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Lessening Cognitive Reading Load Using Visual-Syntactic Text Formatting

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Abstract

The study explored the use of a new reading formatting method, Visual-Syntactic Text Formatting (VSTF, Walker, Vogel, & Fletcher, 2004). Previous work on VSTF found significantly increased rates of comprehension in experimental trials. This was arguably facilitated by reducing cognitive load, resolving syntactic ambiguity, and augmenting natural eye-span fixations. It was hypothesised that if VSTF did deliver the above benefits, higher comprehension rates and fewer backward eye movements (regressions) would be found in this condition. The study employed a repeated-measures, counterbalanced design, comprised of three formatting conditions: *Block*, *VSTF*, and *Syn/slash* (amalgamation of block and VSTF). The total sample was comprised of 71 undergraduate students at the University of Cape Town (UCT) and included 52 females and 19 males (Mean age = 21) of whom 50 were first-language English speakers. A subset of 30 participants was eye-tracked. All participants read three 780-word re-formatted passages and were tested using multiple-choice items. Number of regression and durations of fixations were collected. No significant effects were found for VSTF formatting condition in terms of comprehension, reading speed, or reading efficiency. A significant difference in duration of fixations between VSTF and Syn/Slash was found. Further research is required to validate the VSTF method.

Keywords; Visual-Syntactic Text Formatting; Cognitive Load Theory; Working Memory; Comprehension; Eye-tracking; Computer-based parsing

Lessening Cognitive Reading Load Using Visual-Syntactic Text Formatting

The economical limitations of paper printing have long dictated that the presentation of text be in standard block formula. Therefore, the traditional formatting of text stems from economical and practical limitations rather than from research indicating that this is the optimal method of presentation. With increasing digitalisation of learning materials and time spent on computers, the economic need to curtail space available for text and other visual resources no longer applies. Despite this, text continues to be presented in dense, block format. In line with Cognitive Load Theory (CLT; Sweller, Chandler, Tierney, & Cooper, 1990), the visual complexity of digital materials and the maintenance of content heavy passages that tax the eyes and working memory may result in hampered learning (Harper, Michailidou, & Stevens, 2009). Findings from reading research have shown that aspects of cognitive processing can be inferred from eye movement data, in particular showing the way in which syntactic complexity and ambiguity, text density and line lengths can negatively influence speed of reading and comprehension of text. A new method of formatting text proposed by R. Walker et al. (2007) could facilitate learning through addressing syntactical complexity and text display to optimise reading and induce heightened understanding of syntactical features, cumulating in increased comprehension of to-be-learnt materials.

Background

Cognitive Load Theory and Working Memory

Reading relies on working memory (WM) to engage attention and cognitive resources, enabling the recognition and comprehension of words, and the building up of semantic understanding from the syntactic structure (Fromkin, Rodman, & Hyams, 2007). WM is hypothesised to consist of a *visuo-spatial sketchpad* (dealing with visuo-spatial elements) and a *phonological loop* (dealing with speech based processing), both of which

have both active and passive modes (Baddeley & Logie, 1999). These two ‘slave systems’ are in turn coordinated and controlled by the *central executive system*. The ‘storage’ capacity of WM is limited to approximately seven plus/minus two bits of information, but this decreases if the material is novel or complex and thus requires additional attention resources (Baddeley, 1992).

Hence, CLT reasons that when attempting to learn new material we are at the mercy of this limited system; overloading of WM leads to a decreased ability to process information (Kirschner, Kirschner, & Paas, 2008). Research has shown that good WM relates to better academic performance therefore lessening avoidable load is critical (de Tong, 2010). CLT differentiates between three related components: *intrinsic*, *extraneous*, and *germane* load. *Intrinsic load* refers to the learning material characteristics, for example the difficulty or complexity of the material itself, as well as the characteristics of the learner in terms of their own ability. *Extraneous load* relates to the format or presentation of the materials used for learning, and is consequently the focus of much applied research. Lastly, *germane load* refers to the processing and construction of schemas that facilitate learning (de Tong, 2010).

In its application to learning materials, much research from CLT posits that redesigning instructional material that lessens overall cognitive load will do so by reducing the levels of extraneous cognitive load. Extraneous factors such as visual complexity place a heavy burden on cognitive load (Harper et al., 2009), which creates competition for attention resources with the text by overloading the visuo-spatial sketchpad of WM (Baddeley, 1992).

Poor learning outcomes may also arise from too little attention being engaged. In aiming to simplify visual presentation and information content, research indicates that if navigation of the material, or indeed the material itself, is made to be overly simple this has detrimental effects on learning. Thus, a tightrope act of creating sufficient interaction and

work on behalf of the learner whilst minimising possible interference must be negotiated (Schnotz & Kürschner, 2007).

At higher educational levels, not only is the *volume* of reading increased (accompanied by increased visual density), but also correspondingly, the *complexity* of the content of the to-be-learned materials intensifies. In terms of WM during reading, the passive storage of the words needs to occur in tandem with the active sub-vocal rehearsal of this information. Overly lengthy, or syntactically complex or ambiguous sentences can cause the breakdown of good WM as the reader attempts to retain the information ‘online’ in order to make sense of it, often squandering necessary attention resources on extraneous elements such as keeping one’s place in the text (Mikk, 2008; Rayner, 2009). The issue of increased *semantic* complexity is often linked to the increased complexity and ambiguity of the *syntactic* structure of the material.

According to psycholinguistic research, reading requires the moment-to-moment updating and processing of meaning as the syntactic structure builds up semantic meaning, often referred to as ‘parsing’ which is determined by the rules of grammar (syntax) and the “sequential nature of language” (Fromkin et al., 2007, 372). The building up of meaning occurs as readers determine what grammatical category the word in question belongs to, in relation to preceding and upcoming words. Ambiguities occur when original interpretations are found to be incorrect upon reaching later stages of the sentence or paragraph. The longer and more complex a sentence is in length and syntactic structure, respectively, the more likely there are to be increases in reading times due to the reader having to return to previously covered, misinterpreted text.

Consequently, the creation of appropriately formatted text that generates less visual competition and syntactic ambiguity are of great importance. Research has for the most part concentrated on scaffolding learning through creating interactions with the text. The use of

integrated and split-attention formats have been found to increase comprehension by the inclusion of questions in specific ways within the text. One study (Al-Shehri & Gitsaki, 2010) showed that the breaking up of passages of text into paragraphs followed by comprehension questions (integrated format) resulted in faster reading speeds and increased understanding compared to continuous text followed by questions at the very end (split-attention format). Al-Shehri and Gitsaki (2010) suggested that this reduced extraneous cognitive load as learners could strengthen their understanding of one part of the text before moving onto the next content area. It could be argued that the favorable results of the split-attention format could also be linked to the creation of less visually-heavy text, thereby decreasing overloading of WM and leading to increased comprehension (Mikk, 2008).

However, in attempting to create the optimal format for learning, it is vital to note that research has suggested that perhaps no universal method that will guarantee increased learning exists. This is due to the inescapable fact that differences in subjective variables (of the learner) as well as in the learning material (e.g., in its semantic content) vary considerably (Kolloffel, Eysink, de Jong, & Wilhelm, 2009). However, one fruitful means of objectively exploring potential similarities in the navigation and processing of different formats and textual characteristics by readers has been in the use of eye tracking technology. This enables the investigation of the link between eye movements and cognitive processing in real time.

Eye-Tracking and Reading

Research on eye movements in reading has progressed with the increasing sophistication of eye-tracking technology. As this research requires the use of computer screen reading, it bodes well that reading speed for both screen-reading and paper-reading are equivalent (Al-Shehri & Gitsaki, 2010) and that no significant advantage for memory retention exists between the two modes (Green, Perera, Dance, & Myers, 2010). Lastly, in

terms of ecological validity it appears that reading rate and comprehension are equivalent across laboratory conditions and ‘real-world’ reading tasks (Tinker, 1939, as cited in Rayner, 1998).

Research from eye-tracking studies has important implications for CLT in the designing of learning materials (Van Gog & Scheiter, 2010). The eye-mind hypothesis (Just & Carpenter, 1976) asserts that the location and duration of eye fixations show what is being attended to as well as the time taken to cognitively process that information. Before exploring some of the ways in which this research could be extended into design principles, I will outline some basic aspects of eye movements in reading.

Eye Movements in Reading

When humans begin to look at a piece of text, the eyes fixate on a word for approximately 200-250 ms, during which text is recognized and processed. The eyes then make a saccade (a short rapid movement typically about 7-9 letter spaces) to another point in the sentence, and finally make a ‘return sweep’ from the end of the sentence to the start of the next line (Rayner, 2009).

The eye has different levels of focal ability; the fovea in the centre is the area of highest visual acuity. This visual acuity lessens drastically in the parafoveal region. Consequently, the eyes make saccades in order to place text into the prime foveal area. Information is only obtained during fixations, which are asymmetric in that only 3-4 character spaces to the left are brought into focus, whereas 14-15 to the right are brought into focus. This indicates that attention is implicated in directing the eye movement process, as in the case of English readers (who read left-to-right) more pertinent information can be garnered from the region to the right of current fixation (Henderson & Ferreira, 1990).

In the parafoveal region, in which the eyes see in less fine-grained detail, approximately 15-20 letters to the left and right of fixation can be discriminated to a lesser extent (Rayner, 2009). Similarly to foveal asymmetry, parafoveal processing is biased to the right side (Morris, Rayner, & Pollatsek, 1990). The saccade latency period (the time between fixation and the eventual eye movement) lasts for approximately 150-170 ms, and has been suggested as occurring in parallel with sentence comprehension (Rayner, 1998). When syntactical complexity is increased and/or a sentence is ambiguous, fixation periods are of longer duration and saccades are of a shorter length. Syntactical complexity has been shown to create competition between foveal and parafoveal information for attention, with fewer attention resources to pay to information at the outskirts of our fixation, resulting in dramatically slowed reading speed (Henderson & Ferreira, 1990).

Reading Speed and Comprehension

Whilst the findings from research on eye movements has suggested that fixations are an index of cognitive processing, and more specifically cognitive load, it would be a mistake to conclude that slower reading speeds and longer fixations always equate to lowered comprehension (Van Gog, Kester, Nieuvelstein, Giesbers, & Paas, 2009). Although increased expertise in reading has been found to be associated with faster reading speeds and higher comprehension rates (Bell, 2001), other studies have found that fast reading decreases comprehension with a speed-accuracy tradeoff (Dyson & Haselgrove, 2000, 2001).

Therefore, whilst there may be increased processing demands associated with these outcomes, 'slower' processing may be engaging learners' full resources, and could, in fact, be related to deeper engagement with the learning materials. Further research into the correlation between reading speeds and duration of fixations with learning outcomes is necessary to tease apart this relationship.

Often other factors unrelated to the material can affect the speed with which a given text is read. Factors such as typographical characteristics (e.g., typeface legibility) have been found to result in longer fixations and shorter saccades (Rayner, 2009). Another more pertinent aspect is the question of what constitutes ‘optimal’ line length. Research into this area has produced mixed results, with more recent research suggesting that lines of 70 characters retain good reading speed, with those being longer or shorter slowing reading speed (Nanavati & Bias, 2005). It should follow from CLT that long line lengths and dense text would hamper WM and therefore reading ease, by having to hold larger amounts of information ‘online’ thereby requiring additional processing, and by using extra attention resources to keep track of placement in the text. New formatting techniques have been suggested that deliberately adjust such typographical characteristics to work in harmony with natural eye fixation spans, potentially promoting optimal comprehension (R. Walker et al., 2007).

Formatting, Cognitive Load and Comprehension

As noted above, in designing educational materials to lessen cognitive load, many adaptations have been aimed at reducing extraneous load. The reasoning behind attempting to reduce extraneous load over intrinsic load is that it is often easier to adapt the *presentation* rather than the *content* of the material. An interesting approach that has not been explored in psychological research has been developed by R. Walker et al. (2004); termed “Visual-syntactic text formatting” (VSTF; Appendix A: Figure A1).

