort, and (d) reduce comprehension (perceived and actual). Participants read 1 of 4 paragraphs that varied in length and whether they were scrambled, then completed a short survey. The findings suggested that scrambling a word influenced reading latency, frustration, and comfort with the message, but not comprehension. Theoretical implications of these findings were discussed.

This email did not operationally define “no problem,” resulting in confusion about what problematic was intended to mean. The concept that letter scrambling did not matter was demonstrated with a sample paragraph consisting of 79 simple words, most of which consisted of two to three syllables. This e-mail also suggested that people do not actually look at each individual letter in every word, but rather decode a word as a whole (personal communication, October, 2003). This explained how an individual could read scrambled words as long as the first and last letters were in their original position. Because the original paragraph contained only simple words, this study questioned the likelihood that the lack of difficulty in reading scrambled words in a paragraph would broadly generalize to other reading samples.

Similar studies of letter order and word manipulation found that reading time and comprehension worsened due to the manipulation of letters in words (Jordan, Thomas, Patching, & Scott-Brown, 2003). Jordan et al. manipulated approximately 1 in every 10 words to one of three settings: initial, exterior, and interior pairs. Using the word castle as an example,
the first two letters of the words were placed in their original location (caetls), the first and last letters were placed in their original location (claste), or the middle two letters were placed in their original location (lestac) respectively. They asserted that by pairing letters of a word together, the human mind could identify the entire word (Jordan et al., 2003).

Results of this study demonstrated that all combinations of pairs were equally important. In fact, it was not the pairing of the letters that mattered as much as the actual letter included in the pairing. Common letters such as “e” were harder to use to identify the word; whereas, words beginning with uncommon letters such as “q” were easier to identify (Jordan et al., 2003). This meant that the ability to decode a word was dependent on the letters in the word. If a scrambled word contained many common letters or began with a common letter, it would take longer to decode that word. This was especially true for most scrambled words consisting of more than one vowel. Thus, one could not assume a person’s ability to decode scrambled letters to be the same from one word to the next.

Another problem arose when letters had the possibility of more than one pronunciation. When reading a word containing a letter that has multiple pronunciations (such as vowels), a person must spend a longer amount of time decoding the word (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004). Balota et al. (2004) found that when presented with words such as pint, the reader must first realize the pronunciation of the “i,” then decode the rest of the word. Given that it is a common word, one would not need to use much cognitive effort to decipher the sound made by the vowel. However, in some scrambled words, readers did not always know what word was being presented to them. When a reader was decoding the scrambled word and came across letters with multiple sounds, it affected latency, comprehension, and frustration. Through the past two studies, every letter played an important role in a person’s ability to decode words. When researchers presented any part of a word incorrectly, problems occurred in a person’s capability to adequately read and comprehend the word.

A comparable study examined the influence of one-letter cues in a word on solving anagrams (Witte & Freund, 2001). The purpose was to identify which letter cue was most useful in decoding anagrams. The three cues included the first letter, middle letter, and last letter in the word. The first letter cue was the most helpful in figuring out the anagram. Though letter placement was critical for word retrieval, this research still demonstrated that any cue was better than no cue at all. Individuals receiving no cue took longer to identify the word than individuals with any cue (Witte & Freund, 2001). This suggests that a scrambled word would be easier to decode if the first and last letters are in the original position (by acting as cues). However, it would not result in the same level of reading comprehension as when the entire word is in an unscrambled form.

Studies using similar methods with shorter anagrams showed less dependency on cues. According to previous studies, the longer (or more complex) a scrambled word, the more need there was for informational cues to accompany the word (Dominowski, 1968; Muray & Mastronardi, 1975). Scrambled words, despite certain letters remaining in their original position, would have a longer latency and result in less comprehension than unscrambled words. Witte and Freund (2001) also found that people typically assumed a consonant as the first letter of a word rather than a vowel. Thus, if given the middle or last letter cue, most people sorted through the consonants first and then moved on to the vowels after exhausting the other options. When this occurred, people reacted with more frustration because it took more effort to read the words.

