THE EFFECTS OF READING ACCELERATION ON READING COMPREHENSION

AND DECODING ACCURACY IN HIGH SCHOOL STUDENTS WITH READING

DISORDERS

by

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Reading disorders have been hypothesized to result from an asynchrony

between speed of processing characteristics of auditory and visual systems involved in

decoding. It is hypothesized that reading at faster rates can in the reduction of the

detrimental effects of this asynchrony. Previous research has revealed that both

decoding accuracy and reading comprehension accuracy have improved when

individuals are forced to read short passages 10-12% faster than they normally read.

However, no investigation to date has systematically examined the influence on reading

comprehension and decoding accuracy of proportionally rates d these levels.

Furthermore, no study to date has investigated whether the effects of this reading

approach continue to be beneficial as passage length increases. For the current

investigation, two experiments were designed to investigate the effects of increased

reading rates and text lengths on the oral decoding and reading comprehension

accuracy of reading disordered individuals.

The first study examined the effects of systematically increasing the amount of

reading acceleration on oral decoding and comprehension accuracy. Twenty high

school students with normal reading abilities and 16 high school students with a diagnosis of a reading disorder completed a series of four oral reading comprehension tasks. The passages were all presented on a computer and the rate of presentation was controlled. Baseline reading rates (words per second) were obtained for each participant. Each participant completed an oral reading task at their baseline rate and with increases of 10, 20, and 30%. Decoding and comprehension accuracy proportions were obtained. Results revealed that decoding accuracy improved above baseline levels when reading 10% faster than the baseline rate. Decoding accuracy did not improve when reading with a 20% or 30% increase in reading rate.

The comprehension accuracy proportions obtained by both groups (control and reading disordered) improved when reading with a 10% or 20% increase in reading rate. Thus, the results of Experiment I indicate that high school students may be capable of reading proficiently at rates higher than previously thought.

In Experiment II, the effects of text length on decoding and comprehension in an oral reading task were investigated. Experiment II included the same participants as Experiment I. Each participant completed four experimental tasks that represented a combination of the two independent variables: passage length (short or long) and acceleration condition (accelerated or unaccelerated). In regards to decoding, it was found that decoding accuracy did not differ between short and long passages during the unaccelerated condition whereas decoding significantly improved when reading longer passages. These results were interpreted as providing evidence for the possible increased efficiency of working memory during accelerated reading tasks by increasing the amount of resources available for the utilization of top down contextual cues.

Results from Experiment II also revealed significant interactions within the reading disordered group relative to comprehension. Specifically, participants with the best reading performance in the 10% increase condition in Experiment I tended to obtain higher comprehension accuracy proportions when reading shorter texts and those who read best at 20 or 30% in Experiment I tended to obtain higher comprehension accuracy proportions when reading longer texts. These results were interpreted as providing evidence for improved utilization of top down contextual cues in accelerated reading tasks. No main effect of group was found. It also was observed that individuals with reading disorders recalled more information when longer passages were presented when the reading rate was accelerated. Furthermore, the individuals with a diagnosis of reading disorder who are more likely to benefit from reading acceleration tend to be those who exhibit the most severe reading profiles. This result suggests that reading acceleration may improve focused attention. In general, the control group was found to exhibit significantly higher comprehension proportions when reading accelerated as well as when reading longer texts. These latter results demonstrate evidence for the beneficial aspects of reading acceleration in oral reading tasks. Overall, results from this investigation exemplify the variable effects of reading acceleration with implication of how this phenomenon may be best utilized clinically. Individuals responded with a wide range of variability as presentation rate and text length varied. However, the results support previous findings indicating that reading acceleration benefits both proficient and deficient readers. Thus, this investigation establishes some parameters that should be considered when determining the best course of treatment for utilizing reading acceleration.

The Effects of Reading Acceleration on the Reading Comprehension and Decoding

Accuracy in High School Students with Reading Disorders

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LIST OF ABBREVIATIONS

AAF   Altered auditory feedback

AM   Amplitude Modulation

ANOVA   Analysis of variance

dB   Decibel

DDH   Double Deficit Hypothesis for the Dyslexias

ERP   Event Related Potential

FAF   Frequency altered feedback

FM   Frequency Modulation

fMRI   Functional magnetic resonance imaging

GORT-IV   *Gray Oral Reading Tests – 4th Edition*

IQ   Intelligence Quotient

IDA   International Dyslexia Association

LGN   Lateral Geniculate Nucleus

LH   Left Hemisphere

ms   Milliseconds

NAF   Non-altered feedback

PET   Positron emission tomography

RAN   Rapid Automatized Naming

RDK   Random Dot Kinematograms

PPVT-!V   *Peabody Picture Vocabulary Test – 4th Edition*

RAN-RAS *Rapid Automatized Naming and Rapid Alternating Stimulus Tests*

RD	Reading Disorder
RH	Right Hemisphere
SOP	Speed of Processing
TIPS	*Test of Information Processing*
TOWRE	*Test of Word Reading Efficiency*
WRMT-R	*Woodcock Reading Mastery Tests – Revised*

CHAPTER I

INTRODUCTION

Reading represents a highly complex cognitive process that dynamically interacts between numerous exogenous and endogenous factors. For this reason, researchers have struggled for decades attempting to adequately describe and define this constantly shifting and continually evolving network of systems that must work in harmony so that accurate reading may occur. Although reading is perhaps the preferred educational delivery method for the majority of the lifespan, it cannot be confined merely to the academic realm. Reading informs, enlightens, entertains, occupies, and allows individuals to engage and share in experiences that they themselves have never lived through.