This method utilises an algorithm to transform block text by ‘chunking’ it into short cascading lines (Appendix A: Figure A1 & A2). The algorithm purportedly works by dividing the text into the most syntactically appropriate groupings. The lines are indented according to their relation to the preceding sentence, illustrating the ownership of one

sentence to another. It has been posited that by lessening syntactical complexity and/or ambiguity one could in turn lessen intrinsic load. The designers suggest that as syntactic awareness is correlated with later reading proficiency, that this awareness is therefore an independent predictor of sentence comprehension for second-language readers (R. Walker et al., 2004). Furthermore, by making syntactic structures explicit, the researchers argue that this reduces the intrinsic load of the material, by reducing complexity and resolving ambiguity.

Moreover, they contend that the cascading format encourages pattern recognition, and allows the eye to move more naturally through the text, as well as keeping attention peaked due to the fact that no two 'paragraphs' are the same. Their argument is that shorter sentences are more amenable to natural eye-span fixation. The algorithm typically produces lines of 8-30 characters that are therefore able to fit into at most two fixation spans. This allows for optimal foveal and parafoveal analysis along with minimum distraction from other competing text in the peripheral area (S. Walker, Schloss, Fletcher, Vogel, & R. Walker, 2005).

In their validation study, R. Walker, Vogel, and Fletcher (2004) conducted a within-subjects design with 48 college students reading 500-word expository passages. They found that those in the VSTF condition scored significantly higher in recall tests. Interestingly, the authors also report that whilst VSTF was preferred above block text by the majority of the participants, even those who indicated otherwise had higher scores in the VSTF condition (S. Walker et al., 2005).

Later, in a longitudinal study, R. Walker et al., (2004) used primary school-aged children who were assigned to either a standard block text or a VSTF reading condition for a year. Impressive improvements were seen in the comprehension scores and reading ability of the VSTF group. These tests were ecologically valid in that they followed the set academic

outline for the children, whereas in the validation study the texts were deliberately abstract and had little valence with the subjects.

Additionally, R. Walker et al., (2007) contend that the VSTF method works favorably over time for low proficiency readers and English second-language speakers (whilst having immediate benefits for those with good reading proficiency), obtaining moderate effect sizes ($\eta^2 = .55$) which calls for attempts to replicate and corroborate. Indeed, the authors contend that even if one returns to block text reading and comprehension abilities are improved through a type of scaffolding process. They suggest that the formatting method may be working in a similar manner to the way in which teachers who read aloud model fluent reading through proper use of prosody (signaling syntactic units) which makes for better comprehension (S. Walker et al., 2005).

Warschauer, Park, and Walker (2011) have since conducted other studies, one in which a 'random truncation' level was added into the experimental design. In this line lengths were made to approximate VSTF, but were 'randomly' chunked. The condition thus lacked the proposed optimal syntactic divisions as well as the cascading, indented formula of VSTF. Whilst they found no difference between block formatting and the random truncation, there were significantly higher comprehension rates in the VSTF group. They therefore argue that it is not simply shortened line lengths delivering the advantage, but the syntactic features of VSTF. The authors also found that reading speed was increased in the VSTF condition, which they combined with comprehension rate to create an efficiency index (defined as amount of comprehension per unit of reading time). Lastly, as participants were eye-tracked, the authors noted that eye movement through the VSTF passages was more streamline with regard to their subjective judgements on heat maps and other eye-tracking data (Appendix A: Figures A3 & A4). More objective measures include their findings for increased efficiency

and performance in terms of reading time, numbers of backwards regressions and total eye fixation duration.

Certainly, the findings for the superiority of the VSTF method are impressive. It follows from its creators' findings that rather than relying on human parsing of written material, which can occasion ambiguity and create confusion; that using the VSTF algorithm succeeds in minimizing these problems, as seen through higher comprehension rates, more efficient reading, and by reductions in fixations duration and number of regressions. Because words can sometimes have several meanings or connotations, for example, "The warehouse fires" could be interpreted as burning buildings or terminating employees (Fromkin et al., 2007, p. 372), the use of VSTF would actively solve this ambiguity for readers if we follow the reasoning outlined in the findings noted above. Because VSTF represents quite a novel or unusual format, the question of whether it is the novelty rather than making syntactic structure explicit that is delivering increased comprehension through expectancy effects in participants needs to be investigated by controlling for this aspect.

Finally, notwithstanding the impressive findings noted above, issues of potential bias demand reflection. The authors of the VSTF have patented this formatting technique and are selling it online, and thus there is a great deal of personal investment in the reporting of these findings. A search uncovered only one other study not conducted by the VSTF authors. That study did not favor the VSTF method.

The study that did not show advantageous results for the VSTF method was conducted by researchers who have created a formatting system of their own called Jenga (Yu & Miller, 2010; Appendix A: Figures A5 & A6). Jenga breaks down block text into paragraphed chunks, with a design based on manipulating the separation and spacing of sentences to improve reading speed and comprehension. This formatting technique has also been targeted at promoting reading ease of English for second-language speakers.

Interestingly, Yu and Miller's (2010) main argument against VSTF was that the method was unsuitable for second-language speakers struggling with syntactical complexity, contending that one must have syntactic understanding to navigate the VSTF method. However, whilst Jenga did produce significantly better comprehension scores than VSTF, it did not manage to outperform standard block text.

Furthermore, although elements in the principles informing the Jenga format have been found to be related to improved comprehension in some instances (e.g., sentence spacing), this formatting technique lacks a strong guiding theoretical orientation such as that seen in the design of R. Walker et al. (2004, 2007). In contrast to Jenga, the VSTF method has powerful conceptual backing by implicating syntactical processing, eye-span underpinnings, pattern recognition, chunked formatting and (albeit indirectly) CLT.

In assessing these formatting systems, the potential financial gain to be garnered from them cannot be overlooked, and therefore results from any parties that have their own stakes needs to be confirmed by external sources to rule out bias arising from competitive financial motives. Therefore, the inescapable interests of both parties mean that these findings need to be replicated in order to ensure that biased interests are not impacting on the report of findings.

Aims and Hypotheses

The reviewed literature suggests that by reducing the visual complexity of learning material and focusing on the typographical and syntactical features of the text this could lessen cognitive overloading of WM. Lessening cognitive load should in turn free up cognitive resources thereby leading to increased comprehension. Improving the learning potential of students is of vital importance. The purpose of this study was to determine whether the VSTF method, through making syntactic structure explicit in tandem with

reducing visual complexity, does in fact lead to optimal performance in terms of comprehension and reading efficiency.

To investigate whether it is the syntactic parsing component that leads to beneficial performance, a hybrid condition utilising VSTF syntactic chunking re-formatted into block formation will be introduced (Syn/slash) in order to tease out the relationship of line-length reduction, as seen in VSTF, and syntactic parsing (this will be outlined under Design).

Furthermore, as research from eye-tracking studies have indicated that syntactically complex text slows reading pace and leads to more backward regressions through text and longer fixation durations, these will be assessed in terms of the three formatting conditions.

The main hypotheses were as follows:

- a. Participants will show better comprehension in the VSTF condition, followed by the Syn/Slash condition, therefore $VSTF > Syn/Slash > Block$
- b. In line S. Walker (2005) preference will be higher for VSTF, however even those not preferring VSTF will have higher comprehension rates in this condition
- c. English second language speakers will have increased comprehension using the VSTF condition.
- d. Reading speeds will be faster in the VSTF condition, followed by the Syn/Slash condition, therefore $VSTF > Syn/Slash > Block$
- e. Reading efficiency will be higher in the VSTF condition, followed by the Syn/Slash condition, therefore $VSTF > Syn/Slash > Block$
- f. The number of backwards regressions will be lowest in VSTF, followed by the Syn/Slash condition, therefore $VSTF > Syn/Slash > Block$
- g. The duration of fixations will be on average lower in VSTF, followed by the Syn/Slash condition, therefore $VSTF > Syn/Slash > Block$

Methods

Design and Setting

The study used an experimental, repeated measures design, taking the form of a 3 (Formatting: VSTF or Syn/Slash or Block) X 3 (Passage content: Passage 1 x Passage 2 x Passage 3) X 6 (Order of format on passage: A x B x C x D x E x F). The use of a repeated measures design allowed for the control of subject variables in terms of reading proficiency and comprehension abilities. Counterbalancing of order of the formatting (Table 1) aimed to control for differences in passage length and difficulty.

Table 1. Study Design Illustrating Counterbalanced Formatting Across Passages

Group	Passage 1	Passage 2	Passage 3
A	VSTF	Syn/Slash	Block
B	VSTF	Block	Syn/Slash
C	Syn/Slash	VSTF	Block
D	Syn/Slash	Block	VSTF
E	Block	VSTF	Syn/Slash
F	Block	Syn/Slash	VSTF

Dependent measures included comprehension rate, derived from scores on multiple-choice questions (MCQ) items; reading speed (words/reading time); an efficiency index (comprehension rate/time); and preference and performance items in a questionnaire. Eye-tracking measures in the form of number of backwards regressions (defined only as those returning over previously covered material and not for explorative behaviour or corrective regressions on return sweeps) and duration of fixations were dependent measures for a subset of participants.

Unravelling VSTF: Syn/Slash Condition

Because the VSTF authors argue that the syntactic formulation is the primary means for the delivery of the improved comprehension (R. Walker et al., 2004, 2007), a new

experimental condition is necessary in order to ascertain whether making syntactic structure explicit, but without the additional change in formatting, can also provide an improvement over block text. In order to separate out the effect of short lines and cascading patterns from syntactical chunking, an additional experimental condition was introduced, termed Syn/Slash (Appendix B: Figure B1).

This experimental condition works by utilising the VSTF algorithm to syntactically chunk the text according to its specifications, and is then reformatted manually into block text. The syntactical separations are not dispersed with completely however, but rather than having syntactic chunks appearing on a new line (as in the VSTF method) they are separated by the use of slashes (“/”). This method thus positions itself as a mediator between the standard block format and VSTF. Syn/Slash therefore serves as a control and experimental condition in its own right, in the process of attempting to tease out what factors (explicit syntax alone or explicit syntax in combination with short line lengths and cascading patterns) are, if at all, delivering the improvement in comprehension.

Participants

The total sample was comprised of 71 undergraduate students at the University of Cape Town (UCT) and included 52 females and 19 males. Mean age was 21.19 years (age ranged from 18 to 40). In terms of language, 50 were first-language English speakers and 21 were second language speakers. Recruitment took three forms. Psychology students (n = 58, 1st years = 29) were recruited through the Student Research and Participation Project (SRPP) initiative in return for their duly performed certificate (a course requirement). This occurred through on-line sign-ups via the SRPP webpage. Additionally, students from across the university (n = 10) were recruited through advertising on noticeboards around the university campus and were paid R40 for their hour participant. Lastly, linguistics students (n= 3) were

invited to take part through their course secretary, as the study deals with a psycholinguistic topic that could be of interest to those in this department. Of the total sample of 71, a subset of 30 participants was eye-tracked. To be included in this portion of the study participants had to have normal, uncorrected vision (i.e., not wear contact lenses or glasses). This subset included 21 females and 9 males. Mean age was 21.67 years (age ranged from 18 to 40). In terms of language, 20 were first-language English speakers and 10 were second language speakers.

Materials and Apparatus

Formatting. The three formats included: Block text, the VSTF algorithm, and the Syn/Slash method (Appendix B: Figures B1-B3). All texts were presented in left-aligned, 12-point Arial type. The choice of Arial type was to maintain consistency with the VSTF program, which offers Arial as its primary typeface. In keeping with the consensus in the literature (Nanavati & Bias, 2005), the standard block text and the Syn/Slash conditions had line lengths of approximately 70 characters. The VSTF method has fluctuating line lengths of 8-30 characters.

VSTF algorithm. The two-week trial-version of the program for the VSTF method was subscribed to from the website allied to the VSTF team, www.liveink.com, and was used to process the passages for both the VSTF and Syn/Slash conditions.

