The Influence of Spacing on Reading Comprehension

by

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ABSTRACT

A pilot study was conducted to discover the influence interword spacing has on reading comprehension. Eleven participants were asked to read four stories adapted from Singapore folktales while their eye movements were monitored by an eye tracker. The stories came in two versions: one retained regular spacing, while others were written in *Scriptura Continua*—text without spacing. Interest areas were created with the eye tracker around spaces, or the location where spaces would be expected, to measure the time difference between these readings. Participants were then asked to fill out short answer and multiple-choice questions to test their comprehension of the stories. Seven participants individually performed better while answering questions based on *Scriptura Continua* texts, but overall results showed largely improved performance in only two of the four stories administered. While the data is inconclusive, it supports the hypothesis that individuals improve comprehension when reading texts which lack spacing.

Keywords: Interword spacing, *Scriptura Continua*, reading comprehension

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Despite literally going unseen, the space between words has a large effect on English comprehension. Most readers pay spaces little mind, and if they do, it is because something has happened (either too much spacing or not enough) to interfere with their comprehension. Interestingly enough, however, Interword Spacing (the act of putting a space between words) is not a universal thing—if one looks at Asian languages such as Chinese and Japanese, one will find the "symbols" running together without spacing, a style of writing called *Scriptura Continua*.

If spaces are not necessary to comprehension, then why are they used in English? More so, what purpose do they play in reading comprehension, and what happens when they are removed when expected? A pilot study was conducted to help answer some of these questions when a literature review proved uninformative.

This paper is divided into the four following sections: Interword Spacing vs *Scriptura Continua*; Spacing and Reading Comprehension; Experiment Methods; and Experiment Discussion. As there is little literature on the actual effects of spacing on reading comprehension, background information into the uses and history of spacing will be given first before an explanation and discussion of the pilot study.

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Interword Spacing vs *Scriptura Continua*

</div>

Written and Oral Language

The main goal of language is the transmission of information through comprehension from one person to another (Gelb, 1963). Despite having the same goal, language divides itself into (at least) two different categories, oral and written, which both follow their own rules. Written language is unique in that it has a lasting impression, and its physical components meet a certain design quality. These qualities (such as

spacing) have no effect on the actual reader; spoken English and written English use the same words, but spoken English has no spacing, no letters, and no punctuation in the traditional sense (Gelb, 1963); in this way, despite reflecting the same source, the brain interprets these two modes separately.

In order for reading comprehension to be achieved, two conditions must be met. First and foremost, the reader must have some prior knowledge of the language. Second, the script being read must be legible, meaning individual forms must be unique enough to distinguish when written together in a group. If both conditions are met, then the symbol is considered legible.

It is interesting to note that there is nothing inherently legible about a letter, symbol, or character: any symbol, no matter how orderly, unique, and differentiated it may be, will be entirely illegible if the reader lacks prior knowledge. In Language Acquisition terms, until the reader has internalized the system, characters will remain foreign and impenetrable (Gelb, 1963).

A major part of what makes a language discernible is how unique the letter forms are, and how readily they can be appraised while on a page. To modern English sensibilities, languages should be something read quickly—but that wasn't always the case (Saenger, 1997). A major part of fast-paced internalization of language comes from word spacing, which is a practice one may think of as common place, but alphabetic word spacing is actually a relatively modern invention limited to western-European based language groups.

Finding ways to differentiate words, sentences, and ideas is a struggle all languages face at some point or another—these difficulties are not grammatical nor

semantic at heart, as spoken language does not suffer to produce adequate differentiation. This is not an issue of semantics then, but of design.

Written languages are not natural creations—one cannot find them outside of human civilization. In fact, sometimes new forms of writing are made intentionally to support an already-existing language, as was the case with Russian Cyrillic, Korean Hangul, or with Japanese Kana. All written languages are designs, with comprehension and legibility as their focus. In some way, shape, or form, the design of writing directly influences the ability of readers to interpret them.

The following sections will primarily be divided into two categories: an evaluation of *Scriptura Continua* and Interword Spaced languages, and a brief look at some languages and their methods for differentiating words in script.

History of Spacing

Written languages fall into two categories when concerned with word differentiation: *Scriptura Continua* or Interword Spaced. These distinctions are as they sound: a language which uses spaces, as modern English does, is considered Interword Spaced, while a language which runs all characters together, such as Chinese, is an example of *Scriptura Continua*.

Spacing was a common practice for antiquated Semitic languages, largely due to the vowel-less nature of Abjad languages (Naveh, 1973). In an Abjad language, characters denote consonants almost exclusively; few vowels appear commonly, such as a hard "A" sound which begins some words. In this way, words might have multiple interpretations: if one were to imagine this system in English, a consonant grouping of letters such as CT could have various readings, such as CAT, CUT, and COT. For clarity's

sake, diacritic marks are added in Abjad learner's manuals and holy works to show appropriate vowels.

As these languages focus on consonants and the reader is expected to fill in the vowel sounds themselves, spaces show the reader where words break off and new ones begin; otherwise, if the words were to run together, an added layer of cognitive difficulty would be added to deciphering reading.

Abjad languages also developed a unique form of letter differentiation to be used in conjunction with spacing: letter forms based on position. In short, a letter may have multiple different forms depending on its location within a word: in modern Arabic, for example, a letter will take a unique shape if it is the first letter of a word, contained somewhere in the body, or the terminal letter. In this way, the language has found a way to double-up on denoting the start and finish of a word: there is interword spacing to show a visible gap, and there are position markers to clearly start and stop words.

As detailed by Paul Saegner in his book *Space Between Words: The Origin of Silent Reading*, spaces remained common in Abjad languages until the Greeks adopted Phoenician characters (Saegner, 1997); the Greeks took the Abjad and added vowels to it. Spaces had only existed in Phoenician to help with vowels, so the inclusion of explicit vowel sounds rendered spaces moot; the Greeks turned Phoenician from a word-divided Abjad into a *Scriptura Continua* Alphabet.

Later, when the Romans transformed Greek letters into Latin, they evaluated their own practices as a divided language (through the use of Interpunct dots) and evolved into a *Scriptura Continua* (Saegner, 1997; Wingo, 1972). In this way, the English language—

which uses an Interword Spaced script—was founded on undifferentiated word groupings.

Scriptura Continua has some advantages which may not be apparent at first glance, at least in regards to the ancient Greek and Roman—while it is true that reading is more cognitively laborious while evaluating a Scriptura Continua text, readers are more likely to retain the information found within (Saegner, 1997). This is largely due to the view these cultures had of reading: it was an oral, public endeavor, and reading to yourself was still done while mumbling the words aloud. Since the text lacked spaces, the expectation was to voice each letter as it was read so the words would be audible—this double method, of reading and listening, allowed the details to remain longer in memory.

The downside to reading a Scriptura Continua aloud, however, is the time it takes. Reading a string of undifferentiated text is cognitively laborious, and takes significantly longer than modern readings based on either Bouma Shapes, Serial Letter Recognition, or Parallel Letter Recognition (Larson, 2004). These theories of reading cognition will be examined individually in a later chapter.

It should be noted that these pros and cons of Scriptura Continua weigh mostly on Latin script—it has already been mentioned that Abjad languages are routinely space-oriented, and the CJK language groups (Chinese, Japanese, and pre-Hangul Korean) find spaces unnecessary, due to varied unique characters (Gelb, 1963).

Modern *Scriptura Continua* Language Examples

Modern day, the most common Scriptura Continua language is Chinese, the learning of which requires intense study from an early age. Some research indicates that

this focus on complex characters instead of letters has led to an increased ability for rapid, proficient reading (Saenger, 1997).

Both Chinese and Japanese (and pre-Hangul Korean) use characters originating in ancient Chinese scripts. These characters are semanto-phonetic, with pictures representing ideas and sounds. While Korean no longer uses them, Japanese still implements the characters—called Kanji—and Chinese, of course, uses them exclusively.

Chinese is a true *Scriptura Continua*, as the only spacing and punctuation comes from sentence terminals and paragraph breaks. Words are typically made up of one, two, or three characters, and readers know when words start or end due to recognition. Of course, there are prepositions and various functional words which are represented by particular characters which then inter-cut the words, creating "spaces" in the most abstract sense.

The Japanese language, on the other hand, is a *Scriptura Continua* which differentiates itself through varied character usage. The written language is comprised of three unique scripts: Kanji, Katakana, and Hiragana. Historically, this character differentiation formed during a period of influence over Japan by China: the Chinese Empire ruled the country for many years and mandated the use of Chinese for formal writing. The Japanese, who spoke a separate language entirely, adopted the use of Chinese, but then modified it to continue on with their own language (Gelb, 1963).

Kanji are characters borrowed directly from Chinese, and are therefore semanto-phonetic pictographic representations of ideas or objects. However, they follow Japanese pronunciation rules, such as using the Chinese character for South, "Nan" in Chinese, but saying "Minami," the traditional Japanese word (Gelb, 1963).

Katakana is a phonetic script adopted from broken-apart Kanji, while Hiragana developed from handwritten cursive, and is much more flowing and soft (it was developed by women to be used in personal correspondence between each other, while the men were supposed to write in Chinese [Bowring & Laurie, 2004]). Hiragana is considered the more standard script, and it is used everywhere from newspapers to kids' books to advertisements, while Katakana is used for foreign words and emphasis.

What is unique is how efficiently these three scripts are used together, and how keenly they function as a design. Japanese is a *Scriptura Continua*, and they tend to use punctuation rarely outside of terminal cases. However, anyone fluent in the language can easily tell when words start and end because of the use of the three scripts: Kanji is used for content words (verbs, adjectives, nouns), while the two Kana scripts are used for function words, emphasis, and clarity.