The benefits of reading are not equally received by all individuals. As is the case with all modes of communication, there are those who are not capable of performing these activities as well as others. Reading disorders affect the way in which readers are capable of engaging in the reciprocal relationship known as reading. The term "reading disorder" refers to a group of disorders that throughout the years have been differentially labeled (see Stein, 2001 for a review). Terms such as congenital word blindness, dyslexia, developmental dyslexia, specific reading disability, reading disability or impairment, garden variety poor reader, and reading retardation are all terms that have been used somewhat interchangeably over the past century. Educational systems typically use the term learning disabled to include those with poor reading skills as well as those with deficits that lie outside of the linguistic realm. The most prevalent term used in the modern lexicon is dyslexia, and this term will be used interchangeably with

reading disorders throughout the current paper except when specific reading disorders other than dyslexia are specified. As dyslexia will be the major focus of this study, its definition will serve as the guide for this review. The International Dyslexia Association (IDA) proposes the following definition:

> Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge (Adopted by the IDA Board of Directors, Nov. 12, 2002).

A close examination of the IDA's definition of dyslexia reveals many important characteristics of dyslexia and reading disorders as a whole. First of all, the authors initially state that dyslexia is a "specific" learning disability. This highlights the uniqueness of the disorder and rejects the notion of synonymy with the term *learning disorder*. As previously stated, the term learning disorder can include difficulties in all aspects of learning such as mathematics, motor, visual, reading, spelling, listening, and speaking. Although it has been estimated that as much as 80% of the learning disabled population exhibits deficits in reading abilities (Lerner, 1989; Lyon, 1995), this term is still too broad to use when specifically discussing dyslexia.

Secondly, the definition states that the disorder is neurological in origin. The specific neurological basis of dyslexia is a hotly debated topic which will be addressed further in this dissertation. A separate increasingly viable avenue of research that is beyond the scope of this review regards the genetic basis of dyslexia (see Scerri & Schulte-KÖrne for a review). In brief, it has been shown that 34 to 48% of children with dyslexia also have either a sibling or parent that has dyslexia (see Williams & O'Donovan, 2006 for a review of these findings).

The definition also indicates that dyslexia is characterized by accurate and/or fluent word recognition. This statement represents a change in the thinking of dyslexia. For decades, dyslexia had been thought of as merely an accuracy issue. The dysfluent reading rates observed in dyslexia were thought to be a secondary consequence of laborious and inaccurate reading. However, there are many studies that show that dysfluent reading may not be secondary to inaccurate decoding (Bergman, Hutzler, Klimesch, & Wimmer, 2005; Bowers, Golden, Kennedy, & Young, 1994; Bowers & Newby-Clark, 2002; Breznitz, 1987; Breznitz, 1997a; Breznitz, 1997b; Breznitz & Misra, 2003; Karni et al., 2005; Wolf & Bowers, 1999; Wolf, Bowers, & Biddle, 2000). As Breznitz (2005) states, "dyslexia is becoming increasingly regarded to be due to inaccuracy as well as dysfluency in word reading. As fluency is essentially a time-based notion, processing time and its measurement have acquired greater significance in dyslexia research" (p. 90).

The fourth aspect of the definition that will be reviewed at length is possibly the most controversial aspect of this definition. The controversy arises over the statement that "these deficits typically result from a deficit in the phonological component of

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language" (IDA, 2002). Just as there are many names by which reading disorders have been labeled there also are numerous theories that explain the underlying basis of reading disorders. The IDA's definition of dyslexia supports the phonological core deficit hypothesis, which is perhaps the most prevalent theory on the origins of reading disorders and has a vast array of supporting literature (Adams, 1990; Adams & Bruck, 1995; Ball & Blachman, 1991; Bradley & Bryant, 1983; Bradley & Bryant, 1985; Brady & Shankweiler, 1991; Bruck, 1990; Felton, Naylor, & Wood, 1990; Goswami & Bryant, 1990; Gough & Tunmer, 1986; Liberman, Shankweiler, Fischer, & Carter, 1974; Liberman, Shankweiler, & Liberman, 1989; Mann, 1986; Perfetti, 1985; Perfetti, Beck, Bell, & Hughes, 1987; Shafrir & Seigel, 1994; Share and Stanovich, 1995; Stahl & Murray, 1994; Stanovich & Siegel, 1994; Torgesen, Wagner, & Rashotte, 1994; Wagner & Torgesen, 1987; Wagner, Torgesen, & Rashotte, 1997; Wilson & Lesaux, 2001).