The English language is read from left to right, yet it is debatable whether words are processed as a whole word or as individual letters read from left to right. Kwantes and Mewhort (1999) studied this by finding the orthographic uniqueness point (OUP), which is the letter at which the word becomes that word and only that. For example in “act,” the third letter is the OUP whereas in “actress,” the fourth letter is the OUP. They presented participants with words having different OUPs on a screen for varying lengths of time. The idea was that if people processed words from left to right, then it would take longer to process the words with later OUPs compared to the words with early OUPs. If this was true, then people need every letter in its correct place in order to decode and comprehend words accurately and at their optimal level. Their study found that retrieving a word involved sequential processing (Kwantes & Mewhort, 1999). In other words, people read words letter by letter, from left to right. If letters in a word were out of place, there would no longer be an OUP defining the word. With no useful OUP, the participants’ brains had to spend more time and effort decoding the word resulting in a longer reading latency and often times more frustration.

Given past research identifying differences when reading words due to abnormal letter variations, the present study challenged the anonymous e-mail claim that scrambling letters within a word would cause “no
problems” when reading. Given that the e-mail was brief and contained relatively short words, it was hypothesized that the assumption that scrambling would not impact reading was false, because every individual letter is vital to the reading process. As such, an experiment was devised to test this assertion by comparing reading performances for the e-mail paragraph and for a more complex paragraph.

The study measured difficulties that readers may experience while reading a paragraph with scrambled words including reading latency, frustration, comfort, and comprehension. It was hypothesized that scrambling letters within words would impact these variables negatively leading to increased latency, frustration, decreased comfort, and comprehension (both perceived and actual). Additionally, reading a more complex paragraph would increase these effects.

Method

Participants

Experimenters selected participants for the study from various settings including malls, schools, and grocery stores. Each experimenter completed the study with one participant in each of four conditions. All participants were over 18 years of age and spoke English as their first language. The researchers set these characteristics as requirements for participants before the experiment began. Any of the participants not meeting these criteria were still able to participate, but their data were not included in the analyses. A total of 114 individuals participated, with 50 men and 61 women, 3 who did not report gender, and 8 individuals did not complete the experiment. Participants’ level of education ranged from high school diploma to doctoral degree. Participants ranged from 18 to 74 years in age.

Materials

Paragraphs. The study used five different paragraphs. One paragraph was used as a control and four paragraphs were used in the experiment condition. The experimental paragraphs were either complex or simple and used either scrambled or unscrambled words.

The control paragraph, employed as a covariate, contained 95 words ($M = 5.08$ letters per word). The control paragraph measured participants’ reading ability. This paragraph remained unscrambled and all participants read it.

The remaining paragraphs served to present the difficulty and scrambling manipulations. The first experimental paragraph was the original mass e-mail that sparked interest in the question. This paragraph was defined as simple due to the length of the words ($M = 4.10$ characters) and the paragraph ($N = 79$ words) being shorter and more common. When scrambled, the paragraph contained words reordered in the following manner: The first and last letters of the words remained in the original positions, while the remaining letters of each word were randomly scrambled. Words with three letters or less retained their original placement.

The third passage was the complex paragraph and was from a practice American College Test (ACT, 2003) website. This was defined as complex by the length of the words ($M = 4.89$ characters) in the passage ($N = 297$ words) as well as the inclusion of less common vocabulary. For this passage, scrambling occurred in the same manner as the simple paragraph.

Questionnaire. Participants recorded levels of comfort, frustration, and perceived comprehension on a brief questionnaire. All items used 7-point Likert scales where higher numbers represented more of the target variable. When reading the complex paragraph, participants also completed a five question, multiple-choice questionnaire taken from a sample ACT to measure comprehension (ACT, 2003). There was no measure used to report actual comprehension for the simple paragraph. The participants also recorded their age and level of education.

Procedure

Participants were randomly selected from several public areas including malls, libraries, dormitories, and parking lots. Each participant read two paragraphs: the control paragraph and one of the four experimental paragraphs (chosen randomly by the experimenter). The participant first read the control paragraph and then read the experimental paragraph. Experimenters timed participants from the first word of the paragraph spoken until the participant was completely finished with the paragraph, then recorded the time for each of the two paragraphs individually. Following the paragraph reading, participants completed the questionnaire. Participants in the complex condition completed an additional comprehension measure.