In this way, the three scripts run one after the other, yet a reader can easily pick apart key phrases in each sentence. For example, if one were to say a sentence like "I ate the food," the content words "I/watashi" "ate/tabeta" and "food/meshi" would be in Kanji, while the grammatical function word marking the subject "wa" and direct object "wo" would be in one of the Kanas. The full sentence would be "Watashi wa meshi wo tabeta // 私は飯を食べた"

As can be seen from the above, spacing is not a necessary component to written language. Two modern languages, Japanese and Chinese, are just as capable of being comprehended by their readers as English is. However, these languages found a way to differentiate words, either through a shifting script or by a complex method of memorization and pairing. These languages function differently from English and

activate different parts of the brain. As will be seen, there is much debate about how one reads, and even more about the effects different forms of reading have on the brain.

Spacing and Reading Comprehension

There is little research which has been done regarding the influence of Interword Spacing on reading comprehension. Much of the work conducted has been centered instead on the psycholinguistic aspects of word recognition and reading cognition. It is important to examine these fronts, as a deeper understanding of how a person reads will lead to a deeper understanding of the effects caused by changes in spacing.

When examining the origins of Interword Spacing, one invariably runs into a long-running argument: did antiquated civilizations—such as the classic-age Greeks and Romans—read silently, or aloud? This seemingly inane question has roots not just in spacing, but in cognition and the sociological use of reading as well.

According to author William Johnson (2000), who believes classical civilizations could easily read silently, the debate began with the 1898 work *Die antike Kunstprosa* by Eduard Norden. In Norden's work, attention is brought onto a passage from the text *The Confessions of Saint Augustine,* wherein Saint Ambrose amazes Augustine by reading silently, without moving his lips or speaking aloud at all. Norden used this passage as evidence that ancient people must not have read silently, either because they did not want to or because they lacked the capability to do so (Johnson, 2000).

Author Paul Saenger (1997), in his work *Space Between Words: The Origins of Silent Reading*, reinforces this idea. He claims that antiquated civilizations had little use for silent reading, and thus only performed it for privacy, or to rest their voices. While he does not claim that these people physically could not read silently, Saenger (1997)

proposes that silent reading merely created an extra layer of cognitive difficulty to the activity, and would not have increased either the speed or comprehension of the text.

Saenger (1997) believes silent reading would serve no function to these people because their texts were written in *Scriptura Continua*. They lacked Interword Spacing and exclusively used the equivalent of modern-day capitalized letters. Unlike modern English, which has morphemic, sometimes random rationales for its pronunciations, classic Latin and Greek allowed for unambiguous spelling and pronunciation rules. As such, groupings of letters into syllables far outweighed the needs of ordered divisions between words.

The physiological effect this had on the reader was twofold: readers required double the amount of saccades—that is, movement of the eye during reading— in order to confirm potential words, and they needed to read ahead of what they were speaking in order to prepare themselves further (Saenger, 1997). In other words, readers gave themselves a type of tunnel-vision where their focus landed firmly in just a few letters, which primed the oral centers of the brain for speech before moving on. This effect means those readers would not be parsing entire words at a time, as is common in modern English, but instead would deliver the text chunk by syllabic chunk.

This style of reading therefore had little impact on short-term memory in the reader. To compensate for this, both reader and participant became active listeners in the activity, dedicating the oral messages to memory rather than the transcribed visual messages. In this way, reading acted as a communal activity focused on mass appeal rather than personal self-enlightenment.

Since the text lent itself to this style of reading, it is no surprise that Ambrose's ability to read silently, without so much as moving his lips, had impressed Augustine. However, that does not imply such a thing was unheard of; rather, it was simply not the norm, since reading for personal benefit rarely outweighed the benefits of reading for a public audiences.

What's fascinating about the way ancient Greeks and Romans read *Scriptura Continua* is how they required nearly double the saccades and regressions of a modern reader to compensate for the lack of spacing. For a modern reader, the eyes typically see between three and four words ahead of a saccade fixation, to about fifteen letters (Larson, 2004; McConkie & Rayner, 1976). Once spaces are removed, the eye can only account for a couple of letters ahead at a time.

If the modern eye is used to seeing entire words, then, it is worth discussing the leading theories on word recognition. As Kevin Larson (2004) discusses in his article "The Science of Word Recognition*;* or How I Learned to Stop Worrying and Love the Bouma," there are three major contenders in the history of word recognition: Bouma Shapes, Serial Letter Recognition, and Parallel Word Recognition.

Bouma Shapes (also known as Word Shapes) refer to the outline a word makes. The theory is readers identify words first based on the shape of the entire word, and not necessarily by the actual letters found within. Therefore, it is possible for a reader to easily gloss over misspelled words with similar shapes, such as "test" and "tesf" (Larson, 2004). For *Scriptura Continua* texts, which rely on all capital letters, the Bouma Shape becomes null; it is a uniform square with no discernible starts or stops. This may add an additional layer of cognitive difficulty in evaluating such texts.

Larson (2004) explains that Bouma Shapes were popularized by Saenger (1997), and many typographers and text-enthusiasts believe they are the end-all-be-all to reading comprehension. However, many cognitive psychologists dismiss the idea of Bouma Shapes due to logical arguments such as commonly shared shapes (Groff, 1975) or weak evidence (see Larson for an in-depth analysis of the shortcomings). Those proponents of the style (Haber & Haber, 1981) claim such shortcomings can be explained away through an oversimplification on the part of the researcher. In short, if participants in research studies happen to fail isolated word tests regarding Bouma Shapes, it may be because said shapes work together with other aspects of a sentence, such as syntax, in order to remove ambiguity.

The second model detailed by Larson (1997) is Serial Letter Recognition, which he admits is the weakest and shortest lived of the variants. In this model, readers interpret words one after the other in a series. Upon reading an initial letter, the reader activates all words in their lexicon which start with that letter. Each successive letter to come narrows the list down further, until the correct word is chosen. In this way, if the reader sees the word "apple," they will initially think of each a-word, then ap, app, appl, and finally hit upon apple.

This is an interesting model in regards to *Scriptura Continua*. As readers are unable to view words in full (no Bouma Shapes), with no hints at separations, and a limited field of vision, they will be forced to read a single letter, or grouping of letters, at a time. Whether this means they cognitively build a word letter by letter or not is a different story, however.

Evidence for Serial Letter Recognition is rather simple: it takes more time for a reader to parse longer words than shorter ones. However, the evidence against it is equally simple: a common test for reading skills is the Word Superiority test, which proves that a letter in isolation is harder to identify than a letter in a word (for example, the letter "d" vs the d in "word"). If the Serial Letter Recognition model were true, one would expect letter identification to take longer the further in a word the letter is. Additionally, one would expect misspellings to greatly increase the parsing time one takes, as the brain would have to rapidly begin a replacement for each potential letter.

The final model is Parallel Word Recognition. In this idea, individual letters are grouped together and activate words which share components with them. Larson gives the example of the word "WORK": here, the brain evaluates it on multiple levels to see if it is correct. It evaluates all words which start with W, then move into O and R (such as WORD), as well as words which may start with a different letter but end in ORK (FORK). In this way, each potential word—misspellings, shape irregularities, or not—is evaluated, compared to the stimuli, and finally selected based on viability (WORK).

With this model, *Scriptura Continua* texts become an evaluation of potential words with the added cognitive difficulty of deciding upon separations. If this model is the way people read, it might explain a few issues readers have when faced with *Scriptura Continua*, such as the increase in saccades (to confirm activated letters) and increased time.

Research shows that removing spacing increases both the time taken to read a text, and the cognitive difficulty with which one is tasked. As Saenger (1997) says, "Experiments performed on adult, English-speaking readers confirm that the total

suppression or partial obfuscation of spatial boundaries between words increases the duration of the cognitive activity necessary for reading, which in turn produces physiological reactions associated with vocal and subvocal activity" (p. 5). Regardless of which model is the correct one, all three lead to an increased time taken with *Scriptura Continua*.

It is worth noting that all of the findings and models above rely specifically on reading models used by readers of Latin-based alphabets. As many languages do not even use an alphabet to transcribe writing, these models fall somewhat short. Languages such as Chinese and Japanese do not use alphabets, but complex characters and syllabaries (Gelb, 1963). These languages also do not use Interword Spacing (Saenger, 1997). Since they use complex characters without spacing, rote memorization is required to master the languages, which is started at an early age—instead of just twenty-six letters, learners must memorize thousands of characters in order to be proficient.

This leads to an interesting question: if Interword Spacing is not necessary in language, then does modern English need it? A pilot study was devised and run in order to gauge the effects Interword Spacing has on reading comprehension, with two major questions: how much longer does it take to read a text in *Scriptura Continua*, and how much influence does spacing have on accurate comprehension of the text? While it is expected to find participants spend longer reading texts, the goal of this pilot study is to see if participants perform better on tests related to *Scriptura Continua* texts.

Experiment Methods

Participants

Volunteers were recruited from the student body of a moderate sized urban university. The participants were informed they would be involved in a reading comprehension study, but were not filled in on the particulars about spacing. No compensation was given to participants.

In total, 11 students agreed to participate in the study. Of them, there were 6 males and 5 females. Age varied across participants; the oldest volunteer was 65, the youngest 19. Academic year also varied across participants, with several freshmen from Writing 1 courses and several Graduate Assistants across varied disciplines. In total, there were six underclassmen, three Graduate Assistants, one participant who labeled their academic year as "Senior (Citizen)," and one participant who left the information blank.

Participants were given an Identification Number, which was placed on their tests and results to protect anonymity. Each experiment was coded and filed with these Identification Numbers.

Due to the rather small number of volunteers, a pilot study was conducted to examine the validity of the theory.

Materials

Materials were selected from *Favorite Stories from Singapore* by Irene-Anne Montiero and Jenny Watson. These stories were selected based on their brevity, simplicity, and relative unfamiliarity to the average American student. In total, four stories were selected (see Appendix A). As the goal of the experiment was to test reading comprehension, names and locations were adapted in the stories to meet more traditional

English-speaking names: for example, King Sang Nila Utama became "Saul," and Palembang became "Portland." The only exception to this adaptation was the foreign name of Singapore, Singapura, as it was used as a comprehension question. In this way, cognitive difficulty related only to the text, not to translation or parsing unfamiliar phrases.