The final aspect of the definition that will be discussed is the secondary consequences statement. Secondary consequences such as comprehension difficulties tend to produce some of the most evident manifestations of reading struggles as children begin to age, especially between third and fifth grades (Best, Floyd, & McNamara, 2008). In fact, reading difficulties emerge so frequently during this period that the term *fourth-grade slump* has been adopted to describe this phenomena (Meichenbaum & Biemiller, 1998; Sweet & Snow, 2003). This age represents the transitioning from Stage 2 to Stage 3 of Chall's stages of reading development (Chall, 1983). This period includes the introduction of new knowledge, differing genres, varying materials, and differing reading purposes. This shift is often described as a transition

between learning to read and reading to learn. Once children begin reading to learn, deficits in comprehension are revealed.

Although reading comprehension deficits may be secondary to more rudimentary word naming or lexical access deficits, these consequences are the ones that most individuals with reading disorders want to alleviate. Most therapeutic techniques do not have an end goal of becoming better decoders or more fluent readers. Instead, the focus tends to be directed toward comprehension. Many programs have been established with this goal in mind and the uniqueness of these paradigms will be reviewed. The purpose of the current study is to objectively and systematically examine the effectiveness of one paradigm, reading acceleration. Reading acceleration has been found to increase both decoding accuracy and comprehension in normal and disordered readers (Breznitz, 1987; 1997a; 1997b; Breznitz & Norman, 1998; Breznitz & Share, 1992; Norman & Breznitz, 1992). This finding, deemed the "acceleration phenomenon" (Breznitz 1997a, 2001, 2002), has been found in both children (Breznitz, 1987; 1997a; 1997b; 1997c) and adults (Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001).

Although numerous studies have been conducted in order to ascertain the neurocognitive processes that are affected in reading acceleration tasks, no studies exist which have addressed the limitations of this ameliorative technique in a clinical sample. The methodologies employed in all of these studies (Breznitz, 1987; 1997a; 1997b; 1997c; Breznitz & Share, 1992; Norman & Breznitz, 1992; Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001) will be addressed to identify potential problems that may have not allowed a complete examination of the effectiveness of the

reading acceleration paradigm. It is clear that a reading rate ceiling exists where the benefits of reading acceleration will no longer be present and performance will decrease below baseline. However, this ceiling has not been identified in the research literature.

Additionally, there is no evidence to date that indicate that reading rate increases can be maintained as passage length increases. Most studies have utilized relatively short passages in order to investigate the "acceleration phenomenon" (Breznitz, 1987; 1997a; 1997b; 1997c; Breznitz & Share, 1992; Norman & Breznitz, 1992; Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001). It remains to be seen whether or not this phenomenon can be extended to lengthier passages.

Research has shown that reading acceleration has many positive effects on the reading comprehension and decoding accuracy of individuals who exhibit reading difficulties. However, limitations of the paradigm have not yet been established; thus, the potential benefits of this technique are not yet evident. Previous research has not investigated whether optimal oral reading rates are naturally produced. Furthermore, the text length at which reading acceleration is most beneficial has not been sufficiently explored. The purpose of this study is to investigate the effects of reading acceleration on the reading comprehension and decoding accuracy in individuals with reading disorders as a function of the amount of acceleration and text length.

CHAPTER II

LITERATURE REVIEW

Normal Reading Processes

It is generally agreed upon that the understanding of written language requires both bottom-up word recognition processes and top-down comprehension processes (see Verhoeven & Perfetti, 2008 for a review). As a result, interactive models of reading comprehension provide the most appropriate framework for the study of both normal and disordered reading processes. The adapted model that will be adhered to in this review is the result of the combination of two previously proposed models (see Figure 1). Catts and Kamhi's model (2005) will serve as the foundation for the discussion of the processes leading to word recognition whereas Verhoeven and Perfetti's model (2008) will guide the single word-to-text integration processes. The combination of these two models can explain the processes behind three crucial elements of reading: perception, decoding, and comprehension. These three phases interact in a cumulative and dependent manner. Each subsequent stage of processing accuracy is dependent on the accuracy of the preceding stage. Although these processes seem to best fit a model that progresses in a linear fashion, this is not the case. However, for clarification purposes, the discussion will proceed in a linear fashion with clearly defined antecedents. This model advocates the serial and interactive nature of each process that is identified by the model.

Perceptual analysis.

As this discussion is centered upon written language comprehension processes, the input for this model will always be print.   There are many parallels between written

and spoken language comprehension processes but these similarities are limited in the perceptual analysis stage. For instance, the sensory mechanisms that are responsible for the initial detection of the input are different between print and sound. Print is reliant on the visual system whereas sound is reliant on the auditory system.