Results

The hypotheses were tested using a 2 (complexity of paragraph) X 2 (scrambling of words) between-subjects analysis of covariance (ANCOVA). The control

$^{1}$ The Dolch Words determined the commonality of the words in each paragraph (Harris, 2003). The Dolch Words are a list of 220 words that generally make up 50-75% of the works that students read. A complexity ratio was computed by dividing the number of uncommon words in the paragraph by the number of total words. The complex paragraph contained more uncommon words than the simple paragraph, having ratios of .51 and .39 respectively.
paragraph, read before the manipulated paragraph, accounted for individual reading differences among the participants. All participants read this paragraph prior to reading the paragraph assigned to their condition. The control paragraph accounted for significant variance in the dependent variable for the following dependent variables: reading latency, $F(1, 100) = 16.34$, $p < .01$, $r^2 = .14$; comfort, $F(1, 100) = 9.34$, $p < .01$, $r^2 = .09$; and actual comprehension, $F(1, 51) = 3.58$, $p < .06$, $r^2 = .03$. This was not true for frustration, $F(1, 100) = 1.41$, $p < .24$, $r^2 = .01$; and perceived comprehension, $F(1, 98) = .72$, $p = .40$, $r^2 = .01$.

To test the hypotheses that latency increased with the complexity of the paragraph and with the degree to which the words were scrambled, an ANCOVA was conducted on reading latencies. Reading latency was longer for the scrambled paragraphs ($M = 120.13, SD = 99.19$) in comparison to the unscrambled paragraphs ($M = 80.91, SD = 62.33$), $F(1, 100) = 35.96$, $p < .01$, $r^2 = .26$. Also, reading latency was longer for the complex paragraphs ($M = 165.83, SD = 66.28$) than the simple paragraphs ($M = 50.98, SD = 26.23$), $F(1, 100) = 293.98$, $p < .01$, $r^2 = .75$. Additionally, a 2-way interaction existed between scrambling and the complexity of the paragraph. This interaction emerged because the difference between the scrambled ($M = 203.25$) and the unscrambled latency ($M = 130.26$) was greater for the complex paragraph than the difference between the scrambled ($M = 41.37$) and the unscrambled ($M = 18.61$) for the simple paragraph, $F(1, 100) = 9.58$, $p < .01$, $r^2 = .09$ (See Figure 1). The effects on latency may have been due to the length of the paragraph and not the complexity. Experimenters conducted a corrected test and the results for all three effects were still significant.

The ANCOVA for frustration revealed that frustration was greater with the scrambled paragraph ($M = 3.67, SD = 2.12$) than the unscrambled paragraph ($M = 2.38, SD = 1.81$), $F(1, 100) = 26.13$, $p < .01$, $r^2 = .21$. Frustration was higher when reading the complex paragraph ($M = 4.33, SD = 1.85$) than the simple paragraph ($M = 1.63, SD = 1.18$), $F(1, 100) = 101.01$, $p < .01$, $r^2 = .50$. There was no interaction between scrambling and complexity with respect to frustration, $F(1, 100) = .89$, $p < .35$, $r^2 = .01$.

A similar analysis conducted on reported comfort levels revealed that comfort was lower with the scrambled paragraph ($M = 4.35, SD = 1.85$) than with the unscrambled paragraph ($M = 5.32, SD = 1.92$), $F(1, 100) = 16.97$, $p < .01$, $r^2 = .15$. Comfort levels were also lower with the complex paragraph ($M = 3.80, SD = 1.68$) than with the simple paragraph ($M = 5.94, SD = 1.55$), $F(1, 100) = 58.66$, $p < .01$, $r^2 = .37$. No interaction was found between the degree to which the paragraph was scrambled and complexity when looking at comfort.