In one case, in story 3, the researcher excluded a single word from a set phrase ("by their [roots]") to measure the attentiveness of the participant.

Four comprehension question tests (see Appendix B) were created to gauge the memory of the participants. Questions were typically left simple (e.g. "How many turtles saved Matt?"), but pointed at more subtle sections of the story, such as minor objects, counts, and terms of address. Some questions were intentionally more difficult (e.g. "What colors were the lion? Which parts of the lion were which?") in order to see if improvement would be made between Interword Spaced stories or *Scriptura Continua* ones.

Tests relied on a mixture of short-answer and multiple-choice questions. One story (story 1) relied entirely on short-answer, while the other three had one multiple choice on each. As there could be some discrepancy on short answer results, these questions were graded as worth two points. One point was given for half-correct responses, such as participant 05's : "[the lion colors were] black, red, and white. Black body, red hair, white chest," where the colors are correct, but the parts are labeled wrong. An expected answer scored two points. Zero points were given in the case of incorrect nomenclature, as the goal of the experiment was to gauge, in part, if participants would remember the story accurately (e.g., If the participant said "a cottage" when the expected

answer was "a house."). In all, tests for story 1 were worth a total of 10 points, while the other tests were worth 9 points each.

Experiments were created using Experiment Builder in conjunction with an Eye Link 1000 eye tracker system. Two versions of each story were created, making a total of eight experiments. These experiments were then labeled based on their configuration, either xA (Interword Spaced) or xB (*Scriptura Continua*). Participants would perform a brief calibration test for each experiment, so the eye tracker could accurately read the movement of their eyes. They were then presented with a screen of text to read. Each screen consisted of one paragraph from the selected experiment, and on a key press by the participant, the page would change to the next paragraph.

Interest areas were created in each experiment version, primarily focusing on the spaces between words. As xB texts lacked spacing, both xA and xB texts created interest areas on the terminal letter of each word and the following initial letter. In the case of a single letter word ("a" or "I"), interest areas were created to include the terminal letter of the previous word, the singular word, and the initial letter of the next word. In this way, regardless of the version, interest areas focused on the location a space should be present. In the case of the final word of each page, interest areas were created around the terminal letter of the final word and the terminal punctuation.

Through use of the Eye Link 1000 eye tracker, the researcher was able to monitor the eye movements of participants while they read, to see if any changes occurred between Interword Spaced stories or *Scriptura Continua.*

Participants were asked to read one of the four stories, in either xA or xB, assigned randomly and balanced based on whether they received a spaced or unspaced

version first. In total, participants were asked to complete at least three of the four stories (ABB or BAB). In cases where students agreed to the fourth experiment, they read two xA and two xB, alternating.

In total, thirty-nine experiments were conducted, with a slight emphasis (five more experiments) leaning towards xB *Scriptura Continua*, due to some participants taking part in three experiments, and others four.

Results

Results varied between sets of stories. As will be examined further, two of the four stories showed greater accuracy in test scores, and a significant increase in time spent reading. That being said, two stories showed little to no improvement in accuracy between xA and xB, with statistically insignificant results in reading times.

First, the results of the short answer/multiple choice tests administered after each test will be examined. In total, 39 tests were administered (3 or 4 per participant), with a slight emphasis on xB readings. A bar graph displaying the scores for tests labeled xA can be found in Figure 1.1, while scores for tests labeled xB can be found in Figure 1.2. As there were discrepancies between the number of tests administered, averages will be examined in closer detail than stand-alone numbers.
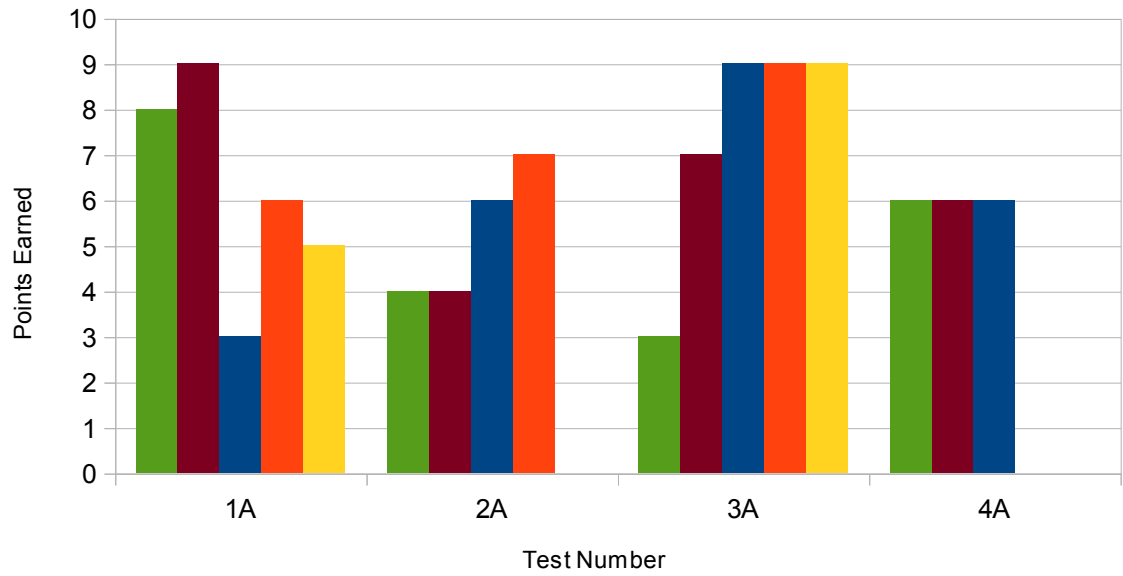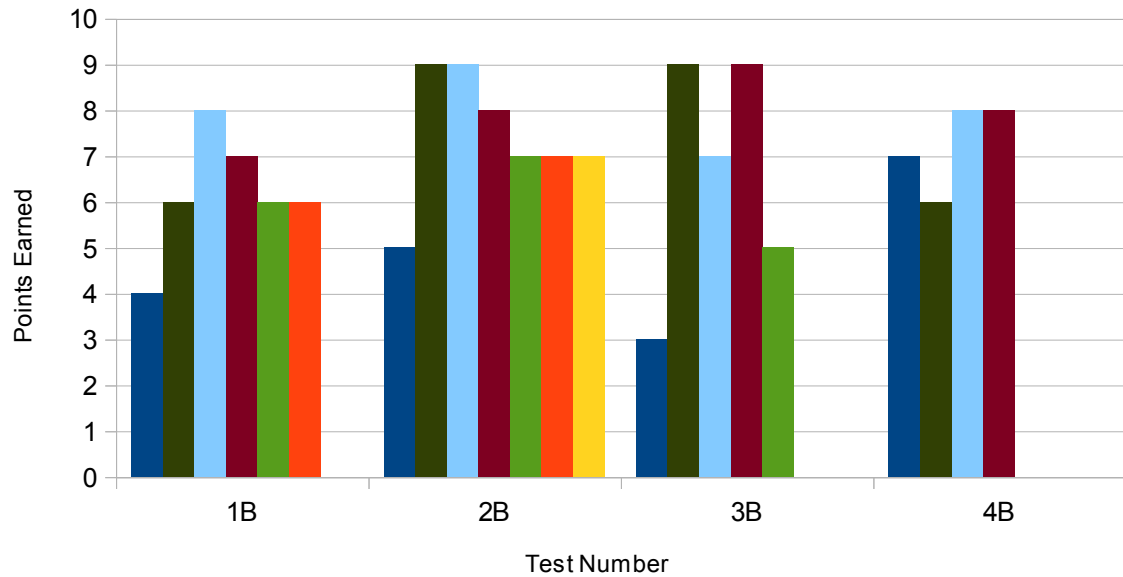
Figure 1.1. Scores for individual xA tests.

Figure 1.2. Scores for individual xB tests.

Averages were calculated for each of the eleven participants. These averages can

be seen in Figure 2. The data show that most participants averaged relatively low scores,

18

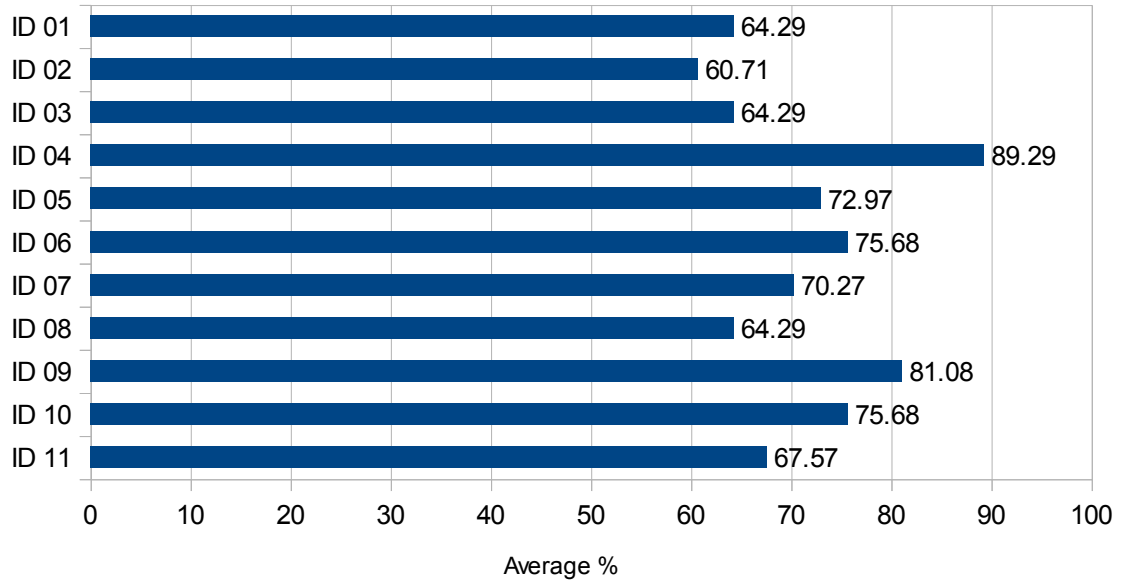falling in the 60% - 75% range. Taking the average of the averages, participants scored a 71.29%.