Detection represents the lowest level ability that is necessary for reading to occur (Catts & Kamhi, 2006). After the print has been detected, it is then analyzed using such features as lines, angles, intersections, curvatures, and openness along with relational features such as left, right, up, or down (Rumelhart, 1970). This is done automatically at a subconscious level by the typical reader, but this stage requires significant time and energy for the inexperienced reader who is learning to associate each visual configuration with a specific letter of the alphabet (LaBerge & Samuels, 1974). This process of associating configurations with letters involves both discrimination and identifying. Discrimination is the ability to see visual differences between different visual configurations whereas identification is the actual coupling of the orthographic symbol along with the relevant information stored by the individual pertaining to that specific letter. For example, the visual configuration may be paired with information on its phonemic representation along with any possible phonetic derivations such as any allophonic variations that may be associated with a particular phoneme (Nazir, 2000). Discrimination and identification, as they are described here, apply best to inexperienced readers. For the experienced reader, this process will be accomplished on larger units than single letters, such as syllables, words or even phrases. However, the individual who is learning to read must become proficient and automatic in regards to discrimination and identification of individual letters (Pynte, 2000).

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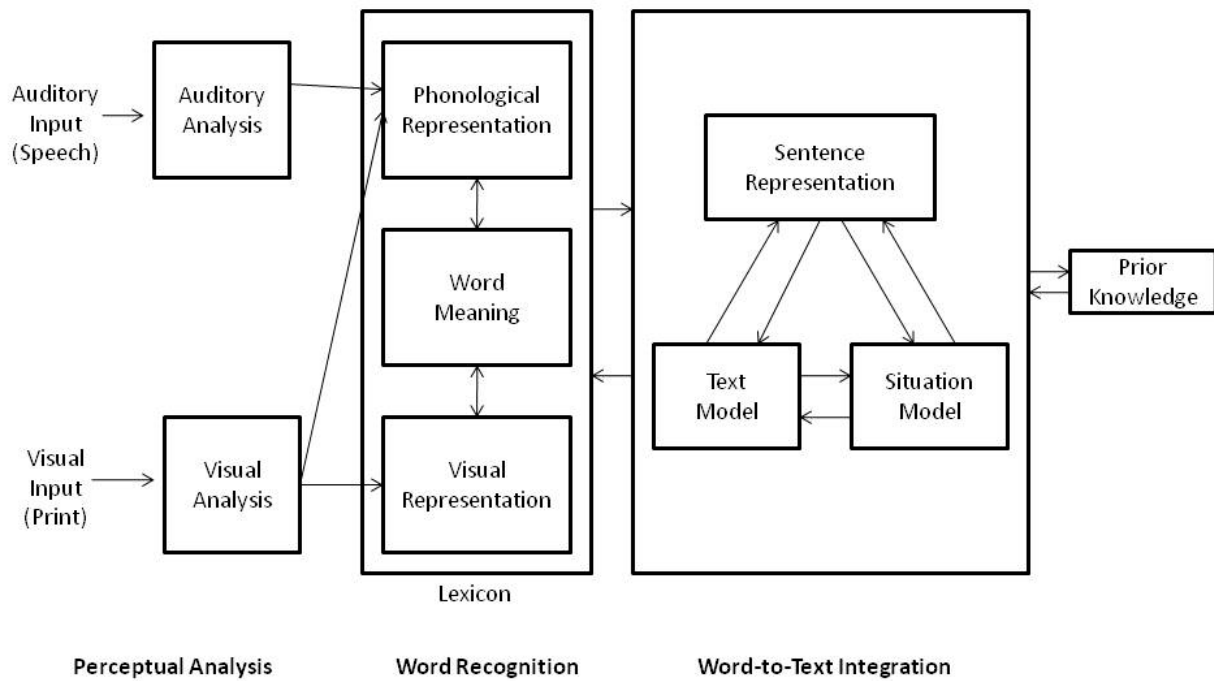
Figure 1. Reading Comprehension Model. Adopted from "Language and Reading Disabilities, (2nd Edition) by H. W. Catts and A. G. Kamhi, 2005, Copyright 2005 by Allyn and Bacon and "Advances in Text Comprehension: Model, Process, and Development" by L. Verhoeven and C. Perfetti, 2008, Applied Cognitive Psychology, 22, p. 294. Copyright 2008 by John Wiley & Sons, Ltd.

Word recognition.

Word recognition is the stage where reading and listening comprehension begin to share similar domains and processes (Carter, Hough, Rastatter, & Stuart, 2011; Holcomb & Anderson, 1993). Before this stage, the processing of print and speech has involved different sensory and perceptual systems (Catts & Kamhi, 2005). The word recognition stage is highly reliant on perceptual analysis. If there is a disturbance in detecting, analyzing, discriminating, or identifying the letter (or group of letters), then errors will be present at the word recognition stage. The end point of this stage is the mental lexicon. The print must activate a stored concept in the individual's lexicon in order for word recognition to occur. The lexicon is hypothesized to contain more than representations of the physical properties of text.