Passages. Three passages were taken from the prescribed first-year psychology textbook, *Psychology: The science of mind and behaviour* (2nd ed.) from the chapter on Consciousness (Holt et al., 2012). The content and length of the passages were as follows: Passage 1 “Levels of Consciousness” (word count = 772); Passage 2 “Why do we sleep” (word count = 785); and Passage 3 “Why do we dream?” (word count = 796). The content of the passages was rated as 12.2 on the Flesch-Kincaid Grade level (Microsoft, 2010), therefore

being most appropriate for first-year students. The passages were viewed using Microsoft (2010) PowerPoint show for the first 41 participants, enabling timing of reading of passages to be taken in tandem with the delivery of the experiment. For the 30 eye-tracking participants, the Tobii Studio program delivered the experiment, allowing reading times, fixations and regressions to be recorded. All participants viewed the experiment on 21” computer monitors.

Tobii eye-tracking equipment. A Tobii 2.3.2.0 eye-tracker was used to capture eye-movement. Major calibration was standardised prior to commencement of the study, and the chair was marked off at a 70cm distance from the monitor as stipulated in the Tobii manual.

Comprehension tests. Comprehension was tested using MCQ items (Appendix C). Ten items were written for each passage (total = 30), with each question had four possible response options. Participants wrote their letter choices on the answer sheet provided (Appendix D). After the completion of the study, I conducted item analyses to determine which items had the best discriminability. Those that were low in discrimination were not used in the final analysis, leaving Passages 1 and 2 with 6 items, respectively, and Passage 3 with 7 items. Scores were computed as percentages to make comprehension on passages comparable.

Demographic and preference questionnaire. A questionnaire (Appendix D) determining basic demographics, evaluation of passage content and formatting performance was included at the end of the testing session. Preference questions were on 5-point Likert-type items with no labelled neutral point.

Procedure

On arrival at the ACSENT laboratory, I obtained written consent from the participant, and answered any questions that would not directly influence expectancy of the formatting

types. Once seated at a computer terminal, I explained to the participant that they would be reading three passages presented in different formats and would be required to fill out MCQ item choices on the answer sheet provided. Participants were told to read at their own speed but that timing would be one of the variables that they would be measured on. After completing the experiment, which took between 20-45 minutes depending on the individual's speed of reading and answering questions, they were asked to fill out the demographics and preference questionnaire. The entire study took less than 1 hour.

Full debriefing occurred at the close of the study session, with the aims and hypotheses of the study being explained to them in full. I asked for their opinions regarding the different formatting types as well as the study itself. Participants were given the opportunity to ask any other questions they had.

Ethical Considerations

Ethical clearance was submitted to and approved by the Psychology department of UCT.

Informed Consent. Written informed consent was obtained from every participant after explaining the outline, process and duration of the study, and having answered any questions that the participant had. The form, which can be found in Appendix E, states that participation in the study is voluntary and that the participant could leave the study at any time during the research process.

Participants were informed of symptoms of eyestrain (e.g., headache, blurred vision, dry eyes, neck pain), and were told to discontinue the study immediately should they experience any one of these.

Confidentiality. Participants were informed both in writing (in the consent form) as well as verbally that all data would be coded to keep their data anonymous.

Remuneration. There were 10 non-psychology students who took part in the study for payment, and were paid R 40 for their participation, in line with standard rates for 30-60 minute studies. All of these students were non-psychology majors therefore no conflict of interest occurred where they could choose money over SRPP points and risk not getting their Duly Performed certificate for their courses.

Beneficence and Nonmaleficence. There are no known risks associated with the study. Rather, the only known effects from the formatting types in this study have been beneficial. The duration of computer screen reading lasted for a maximum of 40 minutes, and was not of a duration long enough to sustain eyestrain. Whilst there is not any direct benefit to the participants, this study could have important implications for on-screen reading and learning.

Despite reservations about indirectly advertising the VSTF format, when two participants requested information on how to access the VSTF format, I gave them the website with the caution that there was not yet substantial proof of the efficacy of the program.

Statistical Analysis

All statistical analyses were completed using SPSS version 17.0 (SPSS, Inc., 2010, Chicago, IL) and Microsoft Excel (2010) with the level for statistical significance set at $\alpha = 0.05$.

A series of analyses of variance (ANOVA) were conducted to test for significant differences. This included a mixed designs ANOVA to test for differences within and between the participants in terms of their performance on the MCQs as per order of passage. Simple one-way ANOVAs were conducted on all other analyses. Scores for common formats were collapsed both across passages and within passages to make comparisons feasible.

Reading speeds were obtained, and a words/seconds reading index was calculated by dividing the number of words in the passage by the time taken to read the passage. This was to control for the differences between passage lengths in order to make assessment standardised across the test.

An efficiency index, defined by Warschauer et al. (2011) as comprehension rate (%) divided by the reading time, was calculated as an index of the amount of comprehension per unit of reading time.

Only those eye-tracking data files having a percentage-captured index (as provided by Tobii statistics) over 75 % were analysed further to ensure that objective measures were not confounded due to non-capture rather than being of a reduced amount (e.g., durations of fixations). Backwards regressions were operationalized as those moving upwards over text *previously* viewed (exploratory eye behaviour, for example scanning down the page and returning to the launch area, were not counted).

Return sweeps were included in the backwards regression score as they represent corrective movements rather than misinterpretation movements. Also, due to the fact that VSTF has more lines of text due to its formatting, counting return sweeps could have created a biased representation against the VSTF condition due to its potential to necessitate more return sweeps.

Missing data for regressions for Groups A and B meant that the number of backwards regressions for Passage 1 was not available for analysis. Total eye-fixation duration was calculated through the Tobii statistics option and exported to excel and SPSS.

Results

Comprehension

Order of Format Presentation

Comprehension rates according to formatting (Table 2.) were analysed in terms of descriptive statistics. Group A had the highest mean score, with Group B and E having the lowest overall scores. In terms of format performance across groups, Syn/slash has the highest mean, followed by Block and VSTF.

Table 2. Mean Comprehension Scores in Each Format across Groups (%)

Group	VSTF	Syn/Slash	Block	Total
A	84.85 (11.67)	81.82 (17.41)	72.72 (17.44)	79.79 (6.31)
B	59.72 (16.60)	55.95 (22.34)	63.89 (27.37)	59.85 (3.97)
C	84.99 (16.57)	78.57 (15.91)	62.61 (16.41)	75.39 (11.52)
D	63.09 (23.16)	75.00 (18.11)	75.00 (24.10)	71.03 (6.87)
E	52.22 (28.08)	58.09 (25.59)	66.67 (24.39)	58.99 (7.26)
F	67.53 (35.62)	75.76 (30.15)	75.76 (21.55)	73.02 (4.75)
Total	68.73 (13.50)	70.86 (11.01)	69.44 (5.77)	69.68

To test the hypothesis that comprehension rates will be higher when using VSTF, a 3 x 6 mixed-design ANOVA was conducted to examine if any between-group differences existed for comprehension with formatting and the alternations of format over passages. Results of the ANOVA indicated no significant main effect of the formatting on comprehension, $F(2, 130) = .324, p = .724$, with an extremely small effect size ($\eta^2 = .005$).

However, there was a significant interaction effect between formatting and order on comprehension, $F(10, 130) = .2.709, p = .005, \eta^2 = .172$. This indicates that formatting was affected differently by order of presentation.

Within Passage Analyses

Due to the convoluted interaction noted above, an analysis on a passage-by-passage basis to control for differences that may be occurring in the testing and to see how the formats

perform in these individual instances was conducted. Scores were collapsed together that shared the same formatting condition (e.g., in Passage 1 both Group A and Group B share VSTF formatting). One-way ANOVAs were run on all passage comprehensions scores grouped by formatting. The analysis indicated no significant effect of format on comprehension within Passage 1, $F(2, 57) = 1.12, p = .332, \eta^2 = .038$. Additionally, there was no significant difference in comprehension scores from differently formatted text within Passage 2, $F(2, 57) = .667, p = .517, \eta^2 = .023$. Lastly, there was no significant difference found for the performance of formatting on comprehension rates in Passage 3, $F(2, 57) = .818, p = .446, \eta^2 = .028$.

Looking at the performance of formats only in terms of the order of the MCQ items, scores are all dramatically lower in the third Passage, with Passage 1 and 2 having similar mean scores.

Table 3. Mean Comprehension Scores for Formats in MCQ Tests

	Passage 1	Passage 2	Passage 3
VSTF	74.99 (17.52)	66.66 (31.53)	35.8 (21.04)
Syn/Slash	75.83 (16.64)	76.66 (24.42)	34.85 (22.92)
Block	67.50 (23.24)	72.50 (26.09)	28.15 (17.52)
Average	71.66 (4.58)	71.94 (5.02)	32.93 (4.17)

Preference and Comprehension

In looking at the preference of formatting over the sample, over half the participants chose Block as their preferred format (Figure 1.). Investigation of the effect of preference of formatting on performance in terms of comprehension was conducted using a one-way ANOVA. The independent variable was the preferred formatting (e.g., ‘Block’) and the dependent variable was participants’ scores on the MCQ items according to the format it was presented in. Those preferring the Syn/Slash formatting type had the highest mean scores (M

= 78.42, $SD = 23.72$), followed by Block ($M = 68.69$, $SD = 16.37$), and lastly by VSTF ($M = 63.87$, $SD = 22.81$).

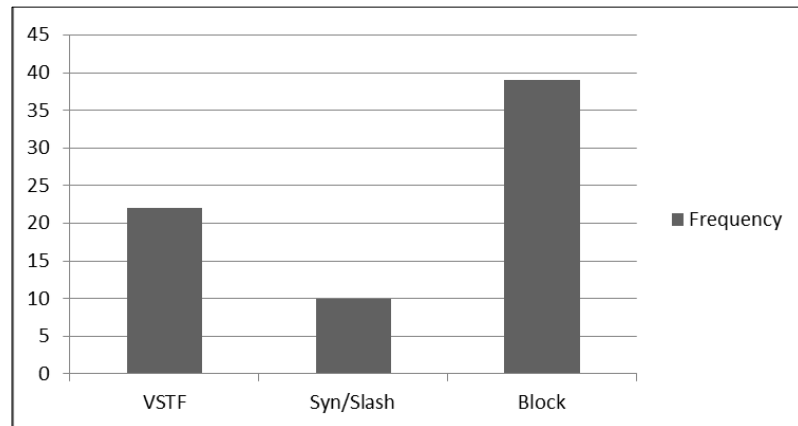


Figure 1. Graph Depicting Preference of Formatting Type

A one-way ANOVA indicated that preference does not create a significant difference for the scores on a VSTF formatted passage, $F(2, 68) = .465$, $p = .570$, $\eta^2 = .0016$. Nor does it have an effect on Block text, $F(2, 68) = .357$, $p = .701$, $\eta^2 = .001$. However, there was a significant difference if preference ran to Syn/Slash, $F(2, 68) = 4.892$, $p = .01$, $\eta^2 = .126$. *Post hoc* analyses indicated if preference ran to the Syn/Slash format, performance on VSTF text was lower.

English First- and Second-Language Speakers

In analysing the performance on MCQ items in terms of first language, English first-language speakers ($M = 72.84$, $SD = 27.96$) had a higher total score average on the MCQ tests than English second-language speakers ($M = 58.39$, $SD = 20.91$). A one-way ANOVA indicated that this was a statistically significant difference, $F(1, 69) = 8.67$, $p = .004$, $\eta^2 = .112$.