Figure 2. Average test score by participant.

Additionally, Figure 3 shows a comparison of individual results between xA stories and xB ones. Participant tests were divided between their xA and xB results, then combined and appraised. For example, Participant 05 scored a 4/9 and 6/9 on his xA tests, and an 8/10 and 9/9 on his xB tests. Together, he scored 10/18 on xA and 17/19 on xB, for a 53% and 89% result, respectively. Of the eleven participants, seven scored a higher percentage in xB *Scriptura Continua* tests while four scored higher in xA Interword Spaced tests.

	A	B
ID 1	80%	56%
ID 2	44%	68%
ID 3	33%	79%
ID 4	90%	89%
ID 5	53%	89%
ID 6	72%	79%
ID 7	63%	78%
ID 8	67%	63%
ID 9	79%	83%
ID 10	83%	68%
ID 11	63%	72%

Figure 3. Individual xA averages compared to xB averages.

Looking at all of the xA interword spaced tests individually, 1A averaged 62%, 2A 58.33%, 3A 82.22%, and 4A 66.67%. All together, a maximum of 158 points could have been earned through xA tests, and 107 points were scored. This means participants scored an average of 67.72% on their xA tests.

xB unspaced tests scored the following: 1B averaged 61.67%, 2B 82.54%, 3B 77.78%, and 4B 80.56%. All together, a maximum of 204 points could have been earned through xB tests, and 153 points were scored. This means participants scored an average of 75% on their xB tests.

Figure 4 shows a comparison of the averages between each xA/xB pair. Participants scored higher in xA Interword Spaced configurations for stories 1 and 3, while xB *Scriptura Continua* scores are higher in stories 2 and 4.
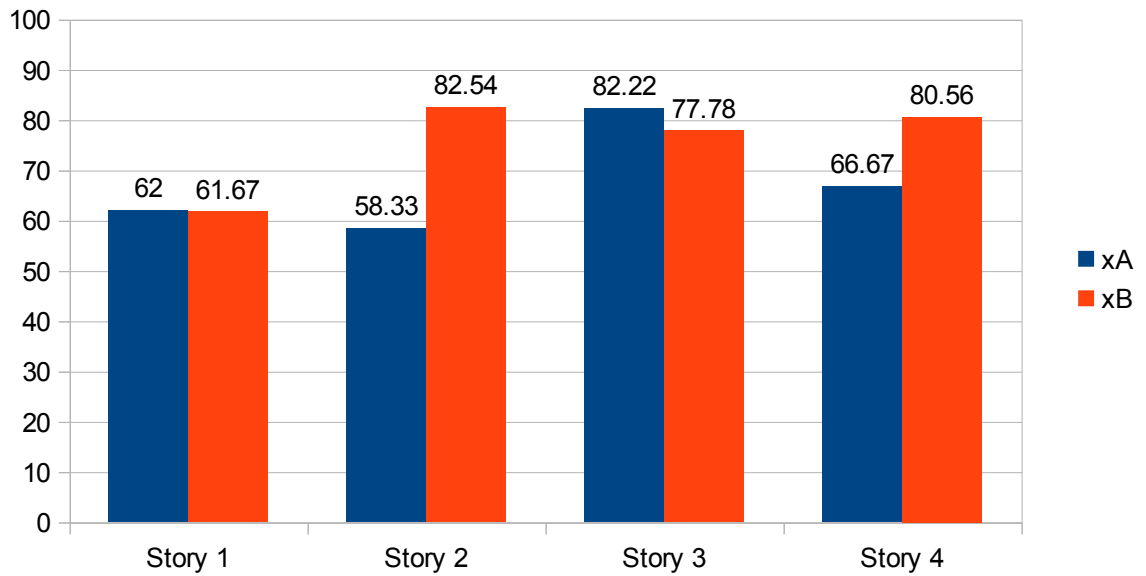
Figure 4. Averages by story compared.

Questions were evaluated individually as well, to see if any trends appeared between the two groups. The individual scores and groupings can be found in Figure 5, which also displays the averages for each question. Of the individual questions, participants scored higher on five questions from xA stories, eight from xB, and showed no significant difference in seven. Story 3 showed almost no preference for either style of text, with four of its five questions having an equal average. Stories 2 and 4 both show increased scores on xB scores, while story 1 has an equal split between xA results and xB.

	Question 1		Question 2		Question 3		Question 4		Question 5	
Story 1	2	2	2	2	2	1	2	2	2	2
	2	2	2	2	2	2	2	2	2	1
	2	2	2	2	0	0	0	2	1	1
	0	2	2	2	0	0	0	0	1	0
	0	2	2	2	0	0	0	0	0	0
		2		2		0		0		0
Average	1.20	2.00	2.00	2.00	0.80	0.50	0.80	1.00	1.20	0.67
Story 2	2	2	0	1	1	2	2	2	2	2
	2	2	0	1	0	2	2	2	2	2
	2	2	0	1	0	2	2	2	2	2
	0	2	0	1	0	2	2	2	0	2
		2		1		1		2		0
		2		1		0		2		0
		2		1		0		2		0
Average	1.50	2.00	0.00	1.00	0.25	1.29	2.00	2.00	1.50	1.14
Story 3	2	2	2	2	1	2	2	2	2	2
	2	2	2	2	1	1	2	2	2	2
	2	2	2	2	1	1	2	2	2	2
	2	2	2	0	1	1	2	2	0	0
	0	0	0	0	1	0	2	2	0	0
Average	1.60	1.60	1.60	1.20	1.00	1.00	2.00	2.00	1.20	1.20
Story 4	2	2	1	1	0	2	2	2	2	2
	2	2	1	1	0	2	1	1	2	2
	2	2	0	1	0	0	1	1	2	2
		0		0		0		1		2
Average	2.00	1.50	0.67	0.75	0.00	1.00	1.33	1.25	2.00	2.00

Figure 5. Individual question scores, xA (left) and xB (right).

In addition to averages, *t*-tests were performed on each story pair as well. For a *t*-test, averages are compared in order to determine if two distinct data sets are statistically unique from one another; the results express the likelihood that data sets come from the same group due to small sampling sizes. If a *t*-test is run and gives a result of, for example, .6, then that represents a 60% likelihood that the datasets came from the same source. In other words, the random sampling would have been too small to show a distinct statistical significance. The smaller the number, the more likely the results are statistically relevant. It should be noted, however, that the numbers represent a percentage chance, and thus are not conclusive; for example, a .1 result (10% chance) means the datasets are 90% likely to hold statistical weight; further study would be required in such

a case. A result of .05 or less (5%, in other words) is considered a statistically significant number.

Data from the *t*-tests *for* xA/xB questions shows a large divergence between stories. Stories 1 and 3 showed no significance differences in accuracy scores between the Interword spaced version (xA) and the Scriptura Continua version (xB), $p = .97$ for story 1, and $p = .79$ for story 3. Story 4, however, showed marginally significant improved accuracy scores on the Scriptura Continua version at $p = .08$, and story 2 comprehension scores were also significantly higher in the Scriptura Continua version at $p = .04$. In sum, participants performed equally well on responding to comprehension questions about the story for two of the stories (1 and 3), and they had improved performance on the Scriptura Continua version of the other two stories (2 and 4) than on the Interword Spaced versions.

Next, the data collected from eye tracker interest areas will be presented. In particular, two major types of data were collected from each eye tracker experiment: First Run Dwell Time and Total Dwell Time. First Run Dwell Time (henceforth just "First Run") is a measure of how much time in milliseconds a participant spent reading an interest area the first time their eyes entered its area. This is sometimes referred to as a first pass as well, since it only takes into consideration the initial amount of time the participant spent in the interest area. Total Dwell Time (henceforth just "Dwell Time"), on the other hand, is the total accumulation of time spent in an interest area, including re-reads and re-entry into an interest area.

To briefly refresh, interest areas were created in the four stories by including both the terminal letter of a word, the space, and the initial letter of the following word. If the

sentence read was "Long ago, there was a king," interest areas would be formed around

[L], [g a], [o, t], [e w], [s a k], and [g,]. In *Scriptura Continua* (xB), these areas remained

despite the line appearing like this: "LONGAGO,THEREWASAKING."

A brief aside: as can be seen in the above example, punctuation was left in the

texts (see Appendix A). The rational for this was largely a matter of technical restraints:

with the eye tracker, texts were loaded into a pre-constructed shell which presented and

recorded data. However, with the unique qualities presented by *Scriptura Continua*, the

on-screen text had a tendency to line-break at the end of a row with no regard to actual

word construction. However, if punctuation appeared within the text, the program

automatically cut the line, allowing for letters to remain grouped within their own word

by line breaks. In an effort to reduce unnecessary cognitive taxing as much as possible,

punctuation was decidedly kept to allow for a smooth presentation of data.

The average First Run times for xA and xB stories can be found in Figure 6.1

below. The average Dwell Time results for xA and xB stories can be found in Figure 6.2.