Much research has been devoted to the investigation of what information is actually represented in the lexicon and how that information is organized and accessed. Specifically, numerous priming studies have revealed that the mental lexicon contains a large network of semantic associations (Antos, 1979; Becker, 1980; Carter et al. 2011; de Groot, 1984; McNamara, 1992a, 1992b; Neely, 1991; Seidenberg, Waters, Sanders, & Langer, 1984). Furthermore, many studies have shown that recognition of target words in lexical decision tasks is more rapid when the word is preceded by the presentation of a prime word that shares semantic similarities as compared to prime-target pairs with no semantic relationship (Posner & Snyder, 1975a; 1975b; Chiarello, Burgess, Richards, & Pollack, 1990; Chiarello & Richards, 1992; Fischler, 1977; Hines,

Czerwinski, Sawyer, & Dwyer, 1986; Lupker, 1984; Moss, Ostrin, Tyler, & Marslen-Wilson, 1995; Perea & Rosa, 2002; Schreuder, d'Arcais, & Glanzenborg, 1984).

Fundamentally, the lexical decision task is used primarily in order to measure reaction time and secondarily to measure the accuracy of a participant's responses to presented words. Words may be presented (either visually or auditorily) in isolation, as pairs (simultaneously or following a delay), or as lists. The presented words often consist of both real words and nonsense words. Typically, the participants' task is to make a word or nonword judgment by the press of a button or by pronouncing the word. When using the isolation or list variation of lexical decision tasks, the participant makes a judgment on each presented word. When participating in a paired lexical decision task, the participant either makes a decision to both the first presented word (prime) and the second word in the pair (target), or they only respond to the target word. Generally, during paired lexical decision tasks, each word pair falls under one of three categories: two semantically related words, two semantically unrelated words, or a real word prime followed by a nonsense word target used as a foil.

According to the dual route theory of decoding in reading, the concepts that are stored in the mental lexicon can be accessed or decoded in one of two ways (Coltheart, Curtis, Atkins, & Haller, 1993). Print may be decoded either by its phonological representation or by its visual representation. Accessing the lexicon via the word's phonological representation is an indirect method that requires much attention and energy to be devoted to recoding the letters that were perceived in the perceptual stage into the corresponding phonemes. These phonemes must be blended into sequences then matched with stored concepts in the mental lexicon. This method relies on the

individual's knowledge of the language sound system and their ability to manipulate and segment individual sounds or clusters of sounds into whole words. At a more basic level, this method relies on the individual's awareness that words consist of discrete phonemic segments. This may be simply stated as "sounding out" the words. This method has been shown to be inefficient in regards to comprehension (see Breznitz & Misra, 2003 for review). However, the mastery of this method is a crucial building block for the development of fluent reading via the direct visual approach. This is in contrast to speech in which there is only one way to access a word's meaning (Catts & Kamhi, 2005).

The lexical route, as previously stated, is much more efficient and rapid as a result of the direct and holistic process of reading words and text. Catts and Kamhi (2005) explain that the process of lexical decoding is accomplished by locating "the word in the lexicon whose visual representation contains the same segmental and/or visual features as those identified in the previous perceptual analysis stage. In other words, a match is made between the perceived visual configuration and a visual representation that is part of the mental lexicon for the particular word" (p. 9). The mastery of the phonological route allows the reader to learn the sound/symbol correspondence that will eventually lead to the automaticity of the lexical route. As a result of this acquired automaticity, more energy and attention can be allotted for comprehension, which will increase comprehension skills. When the lexical route is the primary decoding strategy, a reader is believed to be an automatic or fluent reader (Penny, 2000).

However, the two decoding strategies in the dual-route system are not believed to operate exclusive of each other during a reading task. The phonological decoding strategy is believed to be used for decoding unfamiliar words while the lexical decoding strategy is believed to be used for decoding familiar words (Coltheart et al., 1993). Together, these two strategies encompass what it means to decode. Assuming normal developmental processes occur, proficient readers will become able to access the word and its meaning with little effort almost simultaneously.   For normal development to occur, this model suggests that extensive exposure to print presented simultaneously with their phonological representations must occur (Ramus, 2004).

Word-to-text integration.

Developing a sufficient model that explains the numerous intricacies of reading comprehension is a daunting task. It is difficult to account for the numerous factors that affect comprehension. As Kamhi (2009) stated "comprehension is not a skill with a well-defined scope of knowledge; it is a complex of higher level mental processes that includes thinking, reasoning, imagining, and interpreting" (p.175). Text comprehension in particular has been defined as "the dynamic process of constructing coherent representations and inferences at multiple levels of text and context, within the bottleneck of a limited-capacity working memory" (Graesser & Britton, 1996, p. 350). There is no consensus in the research as to whether comprehension should even be investigated as a construct all to itself. The narrow view of reading claims that comprehension is far too complex to be reduced to one single standard score (Kamhi, 2009) and therefore should not be assessed. Kamhi goes on to say that due to

comprehension's complexity and its resistance to treatment, it should never be a treatment focus.