Table 4. Performance on MCQ Items by Format

	English	Mean Score (%)	Min	Max
VSTF	First	71.18 (23.26)	16.67	100
	Second	58.28 (30.28)	0.00	100
Syn/Slash	First	75.38 (21.84)	0.00	100
	Second	56.80 (24.09)	16.67	100
Block	First	72.71 (21.21)	33.00	100
	Second	61.45 (23.48)	16.67	100

Inspection of descriptive statistics (Table 4.) indicated that English second-language participants had higher mean scores in the Block condition. To investigate whether formatting could aid comprehension in second-language speakers another one-way ANOVA was conducted to determine the effects of VSTF, Syn/Slash and Block formatting on the MCQ item performance across the test rather than per passage). There was a significant difference in the performance of the two groups with Syn/Slash $F(1, 69) = 10.06, p = .001, \eta^2 = .0127$. There was a tending towards significance in the Block condition, $F(1, 69) = 3.91, p = .052, \eta^2 = .053$; as well as the VSTF condition, $F(1, 69) = 3.79, p = .056, \eta^2 = .0052$.

Reading Speed

Inspection of the reading speed performance of the three passages indicates that Block and Syn/Slash have slightly higher words/second reading speeds than VSTF averaged across passages. A series of one-way ANOVAs were conducted to determine whether reading speed differed within the set passages. Descriptive statistics are indicated in Table 5.

Table 5. *Reading Speed (words/s) Of Formats in Passages*

	Passage 1	Passage 2	Passage 3	Total
VSTF	1.76 (1.46)	1.26 (0.99)	1.32 (1.17)	1.44 (0.27)
Syn/Slash	1.61 (1.48)	1.42 (1.22)	1.35 (1.09)	1.46 (0.13)
Block	1.37 (1.37)	1.44 (1.29)	1.57 (1.23)	1.46 (0.10)
Total	1.58 (0.19)	1.37 (0.09)	1.41 (0.13)	1.45 (0.11)

Three one-way ANOVAs comparing performance on reading speed showed no significant differences between the three formatting conditions in any of the passages. In Passage 1, $F(2, 57) = .377, p = .687, \eta^2 = .013$; Passage 2, $F(2, 57) = .135, p = .874, \eta^2 = .035$; and finally Passage 3, $F(2, 57) = .361, p = .768, \eta^2 = .009$.

Efficiency Index

In looking at the efficiency indexes shows a large difference in the performance of *all* the formatting conditions in Passage 3 as compared to their performance in previous passages. One-way ANOVAs conducted on these efficiency indices indicated no

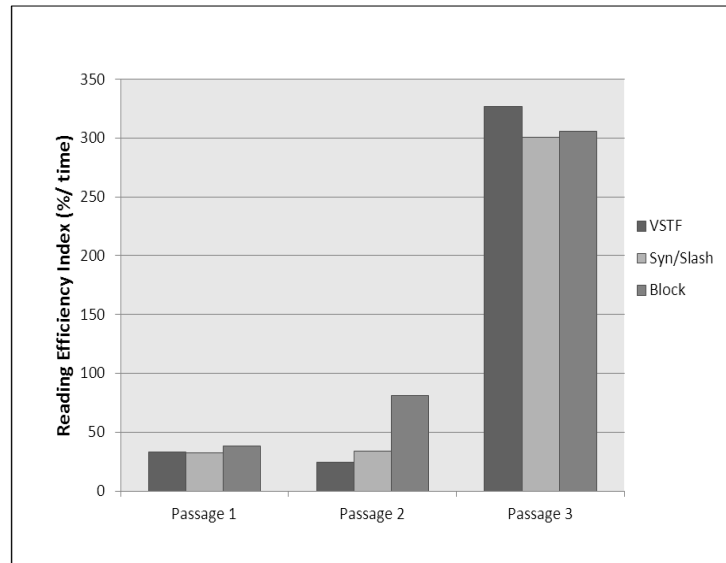


Figure 2. Reading Efficiency Index Across Passages

significant differences between the formatting groups. In Passage 1, $F(2, 57) = .355, p = .703, \eta^2 = .012$; Passage 2, $F(2, 57) = 1.27, p = .287, \eta^2 = .04$; and finally Passage 3, $F(2, 57) = .229, p = .796, \eta^2 = .007$.

Eye-tracking measures

Regressions

Inspection of descriptive statistics for Passage 1 showed that the Syn/Slash condition ($M = 148.2; SD = 68.58$) had more backwards regression than Block ($M = 148.2; SD = 68.58$). However, a one-way ANOVA showed no significant difference between the two formats, $F(1, 18) = .085, p = .775, \eta^2 = .004$.

In the case of Passage 2, the Block format again had the least amount of backwards regressions, ($M = 118.9; SD = 63.55$), followed by Syn/Slash ($M = 120.4; SD = 40.71$) and VSTF ($M = 142.4; SD = 38.39$). Another one-way ANOVA indicated that no significant difference existed between the three formatting groups, $F(2, 27) = .724, p = .494, \eta^2 = .0002$.

Lastly, the number of regressions in Passage three were dramatically lower than those seen in Passage 1 and 2 across all formatting types, with Syn/Slash showing the least ($M =$

22.89; $SD = 14.83$); VSTF having the second most frequent amounts of regressions ($M = 24.37$; $SD = 14.73$) but followed closely by Block ($M = 25.43$; $SD = 12.77$). A third one-way ANOVA concluded that there was no significant difference in the performance of the formats in terms of numbers of backwards regressions in passage 3, $F(2, 57) = .163$, $p = .850$, $\eta^2 = .0001$.

Fixations

In terms of fixation durations, these were lowest in Passage 3. However, in Passage 1 the Syn/Slash condition had much longer fixation periods ($M = 1052.60$, $SD = 221.46$) in comparison to Block ($M = 925.60$, $SD = 134.55$) and finally to VSTF ($M = 860.7$, $SD = 139.83$) which had the lowest fixation durations of the three formatting conditions. A one-way ANOVA showed a tendency towards statistical significance in Passage 1, $F(2, 27) = 3.297$, $p = .052$, $\eta^2 = .196$. Inspections of *post hoc* analyses indicate that the difference could lie between Syn/Slash and VSTF, with VSTF having shorter fixation durations. Despite no other effects being found for a difference between the duration of fixations for any of the formats in Passages 2 and 3, it bears noting that VSTF also had the shortest mean durations of fixations in Passage 3.

Discussion

The aim of this study was to determine if VSTF could facilitate increased learning through lessening extraneous load (visual complexity) and whether the visual-parsing of the syntactic structure could begin to address intrinsic load (de Jong, 2010). The results of this study did not support those of R. Walker et al. (2004) or of the eye-tracking study conducted by Warschauer et al. (2011). Possible reasons for these findings will be outlined, as well as a more in-depth examination of the VSTF method in terms of its linguistic structuring.

Fatigue, Efficiency Index and Attention on Comprehension

One of the chief appeals of the VSTF method is the claim that the format keeps attention 'peaked' due to the distinct form of every sentence or 'paragraph' (R. Walker et al., 2004). Attention in turn leads to optimal learning. In this study however, fatigue set in during Passage 3 leading to decreased comprehension rates across formatting. The main issue is not that there was a universal decline in comprehension rates across formatting, but rather the lack of VSTF maintaining attention as a last condition. If VSTF does indeed have the ability to keep readers' attention peaked then it should have outperformed other formatting in this instance.

Interestingly, some participants indicated that the VSTF method made the passages seem overly long, and this caused their attention to wane. The text is interpreted as being longer because of the greater number of pages. Thus, readers' subjective feelings of reading load is higher despite the reduction of visual complexity on each page. However, in defence of the VSTF method, the consensus across many participants was that test itself was overly lengthy. In the study conducted by R. Walker et al. (2004) they used 3 passages of 500-words, whereas in this study the passages had a mean of 784 words. At university level this does not represent a great deal of reading, taking on average 25-to-35 minutes to complete. This leads to the conclusion that the material may not have been engaging enough or that the test did not manage to tap adequate motivation to perform well.

A benefit of the fatigue experienced by the participants was the illustration of the possible bias in using an efficiency index as outlined by Warschauer et al. (2011). Lower comprehension rates combined with faster 'reading' speeds (when in fact participants were merely scanning through the text and moving on) meant that Passage 3 showed performance

peaking rather than waning. Future testing should keep passage short and control for time-of-day effects to ensure optimal performance.

Format Preference, Familiarity and Attentional Processing

Related to the issue of the perceived lengthiness of VSTF, participants indicated a strong preference for the more familiar block formatting. This was in direct contrast to the findings of R. Walker et al. (2004) who have systematically reported a strong preference for VSTF. Their contention that even those who preferred other formatting methods would have higher comprehension rates in the VSTF passages was not confirmed by this study. One possible explanation that arose from the self-reports of the participants related this to familiarity with block formatting.

University-level students or more proficient readers might already be engrained with their own method of reading, and attempting to adapt to a novel format may prove difficult. Indeed, Koen, Becker, and Young (1969) have noted that: “the paragraph represents a conventional (learned) way of chunking large amounts of information” (p. 49). Reading is traditionally acquired via block formatting, and disruption of this familiarity could lead to decrements in learning. Thus, a standard way in which to process text is already ‘over-learned’ and would relate to how attentional processing is biased in reading. The asymmetric bias in English readers to the left-hand-side and for example in Arabic readers to the right-hand-side, shows that reading is not a standardised process but rather reflects learning of how to weight attentional processes in gaze (Henderson & Ferreira, 1990).

In relation to eye movements in reading, the VSTF method, through reducing visual complexity, also eliminates possible parafoveal processing. Parafoveal processing may act as an implicit ‘previewer’ of information (Henderson & Ferreira, 1990). This loss of information on upcoming words could lead to miscomprehension. By chunking material into much

smaller line spaces, this may in fact hamper reading, as seen through reduced reading speeds and decreased comprehension. Indeed, participants noted that while reading in VSTF they had trouble ‘stringing’ the sentences together to build up semantic meaning. This may reflect differences in WM storage, in that some participants were unable to hold the information “online” while proceeding through the text. Another possible explanation could be due to the experimental delivery of VSTF in this study.

In its original form, VSTF is presented in a window that continues downwards into space indefinitely. In this study however, VSTF text was presented in a slideshow format, only allowing participants to move forward rather than scrolling downwards. This necessitated the display of less text. Therefore, while block formatted pages showed a substantial portion of the passage over 3-4 pages, the VSTF format was split across 17 pages. This could have led to participants not being able to re-read text and build up sufficient comprehension of the information in context, and therefore no significant difference was found on this account. Future testing with the VSTF method should thus strive to retain the intended mode of presentation.

Another criticism of the current study that should be noted is that participants were not given the opportunity to become familiar with the VSTF method in a practice presentation. If block paragraphing already represents an overly ‘learnt form of chunking’ (Koen et al., 1969) then attempting a transition to a new method could perhaps be one reason why VSTF did not outperform block text in this sample. This raises another interesting point however, in that Yu and Miller (2010) argued that navigation of the VSTF method is not simple. Second-language speakers do not necessarily have the deeper, intuitive understanding of English syntax required for this format to be of benefit. Thus, they argued that the need to first adapt to, and learn the rules of VSTF, makes it unsuitable for second-language English speakers.

In the current study second-language English speakers had significantly lower comprehension rates as compared to first-language speakers on the entire test. VSTF did not benefit them any more than either of the other two formats. Further research is needed to ascertain whether VSTF does in fact act as a scaffold for second-language speakers, and whether this might come from using the format over an extended period.

In addition, what might be of interest in future studies of VSTF is whether it might serve children better than adults. The VSTF authors have noted that the method is very useful over time for young children and low proficiency readers. It might be that university-level students, or overly proficient readers, can gain very little from the VSTF method due to an already ingrained attentional bias for block text. Adult readers may already have an established way of reading, which could involve sampling from multiple lines of text and for explorative behaviour over the page that serves to frame their reading with knowledge of the context and upcoming information. On the other hand, it is questionable whether instructing children how to read with VSTF would be beneficial. VSTF could hamper their ability to actively process denser text. Much in the way that children who are not exposed to competing attentional stimuli develop an inability to filter distractors out, learning to read in a visually sparse manner might hamper later reading.