In total, the average First Run time for xA stories was 535 milliseconds, and for xB 727

milliseconds. The average Dwell Time in xA stories was 634 milliseconds, and for xB

943 milliseconds. Universally, participants spent more time both interpreting the area

where spaces are/should be and rechecking the text in xB *Scriptura Continua*
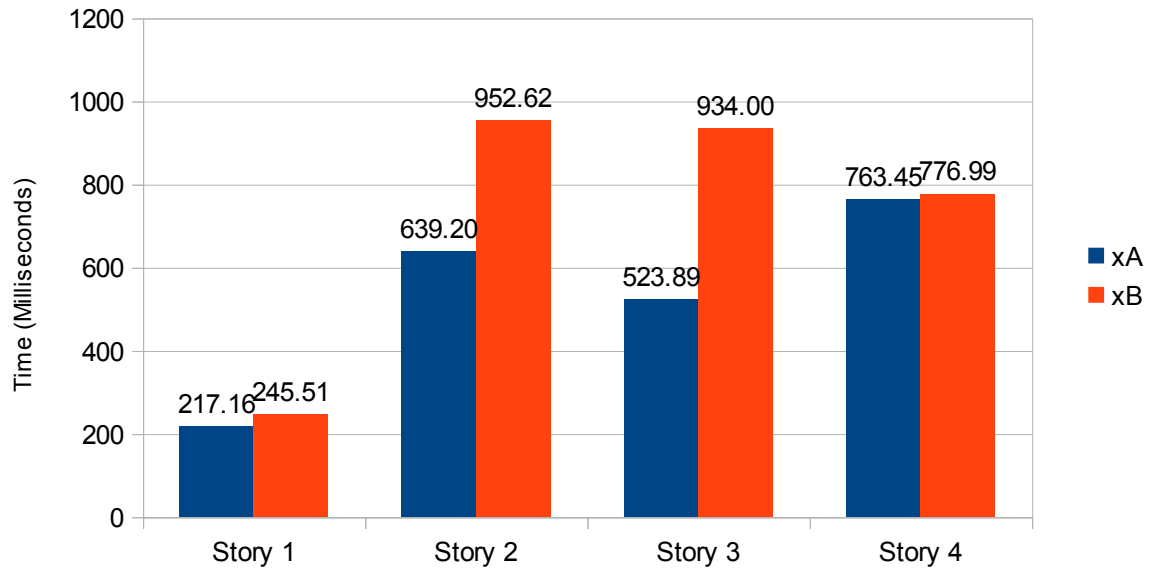
stories.
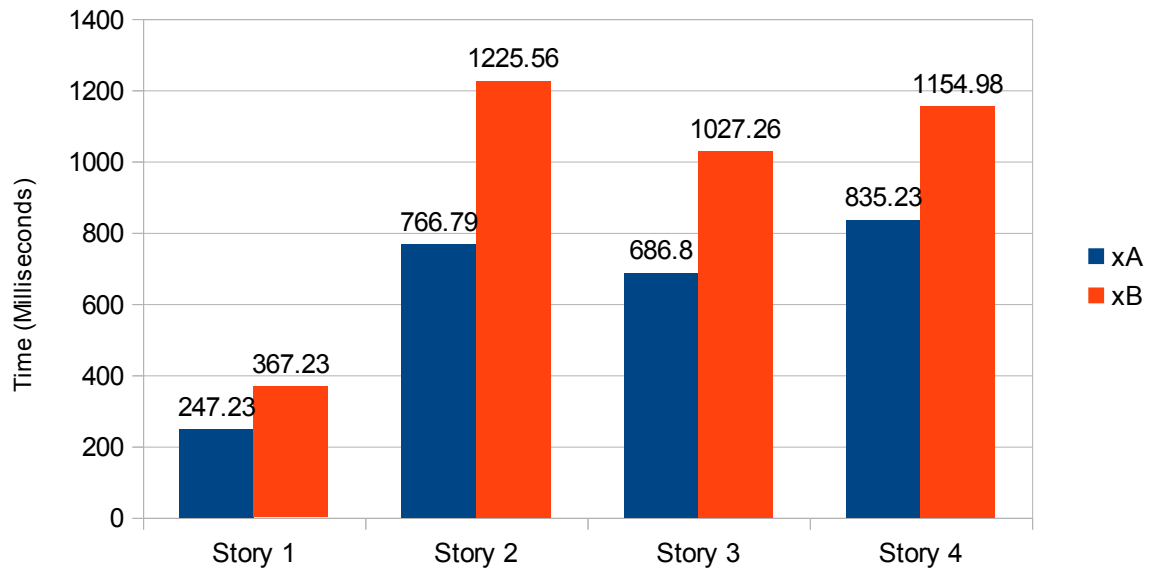

Figure 6.1. First Run Dwell Times by story.

Figure 6.2. Total Dwell Times by story.

T-tests were also administered comparing the First Run times and Dwell Time results of xAs to their xB counterparts. Stories 1 and 3 showed significantly greater fixation times on the Scriptura Continua versions in the First Run t-tests, with results falling below $p < .01$. However, Stories 2 and 4 did not show any significant differences in fixation times between the two versions of the story: story 2 received a $p = .14$ on its First Run scores, and story 4 a massive $p = .64$. These results are not mirrored in Total Dwell Time t-tests—all stories showed significantly longer fixation times on the *Scriptura Continua* versions than the Interword Spaced versions, all below a $p < .05$ score. For example, story 4's Total Dwell Time t-test was t (2280) = 1.96, $p = 0.0013$.

The overall findings of the stories can be found summed up in the following table, for clarity's sake:

Story	Accuracy	First Run Dwell Time	Total Dwell Time
1A vs 1B	No significant change	No significant change	Slight xB time increase
2A vs 2B	Significant xB preference	Large xB time increase	Large xB time increase
3A vs 3B	Slight xA preference	Large xB time increase	Large xB time increase
4A vs 4B	Slight xB preference	No significant change	Large xB time increase

Experiment Discussion

This research considered whether participants spent more time fixating word boundaries in *Scriptura Continua* versions of a story than Interword Spaced. As the First Run and Dwell Time results show, participants spent substantially more time reading the *Scriptura Continua* stories than their Interword Spaced counterparts. Since the interest areas were created around the spaces of words, the First Run and Dwell Time results indicate the attention participants devoted to noting spaces, or lack thereof.

In xA Interword Spacing stories, participants spent roughly 536 milliseconds on average assessing the spot where a word ends and a new one begins before leaving the interest area (i.e., according to the First Run measure). In xB *Scriptura Continua* stories, that number jumps to roughly 727 milliseconds, a 27% increase. Participants spent one-fourth more time initially parsing the spot where a space could and/or should be. It should be noted that this number does not take into account a participant over-extending and reading too far; once their eye leaves the interest area, repeated viewings enter into Dwell Time. As such, readers spent 27% more time examining the spot a space could be before either mistakenly or intentionally continuing.

The Dwell Time of an xA story averages at around 634 milliseconds, meaning once a space has been assessed, the participants spent little time returning to that area (less than a 100 milliseconds). On the other hand, in xB stories, Dwell Time jumps up to a rounded 944 milliseconds, a 33% increase. This means the participants spent a third more time returning to the perceived separations between words. This jump also reflects the possibility that participants over-extended their reading of an interest area and were forced to backtrack, or that participants encounter a "garden path" scenario.

Briefly, a "garden path" situation is where a reader mistakenly attributes the wrong parts of speech to a grammatical category. A classic example is "The old man the boat," where *old* is interpreted as an adjective linking to *man*, instead of the noun it truly is (while "man" is not a noun, but a verb, as in *to man*). These sentences can be difficult to interpret on an initial read through, as the reader falls back on expectations and prior information rather than the provided syntactic information.

In the case of these eye tracker results, participants would sometimes read words which did not exist, thanks to the *Scriptura Continua* nature of xB stories. For example, one line in story 2 read "Soon the turtles had finished laying their eggs and then went back into the sea." Many participants became caught on the words "eggs and," as they created two distinct words, "egg sand." In some cases, participants returned to this spot multiple times, until the correct parsing was achieved. However, some participants continued on, not noting the mistake their brain had played on them. For these participants, they had brought prior assumptions (turtles lay eggs in the sand), and when presented with words which looked similar to their expectation, they continued on. When asked candidly if the story explicitly mentioned where the eggs were laid, those participants who continued on without backtracking replied with "It said they laid them in the sand."

The increased backtracking may account for the 27% increase, but that does not mean they always fall for a garden path. In some cases, participants may be returning because they must confirm they have read the entire word, as they have been building it letter by letter with no help in determining starting or stopping points.

The *t*-tests for First Run and Dwell Time are rather interesting. The results for First Run in stories 1 and 3 are extremely small; a $p < .05$ result means there's less than a 5% chance that the numbers are flukes, and the First Run results of stories 1 and 3 are $p = .00002$ and $p = .00075$, respectively. What makes this interesting, however, is the First Run results for stories 2 and 4 are the opposite: in story 2 the difference in averages between the two versions of the story was not significant at $p = .14$, and even less for story 4 where $p = .64$. In other words, while it's near impossible to assume the results of

stories 1 and 3 are random happenstance, story 2 has a 14% chance of being influenced by the small sample size (and thus requires more research), and story 4 has a larger than 50% chance of being affected by the small sample size.

With the *t*-tests for Total Dwell Time, however, the results are vastly different. Each difference in Dwell Time averages between spaced and unspaced versions was highly significant according to the $p < .05$ benchmark. In this case, there is less than a 1% chance that the numbers received were negatively influenced by the small sample size, and thus represent accurate results. Participants spent significantly more overall time fixating on interest areas in the Scriptura Continua condition than the Interword Spaced condition when considering Total Dwell Time.

In regards to the fixation data, it is likely that more research will be required, mostly with the First Run dwell times.

Candidly, several observations were made about the experiences the participants had with *Scriptura Continua* while using the eye tracker. Namely, there were expressions of mental fatigue, coping mechanisms, and variations in saccades.

Many participants expressed shock or dismay upon seeing the texts in their *Scriptura Continua* form. After reading a text, one participant said "that was brutal," while another whispered "that sucked..." under his breath. Universally, participants disliked reading the xB stories. A few expressed issues with being mentally exhausted after reading just one such text, and asked if they actually *had* to read more (they were politely told they could withdraw at any time). Oddly, despite the complaining, nobody quit after reading just one xB story; everyone finished a minimum of two xB stories, for a minimum of three results per participant.