The narrow view claims that treatment should instead focus on decoding, or the word recognition level, as research has shown that this ability can be improved in nearly every population. However, treatment methods are available that have been shown to improve reading comprehension in the absence of improving decoding abilities. For instance, altered auditory feedback paradigms have been shown to increase reading comprehension by approximately 3 grade levels while there were no significant improvements in decoding accuracy (Carter, Rastatter, Walker, & O'Brien, 2009; Rastatter, Barrow, & Stuart, 2007). Furthermore, another treatment paradigm that has been shown to improve reading comprehension abilities while having highly variables effects on decoding depending on the study is reading acceleration. These successful techniques do not support any theory that states that decoding should be the focal point of remediation. Although decoding skills are extremely important for the development of higher level reading processes, they should not be viewed as the primary emphasis for enhancing reading abilities.

To understand the complexities of reading comprehension, it is valuable to establish a coherent representation of the relevant processes that provide the framework for comprehension. In addition, the factors that can have an effect on comprehension need to be addressed, as these factors can serve as possible bases for disruptions or improvements in reading abilities.   The processes leading to text comprehension occurring after word recognition require word-to-text integration (Verhoeven & Perfetti, 2008). After each successive word is identified, it must be

connected to a continuously changing representation of the text. Studies conducted on eye-fixation behavior during reading tasks have revealed some aspects of this process (Reichle, Pollatsek, Fisher, & Rayner, 1998). Reichle et al. determined that duration of fixations on words can be used to infer cognitive processing in reading. They also claimed that eye movements in reading are largely guided by lexical access. It has been shown that approximately 80% of content words are fixated on by the eyes (Carpenter & Just, 1983, Rayner & Duffy, 1988) which is taken as evidence that reading is in fact a word-by-word process, at least when an individual is reading for the purpose of comprehension. It also has been shown that visual fixations tend to be longer in duration at the end of sentences. These two findings have led some researchers to infer that word-to-text integration is best suited to occur at the end of sentences (Carpenter & Just, 1983; Just & Carpenter, 1992; Rayner & Duffy, 1988; Reichle et al., 1998). This also implies that the structure of the sentence is itself may be an important component of this integration.

Comprehending sentences may be thought of as a cognitive process that is reliant both on syntactical (word structure) and semantic (word meaning) aspects of the sentence. The syntactic processors identify the sentence constituents while each word is attached to a syntactic phrase (Macdonald, Perlmutter, & Seidenberg, 1994). Beyond this attachment is the attachment of a word's referential meaning to the semantic representation (Verhoeven & Perfetti, 2008). It is by these means that word-by-word processing becomes word-to-text integration which forms sentence representations. It is this referential integration that will allow the comprehension of the situation that is being described by the text.

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It is apparent that sentence representation is not sufficient in order for complete comprehension. The reader must combine all the meanings of each sentence that is determined to be relevant to the topic. This additive process is highly reliant on different aspects of memory and attention. By this hypothesis, reading comprehension is a product of multiple evaluations of the information that is present in the text. Supporting evidence for this theory is found in studies that have shown that reading comprehension cannot be accomplished with only the information that is presented in the body of the text itself (Gerrig & McKoon, 1998). Instead, it has been found that individuals have to use their prior knowledge to construct new knowledge that must be relevant to their own individual experiences and situations (Kintsch, 1998; van den Broek, Risden, Fletcher, & Thurlow, 1996). Two types of structures are delineated from the propositional structure of the text. The micro-propositional structure refers to the coherence of propositions which are in close proximity in the text whereas the macro-propositional structure specifies a more global level of meaning (Weir & Khalifa, 2008). The micro-propositional structures typically exist within a single sentence or clause whereas the macro-propositional structures address the relationships between ideas represented in combinations of micro-propositions which tend to be logical or rhetorical.

Using the model presented in Figure 1, readers construct their own models as they attempt to comprehend what they are reading. Specifically, readers activate two levels of representation: a text model and a situation model. The text model is a representation of the propositions of the text whereas the situation model reflects the main idea(s) of the text. In the process, the basic meanings are continuously extracted from the sentences in an additive fashion in order to make the text comprehensible.

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Texts typically are not all-encompassing regarding a particular subject matter; thus, the

reader is required to make inferences about what is in the text based on their prior

knowledge (the situation model). The situation model provides a means of identifying

and defining problems, specifying reasons for solutions, generating strategies for

solving other problems, and observing results of attempted solutions (Zwaan &

Radvansky, 1998). In other words, text comprehension involves the cognitive

simulation of the referential situation which is constrained by the linguistic and pictorial

information in the text, the processing capacity of the brain, and the nature of human

interaction within the world.

Working memory.