This study measured two types of comprehension — perceived and actual. All participants reported perceived comprehension. No effect for scrambling emerged for perceived comprehension, $F(1, 98) = .78$, $p < .38$, $r^2 = .01$. However, perceived comprehension was lower for the complex paragraph ($M = 3.19, SD = 1.65$) than for the simple paragraph ($M = 6.29, SD = 1.21$), $F(1, 98) = 119.82$, $p < .01$, $r^2 = .55$. There was no interaction between scrambling and complexity in regards to perceived comprehension, $F(1, 98) = 3.04$, $p < .08$, $r^2 = .03$. Actual comprehension was measured only in participants in the complex (the paragraph taken from the practice ACT) conditions. No main effect was found for actual comprehension, $F(1, 51) = .87$, $p < .36$, $r^2 = .01$.

**Discussion**

The data supported the first hypothesis that complexity and scrambling of a paragraph would affect latency in reading time, and that scrambling a complex paragraph would amplify this effect. This suggests that the assertion that there will be “no problems” reading a scrambled message was false. Scrambling the letters of a word did affect how one reads it, demon-

\footnote{For the corrected test, the number of words in the complex paragraph was divided by the number of words in the simple paragraph to compute a ratio (3.76) that would correct for length. Then, researchers multiplied the latencies for the simple paragraph by this ratio. There was still a main effect for complexity, $F(1, 100) = 31.13$, $p < .01$; scrambling of letters, $F(1, 100) = 22.24$, $p < .01$, and an interaction $F(1, 100) = 5.17$, $p < .05$.}
strated by the fact that it took longer to read. These results supported past research that showed an increase in latency due to the changing of words (Balota et al., 2004; Kwantes & Mewhort, 1999). Even with the correction for length, there was still a difference in latency between paragraphs (whether they were scrambled) and an increased effect when the complex paragraph was scrambled. This demonstrated that it was the complexity of the paragraph, not the length, which impacted the reading time.

The data also supported the second and third hypotheses. Participants experienced an increase in frustration and a decrease in comfort due to both the complexity of the paragraph and the scrambling of words within it. Participants became more frustrated and less comfortable with a scrambled message compared to an unscrambled one and with a complex message rather than a simple one. There was no interaction between complexity and scrambling. This illustrates that the effect of scrambling was equal across levels of complexity. Once again, this demonstrates that participants cannot read a scrambled paragraph without problems, as the e-mail claimed.

The data partially supported the fourth hypothesis. Participants reported difficulty in comprehending the complex paragraph in comparison to the simple paragraph. However, there was no significant difference in the perceived or actual comprehension levels in regards to scrambling. Although this supports the e-mail claim, the significance could have been lost due to the complexity of the paragraph. The average comprehension was quite low suggesting that the paragraph may have been too complex. Although these results support the e-mail’s claim, the results may suggest a floor effect in comprehension from using a paragraph that participants did not understand even when unscrambled. Therefore, participants could not exhibit less understanding when the passage was scrambled. Another possible explanation for why there was no difference in actual comprehension could be that because the participants in the scrambled condition took longer to read the paragraph, they were just taking longer in order to better comprehend the paragraph. If this is true, then perhaps a time restriction while reading the paragraph would have yield more of a difference in comprehension.3 Finally, we must concede that these results might reveal that the email assertion was correct in regards to comprehension. While scrambling clearly impacted reading latency, frustration and comfort, perhaps the one area of reading that scrambling the words did not impact was comprehension.

Familiarity

The effects due to paragraph complexity may have been due to the familiarity of readers with the words themselves. According to Perfetti and Roth (1981), the more familiar a word, the easier it is to recognize and comprehend. Based on a list of Dolch Words (Harris, 2003), the complex paragraph contained more uncommon words. Participants easily recognized words in the simple paragraph even in the scrambled condition because of repetitive, past exposure, and familiarity to the words. Participants did not easily understand the experimental paragraph regardless of whether it was scrambled or not, which is demonstrated by lack of an effect for the perceived or actual comprehension measures.

Context and Positioning

The study also demonstrated the importance of context and correct positioning of letters when encountering new words. According to Nicholson, Bailey, and McArthur (1991), people comprehend more when provided contextual cues than when no contextual cues are provided. Within the scrambling condition, there are no contextual cues present resulting in poor comprehension. Also, when presented with a complex, scrambled word, the majority of participants became frustrated, resulting from decreased cognitive functioning.