Most participants later said the second *Scriptura Continua* story was significantly easier to read than the first, despite the random order of texts. The initial shock wore off, though it still appeared to be a taxing experience, with several participants declining to stay for the fourth (Interword Spaced) story. It also should be noted that most of the "take three and leave" participants were freshman, while the upperclassmen stayed to take the fourth story and talk with the researcher afterward about their experiences. While it is easy to attribute the shock and dismay to unfamiliarity to the text format, it should be noted that increased time and unfamiliarity do not necessarily go hand in hand. Participants were able to read the second *Scriptura Continua* text more easily, but at an increased time; familiarity seems to be related to impressions and not with ease of reading, which harkens back to Saenger (1997).

An interesting coping mechanism appeared in several participants reading the *Scriptura Continua* texts: they began to either move their lips silently, or asked permission to read aloud (strangely, nobody just started to read aloud first). The participants who did this did not display the behavior during xA Interword Spaced stories, nor were they all aware that they had begun to move their lips.

This appears to reinforce the idea expressed by Saenger (1997), who explained how the original *Scriptura Continua* practice was founded on oral practices rather than contemplative immersion. It would make for an interesting follow-up study to explore the effectiveness of "oral reading" and comprehension compared to silent reading, in regards to *Scriptura Continua*, of course.

Finally, the movement of participants' eyes changed slightly between Interword Spaced stories and the *Scriptura Continua* ones. While eye movements generally

30

followed the same erratic back-and-forth movement expected while reading xA stories, participants during xB stories did not skip ahead as much. Their eyes did jump around, but with more emphasis on backwards movement than forwards. This supports the initial eye tracker Dwell Time results, showing an increased amount of backtracking and an extended time prior to leaving interest areas. This may be due to the lack of clear delineating spaces, keeping the initial focus on the letters in question, not on finding the next break.

Next, the results of the short-answer/multiple-choice tests will be examined. The best result of any participant was an averaged 89.29%, while the worst a 60.71%. Interestingly, both of these scores were earned by participants who identified themselves as freshmen. Participants averaged 71.29%, and most of the scores remained fairly close to one another—it does not appear that the scores were highly influenced by different capabilities in individual participant ability. Overall, the most successful test was 2B, with an average score of 82.54%, while the most difficult was, oddly, 2A, averaging 58.33%.

It is possible story 2 was merely the easiest to read story, and the 2A results represent a lack of focus in the participant from its simplicity. If this is the case, the 2B results show a distinct improvement due to the increased cognitive difficulty. Whether the increased scores are thanks to the *Scriptura Continua* or just increased time (and would be replicated with any method of increased reading time) is beyond the scope of this study.

Individually, there is some evidence in support of xB *Scriptura Continua* questions having improved results over xA Interword Spaced ones. Each question was

tallied and averaged individually within its group (as in, each Question 1 result for test 1A added together, then averaged) to see which question format received an averaged better score. In total, xB stories performed better in 8 questions, xA in 5, and they showed no preference in 7 questions. In other words, out of 20 questions, xB performed better in 40% of the questions, xA in 25%, and no particular sway could be found in 35% of questions.

The most impressive improvement between xA and xB comes from story 2, question 2: "What did the small turtle do to him?" The question was multiple-choice, and each person who read the story with normal spacing missed the question. Conversely, everyone who read it *Scriptura Continua* answered correctly.

This question is important to analyze, as it refers to an event which happens at the beginning of the story, and is mentioned in only one line. In the story, the protagonist (simplified to "Matt" for comprehension sake) is saved by two turtles while drowning in the ocean. It is repeated many times that he was saved by turtles, using the plural, and all but one participant was able to accurately recall the number of turtles (Question 1 in story 2, missed by one xA participant). Participants who read the xA story were split equally between the multiple choice answers "Held up his head" (which was done by the larger turtle) and "there was no small turtle." Again, despite the event being mentioned multiple times and taking up several paragraphs, the actual actions of the turtles (and their sizes) are only mentioned once. Each xA participant failed to accurately recall the information, while each xB participant was able to answer correctly.

Story 1, the only story to tie completely with xB, featured exclusively short-answer questions. Most averages were within .30 points of each other, with the exception

of question 5: "What is the new name of the island, and its translation?" Interestingly, this is literally the last sentence of the story, the final piece of information the participants read. The correct answer should be "Singapura, City of the Lion." Two xA participants correctly replicated this response, while two more received half points for either missing Singapura or City of the Lion, and one was unable to reproduce either side of the correct answer. For xB participants, one answered correctly, two received half credit, and three failed the question entirely. In this question, the average score for xA was 1.20, while xB's was .67.

Story 3 is unique in that it had four ties and one xA score higher than xB. As there were only seven instances of tied scores, that means more than half of these all came from one story. Between the two tests cumulative, there was only a two point difference coming from question 2 in story 3, "What did the young dragon call the old dragon?" This was an event close to the beginning of the story, and is largely removed from the action of the actual plot. Some participants candidly remarked that they remembered that there had been a young dragon, but that he hadn't been important so they had forgotten until they were asked about it. Even still, all but one xA participant was able to recall the correct answer of "uncle," while two xB participants were unable to correctly recall the fact.

Together, xB participants had improved performance in two of the stories (2 and 4), while xA achieved better results in story 3, and they showed no particular sway in story 1. Looking at the simple averages of all the tests, stories 1 and 3 run counter to the hypothesized claim that scores will improve in *Scriptura Continua*: in both of these

stories, xA Interword Spaced scores surpassed the results of xB *Scriptura Continua* ones. 1A results were 1% higher than 1B, while 3A had a 5.5% increase over 3B.

On the other hand, tests 2 and 4 support the hypothesis. 2B had a 29% increase to test scores from 2A, while 4B had a 17% improvement. Of interest is noting that test 2 had the most xB tests administered, while test 4 had the fewest.

Together, it would seem the data are inconclusive—half of the results follow expectations, while the other half run counter. However, the *t*-tests add an insightful foil to these figures. Ideally, a *t*-test will give a result of $p < .05$ to show statistical significance: anything higher is likely to be random, a small sample size, or a truly undifferentiated result. Story 2 easily passes, at $p = 0.03819$, and story 4 is just slightly above the $p < .05$ ideal at $p = .07814$. Stories 1 and 3, however, check in at $p = .97722$ and $p = .79239$, respectively. These both fail the *t*-test by large measures. These results support the idea that stories 1 and 3 were affected by the small sample size of the test, and further research must be conducted in order to achieve a conclusive result.

To put it more plainly, the two test groups which support the hypothesis met (or missed the mark by .03%) the $p < .05$ *t*-test threshold, while the two results which argue against it have close to a 100% chance of being negatively affected by sample sizes. By this logic, it would seem more testing would be required in order to make any conclusive statements, though the results found are promising.

One last insight comes from the comparison of individual averages for participants in xA and xB scores (Figure 3). Here, seven participants scored better in xB *Scriptura Continua* tests than on their xA Interword Spaced ones. Interestingly, in two of the four cases where xA out performs xB, the difference in percentage points is small—

between 1% and 4%, respectively. The smallest gap for an xB performance improvement was 4% (Participant 08), and the largest was 46% (Participant 03). The largest gap for xA performance over xB was 24% (Participant 01). While these numbers do not prove that xB texts improved comprehension, they show support for the idea that readers retain more information while reading a text without spacing.

This research lends itself to several future avenues of study. If a correlation is found between *Scriptura Continua* and improved reading comprehension, a follow-up study could be conducted in order to determine if the link is established by the spacing itself or simply by the increased time required. Psycholinguistically, the actual effect of spacing on reading is still somewhat unclear—these results show spacing is related to time and clarity, but there is little data in regards to spacing and the cognitive reading models discussed by Larson (2004).

Conclusion

While the data are mixed, it does seem that participants improved their test scores while reading texts in the *Scriptura Continua* format. As expected, participants spent more time reading the texts, which may account for the improved performance. It is possible that, with time and practice, participant results might meet the same averages as xA.

However, there is also the potential that participants actively improved their scores not just because of time, but because of the different way in which they were forced to interpret the text. More research, with a larger participant body, would be required to confirm.

As it stands with this pilot study, participants performed better while reading *Scriptura Continua* in two of the four stories as a whole. Individually, seven participants performed better on *Scriptura Continua* texts while four performed better with Interword Spacing. There is no concrete evidence to prove *Scriptura Continua* drastically improves performance, though there is some support for the idea which warrants further study.

References

Bowring, R. J., & Laurie, H. U. (2004). *An Introduction to Modern Japanese: Volume 1, Grammar Lessons*. Cambridge University Press.

Gelb, Ignance Jay. (1963). *A study of Writing*. University of Chicago Press.

Groff, P. (1975). Research in brief: Shapes as cues to word recognition. *Visible Language*, *9*(1), 67-71.

Haber, R. N., & Haber, L. R. (1981). The shape of a word can specify its meaning. *Reading Research Quarterly*, 334-345.

Johnson, W. A. (2000). Toward a sociology of reading in classical antiquity. *American Journal of Philology*, *121*(4), 593-627.

Larson, K. (2004). The Science of Word Recognition or how I learned to stop worrying and love the bouma. *Advanced Reading technology, Microsoft Corporation, available from www. microsoft. com/typography/ctfonts/WordRecognition. aspx, accessed July*, *1*, 2016.

Naveh, J. (1973). Word division in West Semitic writing. *Israel Exploration Journal*, 206-208.

Rayner, K., & McConkie, G. W. (1976). What guides a reader's eye

movements? *Vision research*, *16*(8), 829-837.

Saenger, P. (1997). *Space between words: The origins of silent reading*. Stanford

University Press.

Wingo, E. Otha. *Latin punctuation in the classical age*. Vol. 133. Walter de Gruyter,
1972.

Story 1A

Adapted from *Favourite Stories from Singapore* by Irene-Anne Monteiro and Jenny Watson

Hundreds of years ago there was a powerful king called Saul. He lived in Portland in southern Sumatra and ruled the kingdoms of the empire.