Although the three previously discussed stages are active systems and

processes at work in reading tasks, they require involvement of other cognitive skills for

successful reading comprehension to occur. Thus, working memory is included in the

model's schematic. As defined by Graesser and Britton (1996), comprehension is "the

dynamic process of constructing coherent representations and inferences at multiple

levels of text and context, within the bottleneck of a limited-capacity working memory"

(p. 350).

Working memory is a term used to describe the ability to simultaneously maintain

and process goal relevant information. More specifically, it is the ability to mentally

store information in an active and readily accessible state, while concurrently and

selectively processing new information, making possible skills such as planning,

reasoning, problem solving, reading, and abstraction (Conway, Jarrold, Kane, Miyake, &

Towse, 2008). It also has been defined as a processing resource of limited capacity

that is involved in the preservation of information while subsequent processing of congruent or non-congruent information occurs (Baddeley & Logie, 1999; Unsworth & Engle, 2007). Individuals who are performing tasks that rely on working memory must be capable of remembering some task elements while ignoring or inhibiting other elements that may not be task relevant (Swanson, Zheng, & Jerman, 2009). Working memory differs from short-term memory in that short-term memory is typically used to describe situations in which small amounts of information are held passively and produced in an untransformed manner, whereas working memory requires active storage and retrieval. For example, a short-term memory task would be reciting a list of stimuli (words, numbers, etc.) in the order that they were presented. This requires no inferencing, transforming, or varying of processing requirements. In contrast, an example of a working memory task would be asking an individual to name back a series of presented objects by a qualifiable attribute (such as size) while ignoring a series of non-targeted items that serve as distracters. This illustration serves as just one example of thousands of possible variations on working memory tasks, but the point is that the individual is required to complete a number of skills such as selecting, rehearsing, maintaining, grouping, and ordering. These tasks require much higher demands on executive attentional systems than short-term memory tasks (Cowan, 1995).

As indicated, working memory should not be confused with short term memory, although the terms are frequently and incorrectly interchanged. The investigation of working memory's relationship with reading comprehension abilities has its roots in Baddeley and Hitch's (1974) multi-component model. Baddeley and Hitch's model has

stood the test of time and as the result of a few minor adjustments, has become one of

the most accepted models of working memory. Baddeley and Hitch originally

developed a model with three main components. A fourth component was added in

2000 and this model will be the focus of this review.

The first aspect of Baddeley and Hitch's model is termed the central executive.

This is the least understood aspect of the model and many researchers have not

described it in detail due to its complicated nature (Morris & Jones, 1990). However, it

is believed that the central executive provides oversight and coordination of the other

two subsystems that are present in the model (Baddeley, 2010). In addition, it has been

hypothesized that the central executive reacts to attentional or multi-task demands while

also providing a link between working and long-term memory (Rapport et al., 2008).

Studies designed to fractionate the central executive are difficult to design due to its

highly integrative nature, but studies have shown that the executive is required for the

encoding of material, except during maintenance rehearsal (Morris, 1987). Morris

interpreted this finding to mean that the working memory system acts as an integrated

system that requires cohesion during active processing, explaining why it is resistant to

fractionation.

Palladino et al. (2001) investigated updating abilities in groups of good and bad

comprehenders as determined by a standardized reading comprehension battery.

Updating abilities tasks are believed to reflect central executive processes (Morris &

Jones, 1990) which are hypothesized to be related to comprehension abilities

(Baddeley, 1990). By using this task, Palladino et al.'s (2001) sought to investigate the

operations that are involved in the selection and use of relevant information during the

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interpretation of a passage. The authors found that the ability to select or maintain the

relevant information provided the best predictor of comprehension abilities. This led the

authors to conclude that updating abilities do not rely on simple inclusion/exclusion

processes but rather more complex processes that involve different levels of activation

to the stimuli which must be continuously updated. In regards to reading

comprehension, the authors stated that the "reader must keep various pieces of

information available in a similar way, tuning activation levels to their relevance and

importance, until a final interpretation can be made and a clear text representation or

mental model built" (p. 353).

The central executive is proposed to maintain an interactive, reciprocal

relationship with its two subsystems: the phonological loop and the visuo-spatial sketch

pad. These two subsystems are often called "slave systems" to the central executive

(Baddeley, 1974) and are considered to be short-term storage systems for verbal

acoustic stimuli (phonological loop) and for visual material (visuo-spatial sketch pad).

The phonological loop is proposed to have two major features. The first feature is a

store in which speech-like memory traces are registered and will spontaneously fade

within two to three seconds (Baddeley, 2010). The second feature is a process

whereby the memory traces can be refreshed by verbal (articulation) or sub-verbal

rehearsal. Baddeley (1998) proposes that the evolutionary purpose for the phonological

loop is not to repeat new words, but instead to learn new words. According to his view,

the ability to repeat a string of alphanumeric stimuli is simply a benefit of a more

fundamental human capacity to generate longer lasting representations of brief and

novel speech events. From a developmental viewpoint, this skill is critical as the task of

forming long-term representations of novel phonological material is a key component of

language development.   The process by which this occurs also has also been

described. The central executive's regulatory duty is to bring phonetic processes into

contact with word level analysis. The phonological loop analyzes the information and

transfers it to working memory storage. This information is then transferred upward

through the system to promote online meaning extraction. Once this is accomplished,

more space is made available for future chunks of phonological information.