Lastly, many participants drew attention to VSTF's similarity to the format of poetry. For some this meant that their dislike of poetry transferred into a dislike for this format. In line with Kolloffel et al. (2009), this might illustrate that there may be no universal format that works across all readers. Even amongst those who expressed appreciation of poetry noted that whilst this format facilitated reading, but did not necessarily facilitate learning. Block text on the other hand is seen to be a more serious, content-based application of text. Interestingly, a few participants indicated that they felt that their reading became more

rhythmic using VSTF, which relates to another claim made by the VSTF creators - the modelling of fluent prosody (S. Walker et al., 2005).

VSTF Algorithm: Optimal Syntactic Boundaries and Prosody

There are several claims about the VSTF algorithm that deserve reflection. The authors of VSTF suggest that the algorithm parses text that augments natural eye-span fixations, breaking text at optimal syntactic boundaries, which through its presentation allows readers to model fluent prosody.

As noted previously, some participants within this study expressed opinions that run in line with the design principles of VSTF, such as the reporting of less eye-strain and more fluid movement through the text. Others however, commented that the information was made ‘disjointed’ by the format, which could be in turn considered to make the information more ambiguous. Both of these issues are contrary to the claims that VSTF allows for the modelling of fluent prosody and the disambiguating of syntactically complex text (S. Walker et al., 2005). Whilst it is not in the breadth of this paper to give a detailed analysis of these elements, it bears noting that there is evidence for the argument that VSTF does in fact parse sentence according to their syntactic properties. For example, the same paragraph as seen in block text (1), VSTF (2) and Syn/Slash (with notes):

1. *Cognitive psychologists and many contemporary psychodynamic psychologists also take issue with the specific aspects of Freud's theory.*

2. *Cognitive psychologists* (noun phrase)
and many contemporary (adjectival phrase)
psychodynamic psychologists (noun/adjectival phrase)
also take issue (verb phrase)
with the specific aspects (noun phrase)
of Freud's theory (noun phrase)

3. *Cognitive psychologists/ and many contemporary/ psychodynamic psychologists/ also take issue/ with the specific aspects/ of Freud's theory./*

In the above three variations, the parsing is successful in terms of dividing text according to its syntactic components. Whether it mirrors normal prosody however is questionable.

Another problem of the algorithm is that it disregards original formatting, for example, a subheading, will on occasion mesh the title of a paragraph along with the word from the first line. This results in confusion which would necessitate more attentional resources to disambiguate meaning, for example:

*Towards Integration Although
there is*

Here, “Although” represents the first word of the sentence following on from the title “Towards Integration”. As this represented a subtitle, if a person were to parse large amounts of information many such ambiguities would occur. Also, while one of the main objectives is to fit each sentence into a maximum of 2 eye-span fixations, this can lead to text becoming difficult to follow, with punctuation (e.g., ‘-’) that is meant to read as a rapid aside becoming lost in this new formatting:

*These models
allow for
the possibility
that motivational factors -
our needs
and desires -
can influence
how the brain
goes about its business
of attaching
meaning
to the neural activity
that underlies
our dreams.*

These models allow for the possibility that motivational factors - our needs and desires - can influence how the brain goes about its business of attaching meaning to the neural activity that underlies our dreams.

The above example could actually overload working memory (7 ± 2 bits of information) as the lines are not being synthesised into a structural whole, but rather remain as discrete ‘chunks’ of small list-like items. Whereas in the block format if meaning were to be lost, backward eye regressions could place the reader at the point where this occurred; in the VSTF condition this could necessitate several backwards regressions throughout the list, attempting to build up meaning all over again. Research has found that lower proficiency readers engage in longer and more frequent regressions whereas more proficient readers are typically very accurate in returning their gaze to the part of the text where comprehension began to breakdown (Rayner, 1998). This means that those already struggling with reading are those who are likely to encounter difficulties.

Heat Maps as Indicators of Simplified Flow

One issue with the usage of eye-tracking data is the way in which it can be biased in its presentation. Warschauer et al. (2011) use heat maps as illustrations of how eye movement in VSTF is more streamlined and and efficient (Figures 3 & 4). The issue of not including a word count in conjunction with the text means that VSTF typically looks as if eye movement is extremely uncluttered; however, this is more because a fraction of the text is present on the page. Let it be kept in mind that a certain degree of caution is advisable when the researchers

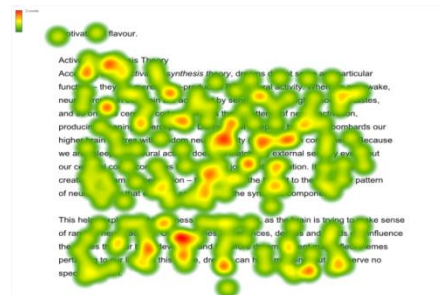


Figure 3. Heat Map of Block Text

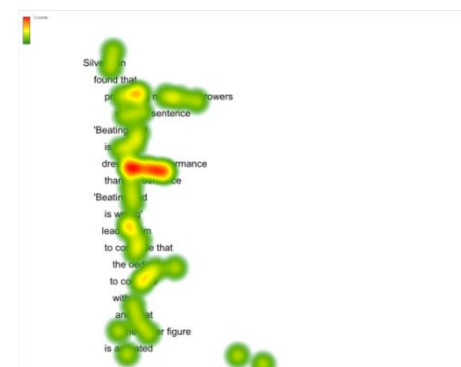


Figure 4. Heat Map of VSTF Text

the researchers have vested interests in official outcomes of studies. Heat maps and gaze data

from the current study were viewed as descriptive rather than objective data. (Appendix F: F1-F6).

Syn/Slash as a mediating condition

In contrast to the ‘random truncation’ level of Warschauer et al. (2011), Syn/Slash directly utilises the syntactical structures of VSTF. Interestingly there were instances where this was predictive of good performance. However, on the other hand, some participants indicated that they found the slashes (/) distracting, and this could have led to increases in visual complexity with concurrent increases in cognitive load. In the same way as VSTF lines are created to fit within two eye-fixations at most, one participant reported that they read the chunks of words as a ‘single’ word, making it seem as if they read faster. Another comment by a participant noted: “this format is confusing and needs one to pay a lot more attention. I felt I took in more information because of the peculiar format.” This links to the idea outlined by Schnotz and Kürschner (2007) that argues that creating a balance between engaging and managing learners’ cognitive resources leads to optimal learning.

Limitations of the Study and Future Research

One of the major limitations of this study is in its use of MCQ items as a test of comprehension that may not have been ideal for gauging actual comprehension abilities of participants. A more thorough test of comprehension that assesses participants understanding in their own words would be of benefit in illustrating exactly what information is taken in during reading in different formats.

Another important aspect that relates to this study and others in the field is that research cannot be conducted on the assumption that being a first- or second-language speaker is automatically indicative of competence. The need to differentiate on competence rather than language status is vital in determining what interventions are the most useful for

lower proficiency readers. It could be interesting to see whether the VSTF method is at all effective for people with reading disorders such as dyslexia.

In terms of eye-movement variables, due to the subjective counting of backwards regressions there is a high likelihood of error. A more objective measurement of the regressions is necessary. In addition, because the nature of regressive movements appears to differ amongst readers, a closer analysis of these in terms of distance travelled could be useful in determining if and how cumulative comprehension occurs. Additionally, information on length of saccades would also be of valuable use in determining the difficulty or ease of reading, as saccades become shorter in more complex text.

In conclusion, the question of whether the use of block text as a learning format has become so ingrained as to make transference to other (possibly better) modes of presentation impossible still remains to be answered. However, while this answer is still forthcoming, the exploration of alternative presentations of textual materials is vital. With the increasing digitalisation of learning materials, and indeed the very classroom itself, the attraction of computer programming in attempting to solve learning difficulties will continue to be a fruitful avenue of research. However, the danger in using materials that have not been externally validated should be emphasised. In the case of the current study, the question of whether an algorithm is able to accurately, each and every time, parse something as nebulous as language remains to be seen.

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- Warschauer, M., Park, Y., & Walker, R. (2011). Transforming digital reading with visual-syntactic text formatting. *The Jaltcall Journal*, 7, 255-270.

Appendix A: Illustration of VSTF and Jenga

**When in the Course
of human events,
it becomes necessary
for one people
to dissolve the political bands
which have
connected them with another,
and to assume
among the powers
of the earth,
the separate and equal station
to which
the Laws of Nature
and of Nature's God
entitle them,
a decent respect
to the opinions
of mankind
requires
that they
should declare the causes
which impel them
to the separation.**

Figure A1. *The First Sentence of the Declaration of Independence Presented with the VSTF Method*

**When in the Course of human events, it
becomes necessary for one people to dissolve
the political bands which have connected them
with another, and to assume among the
powers of the earth, the separate and equal
station to which the Laws of Nature and of
Nature's God entitle them, a decent respect
to the opinions of mankind requires that they
should declare the causes which impel them
to the separation.**

Figure A2. *The First Sentence of the Declaration of Independence Presented with Block Text Formatting*