One day, the king decided to travel to the island of Bend. When the ships were ready, he and his followers set out. While they were at sea a fierce storm blew up; the wind howled and the sea became very rough.

"Your majesty, it is dangerous to travel in such weather," said the captain of the ship. "Timber Island is nearby, and we could stay there until the storm is over." The king agreed, and so the ships left the stormy sea and sailed into the safe and quiet harbor of Timber Island.

"Since we are here, we should have a look around," said the King. Saul and his followers then left their ships to explore the island. It was heavily wooded and had many beautiful flowers. As the men walked further from the sea, Saul suddenly saw a fine large animal. Its body was red as the sunset; its head was black, and its breast was snowy white. Larger than a goat, the animal moved quickly and soon disappeared into the dark forest.

"What was that?" asked the king. "I have never seen such a strange and wonderful animal."

"It's a lion," replied one of his followers.

"If the animals here are as fine and a fierce as lions, this would be a good place to start a new kingdom," said the king.

"I agree," said a prince, "but I think we should rename the island to mark your visit."

"Good idea," said Saul. "I think we should call it Singapura, which means the City of the Lion."

Story 1B

HUNDREDSOFYEARSAGOTHEREWASAPOWERFULKINGCALLEDSAUL.HELIV
EDINPORTLANDINSOUTHERNSUMATRAANDRULEDTHEKINGDOMSOFTHEE
MPIRE.

ONEDAY,THEKINGDECIDEDTOTRAVELTOTHEISLANDOFBEND.WHENTHESHI
PSWEREREADY,HEANDHISFOLLOWERSSETOUT.WHILETHEYWEREATSEAAF
IERCESTORMBLEWUP;THEWINDHOWLEDANDTHESEABECAMEVERYROUG
H.

"YOURMAJESTY,ITISDANGEROUSTOTRAVELINSUCHWEATHER,"SAIDTHECA
PTAINOFTHESHIP."TIMBERISLANDISNEARBY,ANDWECOULDSTAYTHEREUN
TILTHESTORMISOVER."

THEKINGAGREED,ANDSOTHESHIPSLEFTTHESTORMYSEAANDSAILEDINTOT
HESAFEANDQUIETHARBOROFTIMBERISLAND.

"SINCEWEAREHERE,WESHOULDHAVEALOOKAROUND,"SAIDTHEKING.
SAULANDHISFOLLOWERSTHENLEFTTHEIRSHIPSTOEXPLORETHEISLAND.IT
WASHEAVILYWOODEDANDHADMANYBEAUTIFULFLOWERS.ASTHEMENWA
LKEDFURTHERFROMTHESEA,SAULSUDDENLYSAWAFINELARGEANIMAL.IT
SBODYWASREDASTHESUNSET;ITSHEADWASBLACK,ANDITSBREASTWASSN
OWYWHITE.LARGERTHANAGOAT,THEANIMALMOVEDQUICKLYANDSOONDI
SAPPEAREDINTOTHEDARKFOREST.

"WHATWASTHAT?"ASKEDTHEKING."IHAVENEVERSEENSUCHASTRANGEAN
DWONDERFULANIMAL."

"IT'SALION,"REPLIEDONEOFHISFOLLOWERS.

"IFTHEANIMALSHEREAREASFINEANDAFIERCEASLIONS,THISWOULDBEAG

OODPLACETOSTARTANEWKINGDOM,"SAIDTHEKING.

"IAGREE,"SAIDAPRINCE,"BUTITHINKWESHOULDRENAMETHEISLANDTOMA

RKYOURVISIT."

"GOODIDEA,"SAIDSAUL."ITHINKWESHOULDCALLITSINGAPURA,

WHICHMEANSTHECITYOFTHELION."

Story 2A

Adapted from *Favourite Stories from Singapore* by Irene-Anne Monteiro and Jenny Watson

One day, while Matt was out fishing, a large wave smashed into his boat. Matt hit his head against the side and fell into the water. When he awoke, he was being helped by two turtles. The larger one held him up by swimming under him, and the smaller one bit him gently from time to time to keep him awake. The turtles brought him to the shore near his village.

Weeks later, a terrible storm came to the island. The wind blew, and it rained hard for several days. Matt stayed inside his house and repaired his nets. When the rain stopped, the beach was covered with turtles! They were large and had strange markings on their gray shells.

A little boy came running up to Matt. "Matt," he said, "look at the turtles! What kind are they? What are they doing? Where did they come from?"

Matt smiled. "You ask so many questions. These are leatherback turtles. They usually go to Island Dungun to lay their eggs, but because of the storm, they have come here instead. They have come all the way from the Indian Ocean."

Soon everyone in the village had come to watch the turtles lay their eggs.

"Why don't we dance on the turtles for good luck?" said one village woman.

Matt laughed. "That is just an old wives tale," he said. "Besides, you might hurt the turtles.

Soon the turtles had finished laying their eggs and then went back into the sea.

"We must protect the turtle eggs," Matt said. "Tell the children to look after them so that dogs and snakes don't eat them."

Soon the day came when the eggs began to hatch. Matt and the villagers helped the baby turtles out of their shells. They carefully put them in the water.

As the baby turtles swam away, Matt smiled. He was thinking of the turtles which had saved his life.

Story 2B

ONEDAY,WHILEMATTWASOUTFISHING,ALARGEWAVESMASHEDINTOHISBOAT.MATTHITHISHEADAGAINSTTHESIDEANDFELLINTOTHEWATER.WHENHEAWOKE,HEWASBEINGHELPEDBYTWOTURTLES.THELARGERONEHELDHIMUPBYSWIMMINGUNDERHIM,ANDTHESMALLERONEBITHIMGENTLYFROMTIMETOTIMETOKEEPHIMAWAKE.THETURTLESBROUGHTHIMTOTHESHORENEARHISVILLAGE.

WEEKSLATER,ATERRIBLESTORMCAMETOTHEISLAND.THEWINDBLEW,ANDITRAINEDHARDFORSEVERALDAYS.MATTSTAYEDINSIDEHISHOUSEANDREPAIREDHISNETS.WHENTHERAINSTOPPED,THEBEACHWASCOVEREDWITHTURTLES!THEYWERELARGEANDHADSTRANGEMARKINGSONTHEIRGRAYSHELLS.

ALITTLEBOYCAMERUNNINGUPTOMATT.“MATT,”HESAID,“LOOKATTHETURTLES!WHATKINDARETHEY?WHATARETHEYDOING?WHEREDIDTHEYCOMEFROM?”

MATTSMILED.“YOUASKSOMANYQUESTIONS.THESEARELEATHERBACKTURTLES.THEYUSUALLYGOTOISLANDDUNGUNTOLAYTHEIREGGS,BUTBECAUSEOFTHESTORM,THEYHAVECOMEHEREINSTEAD.THEYHAVECOMEALLTHEWAYFROMTHEINDIANOCEAN.”

SOONEVERYONEINTHEVILLAGEHADCOMETOWATCHTHETURTLESLAYTHEIREGGS.

“WHYDON’TWEDANCEONTHETURTLESFORGOODLUCK?”SAIDONEVILLAGEWOMAN.

MATTLAUGHED.“THATISJUSTANOLDWIVESTALE,”HESAID.“BESIDES,YOUMI

GHTHURTTHETURTLES.

SOONTHETURTLESHADFINISHEDLAYINGTHEIREGGSANDTHENWENTBACKI

NTOTHESEA.

“WEMUSTPROTECTTHETURTLEEGGS,”MATTSAID.“TELLTHECHILDRENTOLO

OKAFTERTHEMSOTHATDOGSANDSNAKESDON’TEATTHEM.”

SOONTHEDAYCAMEWHENTHEEGGSBEGANTOHATCH.MATTANDTHEVILLA

GERSHELPEDTHEBABYTURTLESOUTOFTHEIRSHELLS.THEYCAREFULLYPUT

THEMINTHEWATER.

ASTHEBABYTURTLESSWAMAWAY,MATTSMILED.HEWASTHINKINGOFTHETU

RTLESWHICHHADSAVEDHISLIFE.

Story 3A

Adapted from *Favourite Stories from Singapore* by Irene-Anne Monteiro and Jenny Watson

Once there was a lonely old dragon who lived in a cave. He liked to lie in the sun, and because he looked fierce, the villagers feared him.

The old dragon wasn't fierce at all. He had lost his horns and only had one tooth left. He mostly lay in the sun and thought about the old days.

One day, a young dragon stopped to talk. "Hello, Uncle," he said.

"I'm not your uncle," said the old dragon. "Go away and leave me alone."

The young dragon laughed and flew away. When the old dragon tried to fly, he found his wings were stiff, and he just lay in the sun, wishing he were young again.

Then, he heard someone shouting "Somebody please help me."

The dragon saw that a young girl had fallen into the river. He jumped into the water and quickly pulled her to shore.

"What were you doing in the river?" he asked.

"My washing floated away, and I tried to catch it."

The dragon smiled. "Aren't you afraid of me?"

"My grandfather says you've never eaten anyone."

"That's true, but how do you know I won't eat you?"

"You saved my life," said the girl," and I must repay you. What food do you like best?"

The dragon told the girl he liked swallows, but that he was too old to catch them. The next day she brought him some fine fat swallows, and after that she came to visit often.

The men of the village saw the girl visit the dragon. "She likes that old dragon more than she likes us," they said.

One day, as he was sleeping in the sun, the young men tied ropes around the old dragon's body. When the dragon woke up, he pulled at the ropes. As he moved, he tore many trees out by their. He made such a noise that the villagers were very frightened. The young girl ran to her grandfather.

"What is that noise?" she said.

"The young men tied up the dragon," he replied.

"But he wouldn't hurt anyone. I must go help him," said the girl. She ran to the river side, but it was too late. The tired old dragon had died, and his body slowly sank into the muddy water.