Length

The length of the paragraphs may account for some of the effects. The length correction demonstrated that the difference in latency was not due to the length of the paragraph itself, but it did not rule out an effect from length on the other variables. It is likely that an increase in length could reduce perceived comprehension because the longer paragraph would include more ideas than the shorter paragraph. Length may have also influenced comfort and frustration as a person may be more likely to feel comfortable with a shorter paragraph.

Scrambling

Scrambling produced an effect on latency. This demonstrates that while people can read a scrambled message, they will not read it as quickly as an unscrambled one. Having to read a scrambled paragraph also increases frustration. When unscrambling the words, an individual’s cognitive processes are required to decode the words while attempting to comprehend their meaning, resulting in a decrease of comfort and

3Experimenters wish to thank an anonymous reviewer for this contribution to the paper.
an increase in frustration. When a sentence contains many complex words, the process becomes more difficult and the effects are magnified. The results found by earlier research demonstrated increased frustration of participants when presented with altered words (Jordan et al., 2003). The increase of frustration with length of paragraph demonstrated a lack of whole-word recognition while reading the larger, unrecognizable words in the experimental paragraph. Thus, the assertions of the e-mail do not apply when words are complex and/or unfamiliar.

**Limitations**

The simple paragraph contained fewer scrambled words (47%) than the complex paragraph (58%). Because a large portion of this study examined how scrambling affected reading between simple and complex paragraphs, this could be a possible confound. If scrambling the words affects latency, frustration, and comfort, the results could be due to the unequal percentage of scrambled words.

Another limitation to this study was the style of writing. In this study, the simple paragraph was informal while the complex paragraph was formal. This could affect the variables because people may comprehend one style better than another style. In future studies, researchers should control for writing style by using only one type, or study it by making the style of writing another independent variable.

This was a class activity resulting in a team of researchers testing participants. The large number of experimenters may have caused errors in the study. Errors could have emerged in the measuring and reporting of latency and in differences in reading the protocol to participants. The way that researchers approached the participants and read the protocol (in a friendly manner versus in a disinterested one) also could have affected the person’s comfort levels. The comfort that the data represents could be due to disparities such as individuals with reading disabilities. People with reading disabilities may also already be accustomed to the difficulty of reading a complex paragraph and thus, when reading a complex paragraph, their level of frustration would be less than that of a typical person. Comparing individuals with reading disabilities to those with normal reading capabilities would help further this research, as well as the health field.

**Conclusions**

This research has important implications. For example, the e-mail seems logical is possibly correct in regards to comprehension. However, the broad assertion is not correct due to ambiguities of its claim. When processing a word, people often use knowledge of consonant/vowel pairings, beginning (prefixes), and ending (suffixes) letter arrangement. As a result, simply leaving only the first and last letter is typically not enough information for one to recognize and comprehend an unfamiliar word. The context of the phrase or sentence is essential for comprehension in such instances.

These results suggest that changes in letter order influence people’s reading of words. One must then be cautious in making extreme spelling errors, especially when using an extensive or specialized vocabulary. While these results illustrated that reading a scrambled message did not affect comprehension, the e-mail’s assertion seems to be incorrectly generalized for all aspects of reading messages.

**Future Directions**

Future studies should look at variables such as gender and level of education with larger sample sizes. They should also test participants in a controlled, experimental setting, limit the number of experimenters, and make sure all participants are previously unknown to the experimenters. In addition, experimenters should use pretests on how the participants would comprehend an unscrambled paragraph, to eliminate a floor effect. There could also be pretests within the study for comfort and frustration to demonstrate an actual change.

Additionally, experimenters should control for complexity versus familiarity by including a passage with complex but recognizable words. For instance, words could be included that are characterized by having more than two syllables but are familiar to those with a limited vocabulary. Examples of such words include “dinosaur,” “characteristics,” and “medication.” This would test if the effect is due to the complexity of the word or the participants’ familiarity with it.

Further research could also examine special populations such as individuals with reading disabilities. People with reading disabilities may also already be accustomed to the difficulty of fighting through a hard paragraph and thus, when reading a complex paragraph, their level of frustration would be less than that of a typical person. Comparing individuals with reading disabilities to those with normal reading capabilities would help further this research, as well as the health field.
References