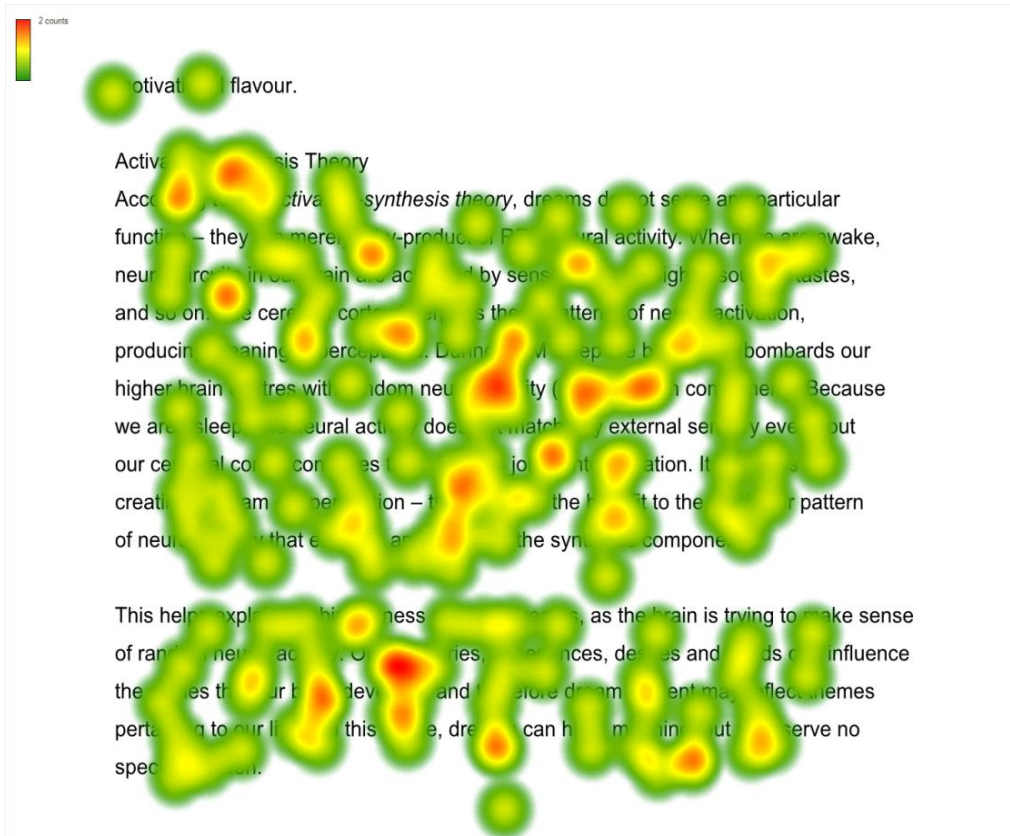


Figure A3: Heat Map Illustrating Eye-Movements in Block Text

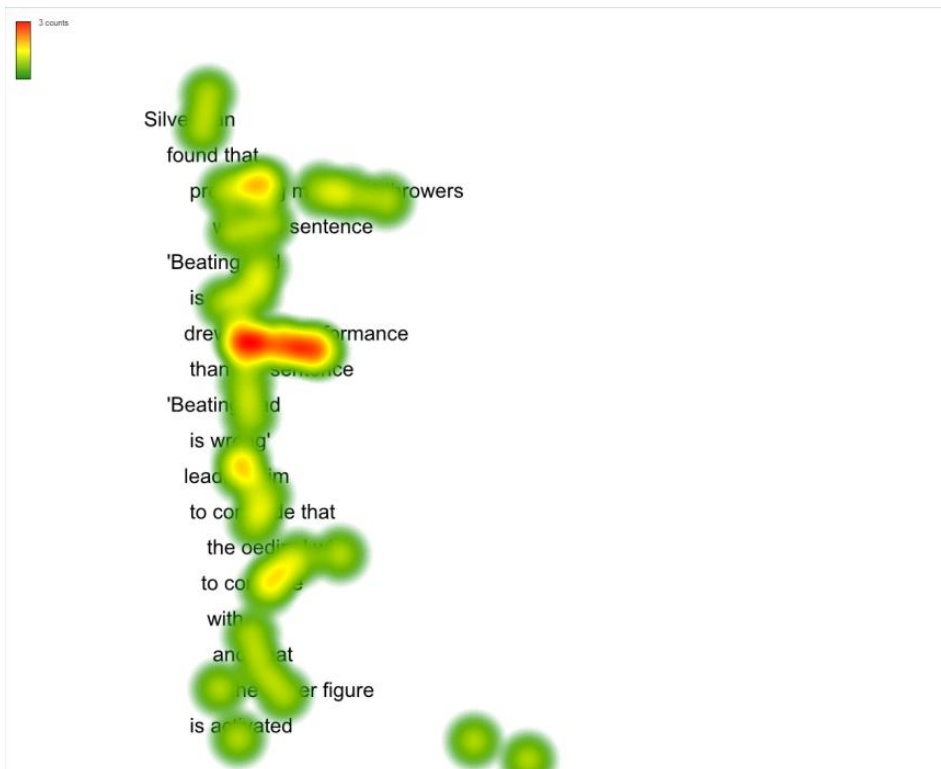


Figure A4: Heat Map Illustrating Eye-Movements in VSTF

Cloud computing--the idea of relying on Web-based applications and storing data in the "cloud" of the Internet--has long been touted as a way to do business on the road. Now software companies are making entire Web-based operating systems. Built to work like a whole computer in the cloud and aimed at a wider audience, these browser-based services could help those who can't afford their own computer.

Having the look and feel of Microsoft Windows or other popular desktop programs, the Web-based operating systems bring together a selection of integrated Web-based applications that typically run with Flash or Java. Users can choose to save data locally or on the Internet. Joshua Rand, the CEO of Sapotek, which makes [Desktop Two](#), says that a major goal of an online desktop is to get the collection of applications working together: "It's not a Tower of Babel desktop. It's entirely fluent." Desktop Two uses a number of open-source applications, including Open Office as its productivity suite.

Once a useful group of applications are collected in a familiar format, cloud computing becomes more accessible to people who aren't comfortable tracking down a series of individual Web applications and combining them, Rand says. Desktop Two's service is free for individuals, although a small scroll bar of ads appears at the top of the screen. The company launched its Spanish-language version, [Computadora.de](#), in Mexico in 2003, three years before launching in the United States. Rand says that he and his business partner, Oscar Mondragon, who lives in Mexico, had observed while traveling that in spite of socioeconomic differences that determine whether individuals own computers and how much bandwidth they have, people were using the Internet everywhere, including in Internet cafes and libraries. With

Figure A5. Text Presented in Standard Block Format

Cloud computing--the idea of relying on Web-based applications and storing data in the "cloud" of the Internet--has long been touted as a way to do business on the road. Now software companies are making entire Web-based operating systems. Built to work like a whole computer in the cloud and aimed at a wider audience, these browser-based services could help those who can't afford their own computer.

Having the look and feel of Microsoft Windows or other popular desktop programs, the Web-based operating systems bring together a selection of integrated Web-based applications that typically run with Flash or Java.

Users can choose to save data locally or on the Internet.

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Figure A6. Text Presented In Jenga Format in Yu and Miller's (2010) Study

Appendix B: Design Conditions: Block, VSTF, and Syn/Slash

These models/ allow for/ the possibility/ that
 motivational factors -/ our needs/ and desires -/ can
 influence/ how the brain/ goes about its business/ of
 attaching/ meaning/ to the neural activity/ that
 underlies/ our dreams./

Figure B1: *Syn/Slash Text*

These models allow for the possibility that motivational
 factors - our needs and desires - can influence how the brain
 goes about its business of attaching meaning to the neural
 activity that underlies our dreams.

Figure B2: *Block Text*

These models
 allow for
 the possibility
 that motivational factors -
 our needs
 and desires -
 can influence
 how the brain
 goes about its business
 of attaching
 meaning
 to the neural activity
 that underlies
 our dreams.

Figure B3: *VSTF Text*

Appendix C: Multiple Choice Items

Note: Those marked with ‘*’ indicate items that were deleted from the final analysis

Passage 1 MCQs

1. **According to Freud, what are the three levels of awareness? ***
 - a. Preconscious; conscious; subconscious
 - b. Preconscious; conscious; postconscious
 - c. Preconscious; conscious; unconscious
 - d. Preconscious; subconscious; postconscious

2. **How can preconscious awareness be defined?**
 - a. Outside current awareness, easily recalled
 - b. Outside current awareness, recalled with difficulty
 - c. Within current awareness, easily accessible
 - d. The state immediately before wakefulness

3. **What three types of unconscious content were listed in the passage?**
 - a. Urges; traumatic memories; emotional conflicts
 - b. Dreams; fantasies; hallucinations
 - c. Urges; dreams; traumatic memories
 - d. Hallucinations; urges; emotional conflicts

4. **According to Freudian theory, repression acts as a buffer against: ***
 - a. Hunger; thirst; pain
 - b. Loss of control; inhibition; pleasure
 - c. Sexual impulses; sorrow; blunders
 - d. Anxiety; guilt; other negative emotions

5. **According to some theorists, such as Grünbaum (1986), Freud’s theories and views:**
 - a. Are open to empirical or scientific testing
 - b. Are always disproved and outdated
 - c. Are outdated and cannot be reconciled with current knowledge
 - d. Are still currently useful and often proved right

6. **What does Silverman’s SPA theory stand for?***
 - a. Subconscious Psychodynamic Activation
 - b. Subliminal Psychodynamic Activation
 - c. Supraliminal Psychodynamic Activation
 - d. Supportive Psychodynamic Activation

7. **Under what circumstances does automatic processing occur?**
 - a. Routine actions; new tasks; unfamiliar circumstances
 - b. Non-routine actions; new tasks; in unfamiliar circumstances
 - c. Routine actions; well-learned tasks; in familiar circumstances
 - d. Dangerous scenarios; unfamiliar circumstances

- 8. Learning a new skill such as typing on a computer involves:**
- Controlled processing, which becomes more automatic with time
 - Automatic processing, which becomes more controlled with time
 - A interplay of controlled and automatic processing
 - Neither type of processing, it is a talent not a skill
- 9. What is the key disadvantage of automatic processing?**
- It increases the time taken to make decisions
 - It reduces the chances of finding creative solutions to problems
 - It is too flexible and open to environmental changes
 - It is slower than controlled processing
- 10. Silverman's SPA research concluded that:***
- Activating conscious desires can modify behaviour/performance
 - Activating subconscious desires can modify behaviour/performance
 - Deactivating subconscious desires can modify behaviour
 - Subliminal messaging can reprogram people's wishes

Passage 2 MCQs

- 1. What are circadian rhythms?***
- Steady rhythmic states occurring in cycles of 24 hours
 - Steady rhythmic states occurring in cycles of 12 hours
 - Unsteady rhythmic states occurring every hour
 - Fluctuating states of consciousness
- 2. How much of our life do we spend sleeping?**
- 24%
 - 33%
 - 40%
 - 46%
- 3. Which theory posits that we sleep to recuperate from physical and mental fatigue? ***
- Circadian sleep model
 - Memory consolidation
 - Restoration model
 - Activation-synthesis model
- 4. According to the study of ultramarathon runners, after their race they slept: ***
- More than usual, with more time spent in slow wave sleep
 - More than usual, with more time spent in high wave sleep
 - The same amount as usual, with more time spent in slow wave sleep
 - The same amount as usual, with more time spent in high wave sleep
- 5. Which hormone has been used to support the sleep restoration model? ***
- Adrenalin
 - Adrenocortico
 - Adenosine
 - Cortisol

- 6. The hormone adenosine acts on the body in the following way:**
- Activating brain circuits responsible for keeping us awake, thereby signalling the body to slow down
 - Activating brain circuits responsible for keeping us awake, thereby signalling the body to speed up
 - Inhibiting brain circuits responsible for keeping us awake, thereby signalling the body to slow down
 - Inhibiting brain circuits responsible for making us sleep, thereby signalling the body up to speed up
- 7. According to which model would the argument of species-specific sleeping patterns apply?**
- Biocircadian
 - Restoration
 - Evolutionary
 - Adenosinic
- 8. Evolutionary theories of sleep argue that:**
- Sleep's main purpose is to increase a species' chances of survival in relation to its environmental demands
 - For humans, hunting, food gathering and travelling were accomplished more easily and safely during daylight
 - Each species developed a circadian sleep-wake pattern that was adaptive in terms of its status as predator or prey
 - All of the above
- 9. According to an evolutionary sleep model, *small* prey animals differ from *large* prey animals in that they:**
- Spend more time asleep
 - Spend less time asleep
 - Do not differ; both sleep less than predators
 - Do not differ; both sleep more than predators
- 10. Experiments exploring the effects of REM-sleep deprivation suggest that:**
- The consequences of REM disruption are not terribly significant on memory performance in normal participants
 - The consequences of REM disruption are very significant on memory performance in normal participants
 - The consequences of REM disruption are very significant on memory performance in brain-damaged participants
 - None of the above

Passage 3 MCQs

- 1. Freud believed that the main purpose of dreaming is:**
- Wish fulfilment
 - The gratification of unconscious desires and needs
 - Exploration of socially unacceptable feelings
 - All of the above

2. **According to Freud, a dream's surface story is the ____ content, and the disguised psychological meaning is the ____ content: ***
 - a. Manifest; Lucid
 - b. Material; Analytical
 - c. Manifest; Latent
 - d. Latent; Manifest

3. **What is one of the major criticisms of Freud's dream theory?**
 - a. There is no way to empirically test dream content; people cannot accurately record dreams
 - b. Dream analysis is too subjective and interpretation can occur in numerous ways
 - c. Most dreams do not involve sexual or aggressive themes therefore psychoanalysis is inappropriate
 - d. People often lie in their dream reports for fear of being judged

4. **How does the example of Claparède's pin-prick test on an amnesiac patient support Freudian claims? ***
 - a. Memories for events of which we are conscious motivate behaviour more than unconscious events
 - b. Memories for events of which we are unconscious can still have emotional and motivational impacts on behaviour
 - c. Memories for events cannot operate without conscious awareness
 - d. Memories are lost in amnesiac patients and no new learning occurs

5. **The activation-synthesis theory suggests that dreams:**
 - a. Are the brain's attempts to make sense of random neural activity
 - b. Are a by-product of REM neural activity
 - c. Are functionless
 - d. All of the above

6. **According to the activation-synthesis theory the activation and synthesis components originate from which brain regions?**
 - a. Brain stem; cerebral cortex
 - b. REM-regions; cerebral cortex
 - c. Brain stem; REM-regions
 - d. REM-regions; cerebral cortex

7. **What fact best supports the activation-synthesis theory?**
 - a. The existence of personal information contained in dreams
 - b. That dreams have meaning and serve particular functions
 - c. That dreams are bizarre in nature and thus reflect random neural activity
 - d. Other theories of dreaming are not as convincing as this theory