Story 3B

ONCETHEREWASALONELYOLDDRAGONWHOLIVEDINACAVE.HELIKEDTOLI

EINTHESUN,ANDBECAUSEHE

LOOKEDFIERCE,THEVILLAGERSFEAREDHIM.THEOLDDRAGONWASN'TFIER

CEATALL.HEHADLOSTHISHORNSANDONLYHADONETOOTHLEFT.HEMOSTLY

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E."

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DTOFLY,HEFOUNDHISWINGSWERESTIFF,ANDHEJUSTLAYINTHESUN,WISHIN

GHEWEREYOUNGAGAIN.

THEN,HEHEARDSOMEONESHOUTING"SOMEBODYPLEASEHELPME."

THEDRAGONSAWTHATAYOUNGGIRLHADFALLENINTOTHERIVER.HEJUMPE

DINTOTHEWATERANDQUICKLYPULLEDHERTOSHORE.

"WHATWEREYOUDOINGINTHERIVER?"HEASKED.

"MYWASHINGFLOATEDAWAY,ANDITRIEDTOCATCHIT."

THEDRAGONSMILED."AREN'TYOUAFRAIDOFME?"

"MYGRANDFATHERSAYSYOU'VENEVEREATENANYONE."

"THAT'STRUE,BUTHOWDOYOUKNOWIWON'TEATYOU?"

"YOUSAVEDMYLIFE,"SAIDTHEGIRL,"ANDIMUSTREPAYYOU.WHATFOODDO

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NDAFTERTHATSHECAMETOVISITOFTEN.

THEMENOFTHEVILLAGESAWTHEGIRLVISITTHEDRAGON."SHELIKESTHATO

LDDRAGONMORETHANSHELIKESUS,"THEYSAID.

ONEDAY,ASHEWASSLEEPINGINTHESUN,THEYOUNGMENTIEDROPESAROUN

DTHEOLDDRAGON'SBODY.

WHENTHEDRAGONWOKEUP,HEPULLEDATTHEROPES.ASHEMOVED,HETORE

MANYTREESOUTBYTHEIR.HEMADESUCHANOISETHATTHEVILLAGERSWER

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"WHATISTHATNOISE?"SHESAID.

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ANTOTHERIVERSIDE,BUTITWASTOOLATE.THETIREDOLDDRAGONHADDIED,

ANDHISBODYSLOWLYSANKINTOTHEMUDDYWATER.

Story 4A
Adapted from *Favourite Stories from Singapore* by Irene-Anne Monteiro and Jenny Watson

Long ago, the world was divided into two parts. Each part was ruled by a powerful giant king. The Easter Lands were hot and wet, while the Western Lands were cold and dark. Sometimes there were wars, but this story takes place during peace.

The youngest son of the king of the West wanted to travel, and he left his father's palace. For many days, the prince travelled east, hiding whenever he saw soldiers. Weeks later, he came to a small lake in the Eastern Lands.

The prince went for a swim in the lake. He saw a beautiful girl on the opposite side. He swam to her, and they began to talk.

"I am a traveler from the Western Lands," said the prince.

"Then you must leave," she said. "My father, the king, will kill you."

The prince was about to swim away when the princess called him back. "Don't go yet. I will hide you, and we can swim together each day."

The prince was glad to have a chance to rest. The princess hid him in a small house in the forest near the lake. Each day he swam with the princess in the lake. Before long, they fell in love.

"I want to marry you, said the prince.

"My father would never allow it," said the princess.

"I'll ask him anyway," said the prince, and he walked to the palace of the Eastern king.

The king immediately threw the young man into prison. Days later, the prince escaped and went to the lake. There he saw the princess. "Come with me to the west," he said. "We can be married there, and my family will welcome you as my wife."

The princess wrapped her jewels and a beautiful fan in a length of silk. Together they ran towards the west. In her hurry, the giant princess dropped her bundle. In the darkness, she was able to find her shiny jewelry, but not her fan. "I've lost my beautiful fan," she cried.

The prince could hear the guards coming closer. He took her hand and together they fled to the Western Lands where they were married.

The fan that the giant princess dropped fell to the earth. Some time later it floated down a river to the sea where it caught on some rocks and turned into an island. This island is now called Singapore.

Story 4B

LONGAGO,THEWORLDWASDIVIDEDINTOTWOPARTS.EACHPARTWASRULED

BYAPOWERFULGIANTKING.THEEASTERLANDSWEREHOTANDWET,WHILET

HEWESTERNLANDSWERECOLDANDDARK.SOMETIMESTHEREWEREWARS,B

UTTHISSTORYTAKESPLACEDURINGPEACE.

THEYOUNGESTSONOFTHEKINGOFTHEWESTWANTEDTOTRAVEL,ANDHELEF

THISFATHER'SPALACE.FORMANYDAYS,THEPRINCETRAVELLEDEAST,HIDIN

GWHENEVERHESAWSOLDIERS.WEEKSLATER,HECAMETOASMALLLAKEINT

HEEASTERNLANDS.

THEPRINCEWENTFORASWIMINTHELAKE.HESAWABEAUTIFULGIRLONTHEO

PPOSITESIDE.HESWAMTOHER,ANDTHEYBEGANTOTALK.

"IAMATRAVELERFROMTHEWESTERNLANDS,"SAIDTHEPRINCE.

"THENYOUMUSTLEAVE,"SHESAID."MYFATHER,THEKING,WILLKILLYOU."

THEPRINCEWASABOUTTOSWIMAWAYWHENTHEPRINCESSCALLEDHIMBAC

K."DON'TGOYET.IWILLHIDEYOU,ANDWECANSWIMTOGETHEREACHDAY."

THEPRINCEWASGLADTOHAVEACHANCETOREST.THEPRINCESSHIDHIMINAS

MALLHOUSEINTHEFORESTNEARTHELAKE.EACHDAYHESWAMWITHTHEPRI

NCESSINTHELAKE.BEFORELONG,THEYFELLINLOVE.

"IWANTTOMARRYYOU,SAIDTHEPRINCE.

"MYFATHERWOULDNEVERALLOWIT,"SAIDTHEPRINCESS.

"I'LLASKHIMANYWAY,"SAIDTHEPRINCE,ANDHEWALKEDTOTHEPALACEOFT

HEEASTERNKING.

THEKINGIMMEDIATELYTHREWTHEYOUNGMANINTOPRISON.DAYSLATER,T

HEPRINCEESCAPEDANDWENTTOTHELAKE.THEREHESAWTHEPRINCESS."CO

MEWITHMETOTHEWEST,"HESAID."WECANBEMARRIEDTHERE,ANDMYFAMI

LYWILLWELCOMEYOUASMYWIFE."

THEPRINCESSWRAPPEDHERJEWELSANDABEAUTIFULFANINALENGTHOFSI

LK.TOGETHERTHEYRANTOWARDSTHEWEST.INHERHURRY,THEGIANTPRINC

ESSDROPPEDHERBUNDLE.INTHEDARKNESS,SHEWASABLETOFINDHERSHIN

YJEWELRY,BUTNOTHERFAN."I'VELOSTMYBEAUTIFULFAN,"SHECRIED.

THEPRINCECOULDHEARTHEGUARDSCOMINGCLOSER.HETOOKHERHANDA

NDTOGETHERTHEYFLEDTOTHEWESTERNLANDSWHERETHEYWEREMARRI

ED.

THEFANTHATTHEGIANTPRINCESSDROPPEDFELLTOTHEEARTH.SOMETIMEL

ATERITFLOATEDDOWNARIVERTOTHESEAWHEREITCAUGHTONSOMEROCKS

ANDTURNEDINTOANISLAND.THISISLANDISNOWCALLEDSINGAPORE.

Appendix B

Comprehension Test 1

1.) Why did the king's ships stop on Timber Island?

_____

2.) What animal was seen in the forest?

_____

3.) What colors were the animal? What parts were which color?

_____

4.) Whose idea was it to rename the island?

_____

    5.) What is the new name of the island, and its translation?

    _____

Comprehension Test 2

1.) How many turtles saved Matt?

_____

2.) What did the small turtle do to him?

      a.) Held up his head

      b.) Bit him gently

      c.) Tugged at his hair

      d.) There was no small turtle.

3.) What did Matt do during the storm?

_____

4.) What did the village woman want to do with the turtles?

_____

5.) What kind of turtles were they?

_____

Comprehension Test 3

1.) How many teeth did the old dragon have?

_____

2.) What did the young dragon call the old dragon?

_____

3.) Why was the girl in the river?

    a. She slipped while walking

    b. A boy pushed her in

    c. The young dragon had startled her

    d. Her laundry floated away

4.) What did the dragon like to eat?

_____

5.) Where did the old dragon's body lay in the end?

_____

Comprehension Test 4

1.) The Prince came from which kingdom?

_____

2.) He came upon what in his travels?

A. A pond

B. A lake

C. A river

D. An ocean

3.) Where did the princess hide the prince?

_____

4.) What objects did the princess drop?

_____

5.) What object became the island of Singapore?

_____

Appendix C

February 28, 2016

Dr. Jennifer Behney, Principal Investigator
Mr. Jamison Van Loocke, Co-investigator
Department of English
UNIVERSITY

RE: HSRC Protocol Number: 091-2016
        Title: The Influence of Spacing on Reading Comprehension

Dear Dr. Behney and Mr. Van Loocke:

The Institutional Review Board has reviewed the abovementioned protocol and determined that it is exempt from full committee review based on a DHHS Category 1 exemption.

Any changes in your research activity should be promptly reported to the Institutional Review Board and may not be initiated without IRB approval except where necessary to eliminate hazard to human subjects. Any unanticipated problems involving risks to subjects should also be promptly reported to the IRB.

The IRB would like to extend its best wishes to you in the conduct of this study.

Sincerely,

Mr. Michael A. Hripko
Associate Vice President for Research
Authorized Institutional Official

MAH:cc

c: Dr. Julia Gergits, Chair
        Department of English