8. **What does the problem-solving theory of dreaming argue? ***
 - a. We sleep more when we have problems in our lives
 - b. Because they are not constrained by reality, dreams allow creative problem solving
 - c. All dreams have problem-solving content
 - d. Only scientists and inventors have useful problem-solving dreams

9. What is the major criticism of the problem-solving theory of dreaming?

- a. Dreams give less effective solutions to problems than conscious problem solving
- b. Many of our dreams focus on small personal issues, not big problems
- c. Self-help books have influenced this idea and used it to 'sell' great inventors
- d. We problem solve while awake by thinking about our dream, not whilst we dream

10. What have integrated models of dreaming proposed as a solution to the question of why we dream?

- a. That researchers need to see how people in all cultures dream in order to create a socially integrated theory of dreaming
- b. That motivational factors influence the way in which the brain attaches meaning to the neural output which creates our dreams
- c. That unconscious material needs to be explored in order to understand where the desires in our dreams originate
- d. That our physical environment interacts with our dream, thus creating an integration between the real-world and the dream-world

Appendix D: Demographics and Preference Questionnaire

Demographics and Preference Form

Participant Number: _____

Date: _____

Demographic Information

Please fill out the form below, indicating with a tick/circling where applicable

Age: _____

Gender: Male Female

Population Group:

White Black Coloured Indian Asian

Other (please specify) _____

Nationality: _____

First Language: _____

Number of years of formal (tertiary) education: _____

Please indicate whether you are a:

- a. Psychology major
- b. Social Work degree
- c. Other (specify) _____

*** In the next few pages you will be asked to rate the content and
then the formatting of the passages you read**

Passage Questions:

**Please rate the following items by indicating with a cross on the scale:*

For example:

Q. How difficult did you find the content of the passage?

Not at all difficult

Very difficult

1	2	3	4	5

Passage 1: Levels of Consciousness

1. How difficult did you find the content of the passage?

Not at all difficult

Very difficult

1	2	3	4	5

2. How broad did you find the content of the passage? For example were there many ideas and theories discussed?

Not at all broad

Very broad

1	2	3	4	5

3. How interesting did you find the subject matter of the passage?

Not at all interesting

Very Interesting

1	2	3	4	5

4. How novel or different did you find the subject matter of the passage?

Not at all novel/new

Very novel/new

1	2	3	4	5

5. How difficult did you find the multiple choice/comprehension questions for the passage?

Not at all difficult

Very difficult

1	2	3	4	5

6. Any general comments?

Passage 2: Sleep theories

1. How difficult did you find the content of the passage?

<i>Not at all difficult</i>					<i>Very difficult</i>	
1	2	3	4	5		

2. How broad did you find the content of the passage? For example were there many ideas and theories discussed?

<i>Not at all broad</i>					<i>Very broad</i>	
1	2	3	4	5		

3. How interesting did you find the subject matter of the passage?

<i>Not at all interesting</i>					<i>Very Interesting</i>	
1	2	3	4	5		

4. How novel or different did you find the subject matter of the passage?

<i>Not at all novel/new</i>					<i>Very novel/new</i>	
1	2	3	4	5		

5. How difficult did you find the multiple choice/comprehension questions for the passage?

<i>Not at all difficult</i>					<i>Very difficult</i>	
1	2	3	4	5		

6. Any other comments on this passage?

.....

.....

.....

.....

Passage 3: Dream theories

1. How difficult did you find the content of the passage?

	<i>Not at all difficult</i>			<i>Very difficult</i>
1	2	3	4	5

2. How broad did you find the content of the passage? For example were there many ideas and theories discussed?

	<i>Not at all broad</i>			<i>Very broad</i>
1	2	3	4	5

3. How interesting did you find the subject matter of the passage?

	<i>Not at all interesting</i>			<i>Very Interesting</i>
1	2	3	4	5

4. How novel or different did you find the subject matter of the passage?

	<i>Not at all novel/new</i>			<i>Very novel/new</i>
1	2	3	4	5

5. How difficult did you find the multiple choice/comprehension questions for the passage?

	<i>Not at all difficult</i>			<i>Very difficult</i>
1	2	3	4	5

6. Any general comments?

Format Questions

Format 1: Block Text

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

Eg:

1. How easily did you adapt to reading in this format?

<i>Not at all easily</i>	<i>Very easily</i>			
1	2	3	4	5

2. Did you find yourself having to re-read sentences using this format?

<i>Very often</i>	<i>Very rarely</i>			
1	2	3	4	5

3. Was it easy to concentrate on the text content using this format?

<i>Not at all easy</i>	<i>Very easy</i>			
1	2	3	4	5

4. Was your flow from sentence to sentence smooth in this format?

<i>Not at all smooth</i>	<i>Very smooth</i>			
1	2	3	4	5

5. Was the information made clearer by this format?

<i>Not at all clear</i>	<i>Very clear</i>			
1	2	3	4	5

6. How novel/different did you find this format?

<i>Not at all novel/different</i>	<i>Very novel/different</i>			
1	2	3	4	5

7. Would you choose to use this format again?

<i>Never</i>	<i>All the time</i>			
1	2	3	4	5

8. Any general comments?

Format 2: Syn/Slash

When in the Course / of human events,/ it become necessary / for one people / to dissolve the political bands / which have connected them with another,/ and to assume / among the powers of the earth,/ the separate and equal station/ to which/ the Laws of Nature / and of Nature's God / entitle them,/ a decent respect / to the opinions of mankind / requires / that they

Eg:

1. How easily did you adapt to reading in this format?

<i>Not at all easily</i>					<i>Very easily</i>	
1	2	3	4	5		

2. Did you find yourself having to re-read sentences using this format?

<i>Very often</i>					<i>Very rarely</i>	
1	2	3	4	5		

3. Was it easy to concentrate on the text content using this format?

<i>Not at all easy</i>					<i>Very easy</i>	
1	2	3	4	5		

4. Was your flow from sentence to sentence smooth in this format?

<i>Not at all smooth</i>					<i>Very smooth</i>	
1	2	3	4	5		

5. Was the information made clearer by this format?

<i>Not at all clear</i>					<i>Very clear</i>	
1	2	3	4	5		

6. How novel/different did you find this format?

<i>Not at all novel/different</i>					<i>Very novel/different</i>	
1	2	3	4	5		

7. Would you choose to use this format again?

<i>Never</i>					<i>All the time</i>	
1	2	3	4	5		

8. Any general comments?

Format 3: VSTF

When in the Course
of human events,
it becomes necessary
for one people
to dissolve the political bands
which have
connected them with another,
and to assume
among the powers
of the earth,
the separate and equal station
to which
the Laws of Nature
and of Nature's God
entitle them,
a decent respect
to the opinions
of mankind
requires
that they
should declare the causes
which impel them
to the separation.

Eg:

1. How easily did you adapt to reading in this format?

Not at all easily *Very easily*

1	2	3	4	5

2. Did you find yourself having to re-read sentences using this format?

Very often *Very rarely*

1	2	3	4	5

3. Was it easy to concentrate on the text content using this format?

Not at all easy *Very easy*

1	2	3	4	5

4. Was your flow from sentence to sentence smooth in this format?

Not at all smooth *Very smooth*

1	2	3	4	5

5. Was the information made clearer by this format?

Not at all clear *Very clear*

1	2	3	4	5

6. How novel/different did you find this format?

Not at all novel/different *Very novel/different*

1	2	3	4	5

7. Would you choose to use this format again?

Never *All the time*

1	2	3	4	5

8. Any general comments?

Please rate the formats above in your order of preference by indicating with the numbers 1, 2 and 3

(1 = favourite and 3 = least favourite)

BLOCK

When in the Course of human events, it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

SYN/SLASH

When in the Course / of human events,/ it become necessary / for one people / to dissolve the political bands / which have connected them with another,/ and to assume / among the powers of the earth,/ the separate and equal station/ to which/ the Laws of Nature / and of Nature's God / entitle them,/ a decent respect / to the opinions of mankind / requires / that they

VSTF

When in the Course
of human events,
it becomes necessary
for one people
to dissolve the political bands
which have
connected them with another,
and to assume
among the powers
of the earth,
the separate and equal station
to which
the Laws of Nature
and of Nature's God
entitle them,
a decent respect
to the opinions
of mankind
requires
that they
should declare the causes
which impel them
to the separation.

Appendix D: Multiple-Choice Answer Sheet**Participant number:** _____

Passage 1

Example:

1. _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____
 7. _____
 8. _____
 9. _____
 10. _____
-

1. A **Passage 2**

1. _____
 2. _____
 3. _____
 4. _____
 5. _____
 6. _____
 7. _____
 8. _____
 9. _____
 10. _____
-

Passage 3

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Appendix E: Informed Consent Form

Consent Form

Informed Consent to Participate in Research

This form provides you with information about the study and seeks your authorization for the collection and use of data. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. By participating in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

1. Name of Participant ("Participant")

2. Title of Research Study

Lessening Cognitive Load in Learning Materials Using Formatting Informed by Reading Research

3. Principal Investigators, Supervisor, and Telephone Numbers

Prof. Colin Tredoux
Department of Psychology
University of Cape Town
021-650-4608

Stacey Jane Hall
Honours Student
Department of Psychology
University of Cape Town
071-875-9369

4. What is the purpose of this research study?

This study is designed to explore the effects of three special format types on reading and comprehension abilities.

5. What will be done if you take part in this research study?

This study requires you to take part in one research session. During this study, you will be required to read three passages and answer multiple choice items or comprehension questions relating to those passages whilst having reading examined by the eye-tracker.

6. What are the possible discomforts and risks?

Reading on computers for prolonged durations of time can lead to eyestrain. This study will take approximately 45-60 minutes, which is not associated with eye-strain. If, however, you experience any symptoms of eyestrain during the study (headache, blurred vision, dry eyes, neck pain) then you must stop immediately and you will not be asked to complete the study.

7. What are the possible benefits of this study?

It is hoped that this research will provide information on optimal formatting for reading, learning and comprehension, which could potentially be used to create interventions to aid in these areas.

8. Can you withdraw from this research study and if you withdraw, can information about you still be used and/or collected?

You may withdraw your consent and stop participation in this study at any time. Information already collected may be used.

9. Once the data has been collected, how will it be kept confidential in order to protect your privacy?

Information collected will be stored in locked filing cabinets or in computers with security passwords. Only certain people - the researchers for this study and certain University of Cape Town officials - have the legal right to review these research records.

10. Signatures

Researcher

As a representative of this study, I have explained to the participant the purpose, the procedures, the possible benefits, and the risks of this research study.

Signature of Person Obtaining Consent and Authorization

Date

Participant

You have been informed about this study's purpose, procedures, and risks. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

Signature of Person Consenting and Authorizing

Date

Appendix F: Eye-Tracking Images

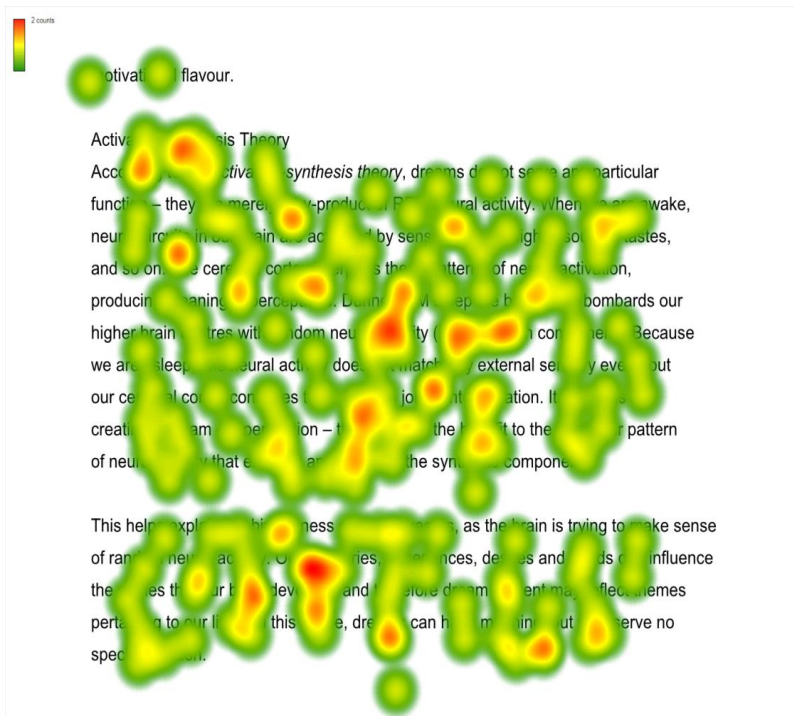


Figure F1. Participant 41 Heat Map Passage 3 Block Format

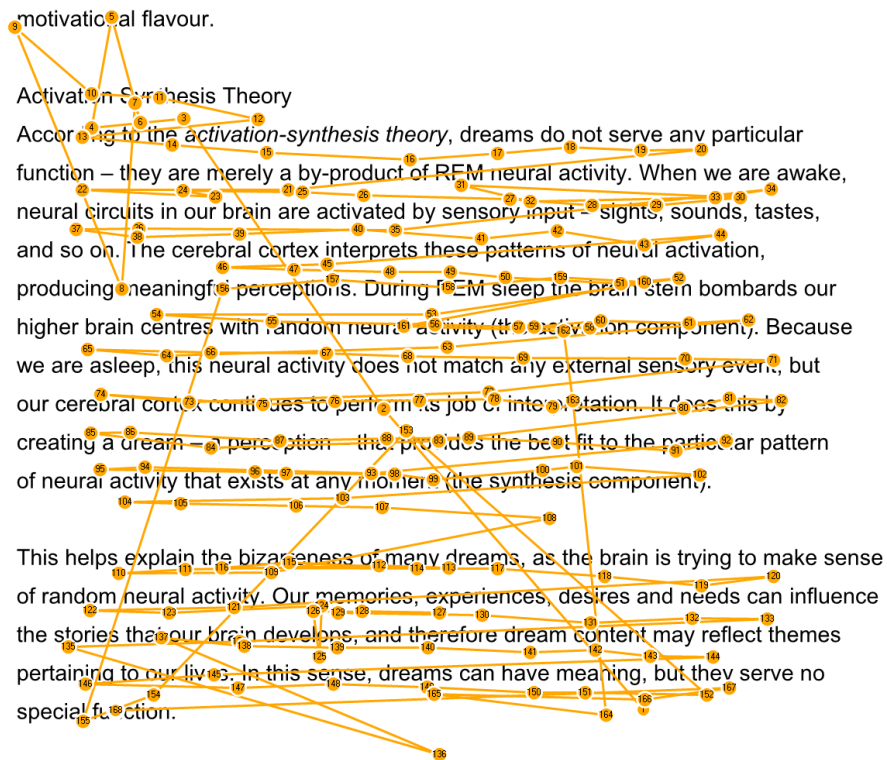


Figure F2. Participant 41 Gaze Map Passage 3 Block Format

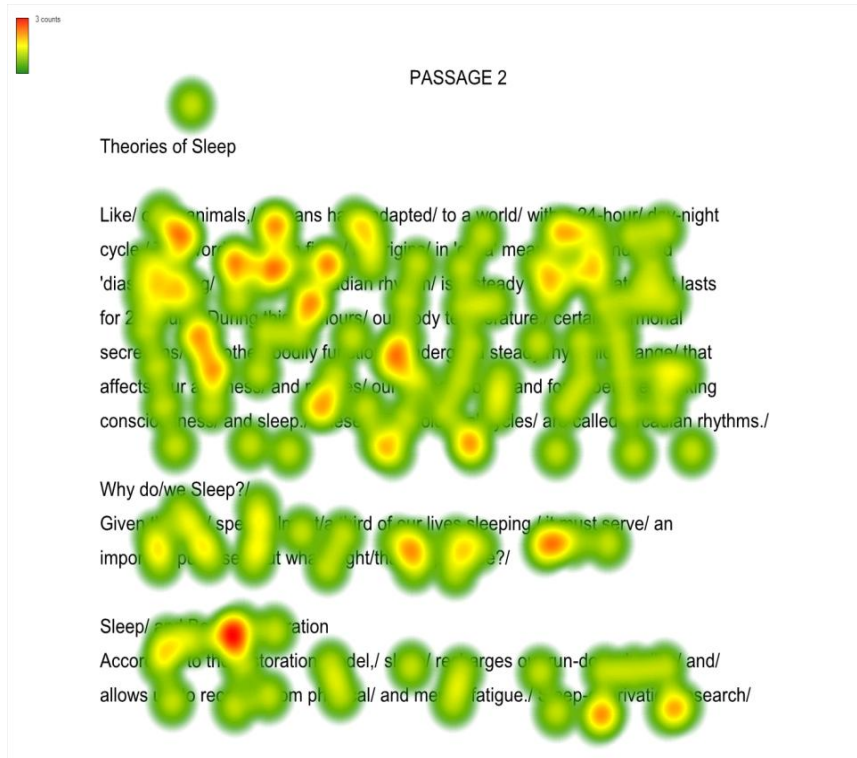


Figure F3. Participant 41 Heat Map Passage 2 Syn/Slash Format

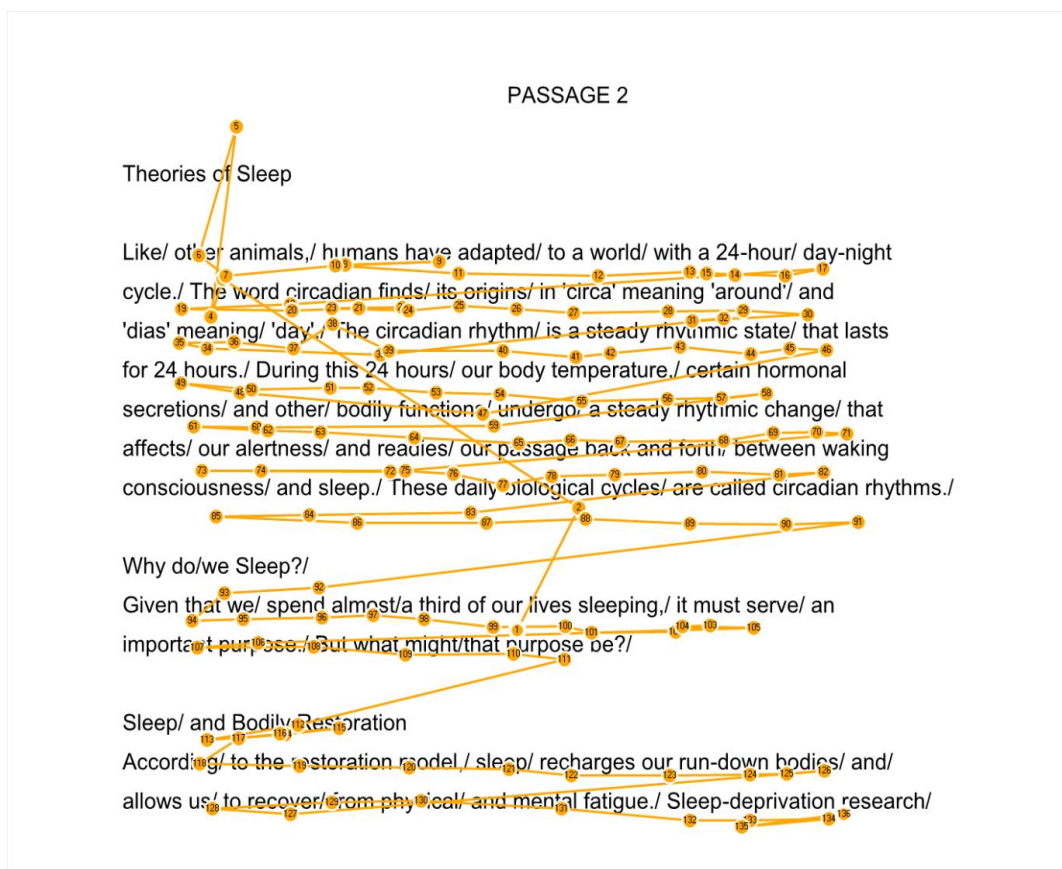


Figure F4. Participant 41 Gaze Map Passage 2 Syn/Slash Format

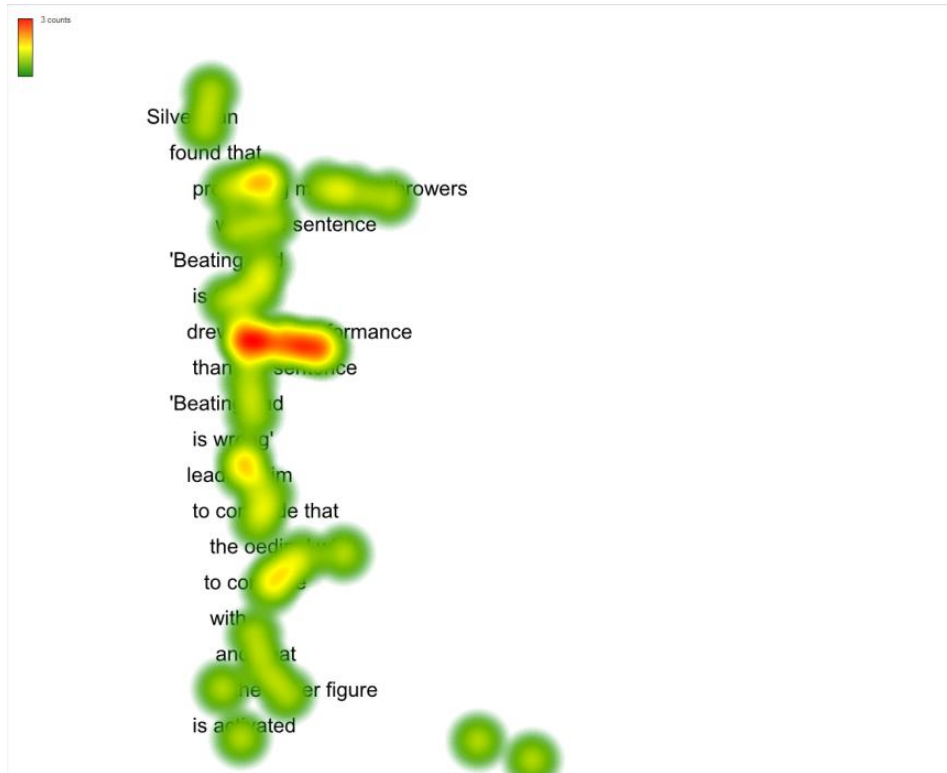


Figure F5. Participant 41 Heat Map Passage 1 VSTF Format

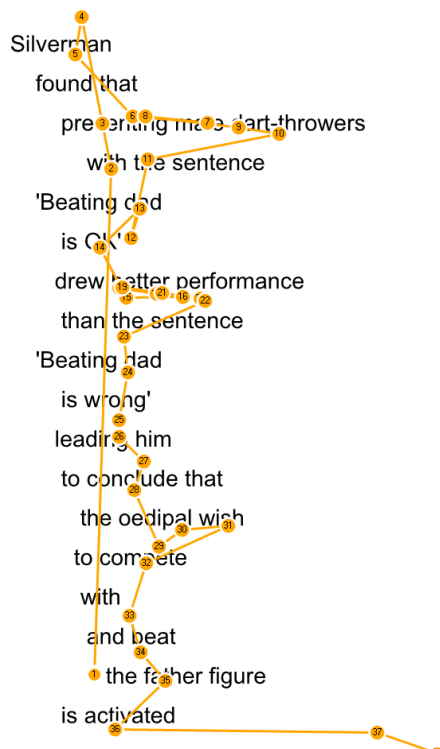


Figure F6. Participant 41 Gaze Map Passage 1 VSTF Format