The visuo-spatial sketch pad is the second subcomponent of the central

executive in Baddeley and Hitch's (1974) working memory model. It is hypothesized

that the sketch pad is responsible for the storage of visuo-spatial information for brief

periods of time. It also is hypothesized that it plays a key role in the generation of

mental images (Hanley, Young, & Pearson, 1991).

Working memory's role in reading comprehension is especially evident when

considering that comprehension involves processing a symbolic sequence that unfolds

over a time frame (Just & Carpenter, 1992). Working memory is necessary in order to

store the dynamic products of a reader's computations while these ideas are being

constructed and integrated from the stream of words that occur in the text. Two critical

characteristics of working memory as it pertains to reading is that it is both finite, and

ever-changing (Baddeley, 1992; Baddeley, 2000; Baddeley, 2010, Baddeley & Hitch,

1974; Daneman & Carpenter, 1980; Gathercole, Alloway, Willis, & Adams, 2006; Just &

Carpenter, 1992; Miller, 1956; Palladino, Cornoldi, de Beni, & Pazzaglia, 2001; Reichle

et al., 1998; Simon, 1974; Swanson et al., 2009). Working memory has a limited

capacity and the proper utilization of its resources has been hypothesized to be at the

core of reading comprehension competency. Research has indicated that working memory measures often correlate highly with reading competence measures (Breznitz & Share, 1992; Gathercole, Alloway, Willis, & Adams, 2006; Henry & Millar, 1993; McDougall, Hulme, Ellis, & Monk, 1994; Swanson & Alexander, 1997; Swanson, Cooney, & O'Shaughnessy, 1998; Swanson et al., 2009). Working memory measures also have effectively differentiated between students with and without reading disorders (Daneman & Carpenter, 1980; Swanson, Saez, & Gerber, 2004).

In order to address relationships between working memory and reading abilities, Daneman and Carpenter (1980) conducted a study in which twenty undergraduate students were administered a reading span test, a reading comprehension test, and a traditional word span test. The reading span task consisted of the participants reading a series of sentences aloud and being asked to recall the last word of each sentence. Three separate measures of reading comprehension were obtained. The word span test consisted of the participant listening to sets of three to seven words and being asked to recall each word in the set. The authors found that individuals with low working memory spans did poorly on the tests of language comprehension. Furthermore, the authors found strong correlations between the reading span task and the three reading comprehension tasks that ranged from .42 to .9 (average .66). The authors claimed these findings revealed that the span task reflects working memory capacity and that this capacity is a crucial source of individual differences in language comprehension.

Reading Disorders

      Cognitive level theories.

The phonological core deficit hypothesis.

The most prominent and widespread theory of reading disorders is the phonological core deficit theory. This theory, first proposed in the 1970's (Liberman, 1973), states that reading disordered individuals have a specific impairment in the phonological processing abilities that serve as the basis for reading acquisition (Torgesen, Wagner, & Rashotte, 1994; Wagner, Torgesen, & Rashotte, 1994; Wagner et al., 1997). According to this theory, a child who is learning to read must first develop an understanding of the segmental nature of speech and understand that spoken words are composed of the smallest of these segments - the phoneme. The beginning reader must also realize that written words have an internal phonological structure based on the spoken word. It is the understanding that the constituents of a printed word bear a relationship to phonemes that allows the reader to connect printed words to the corresponding words in his/her lexicon (Pugh et al., 2001).

Phonological processing abilities can be broken down into three main categories: phonological awareness, phonological memory, and phonological naming. Phonological awareness refers to an individual's awareness and access to the sound structure of oral languages. This ability can be further fractionated into phonological analysis and phonological synthesis. Phonological analysis is the ability to break down words into its constituent parts (e.g.: syllables or phonemes) whereas phonological synthesis is the reverse process of blending syllables or phonemes. Research has shown the development of phonological awareness abilities to follow a progression from syllables, to sub-syllabic units of onset and rime, to individual phonemes within rimes, to individual phonemes within consonant clusters (Wagner et al., 1997). Tasks that

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measure phonological awareness include blending, segmenting, sound categorization, and elision. Phonological memory refers to the short-term retention of speech-based information. Tasks that measure this ability include repeating sentences of varying lengths and complexities and digit span tasks. Phonological naming refers to the rapid retrieval of phonological codes from long-term memory stores. These tasks typically either use isolated naming tasks where the person is required to name individual items as quickly and accurately as possible, or serial naming tasks where the participant is required to name a series of items as quickly and accurately as possible. The stimuli for these tasks typically consist of colors, letters, numbers, shapes, animals, or single words.

Research has shown that phonological deficits are commonly observed in the reading disordered population. In fact, no current theory of any relevance attempts to dispute this claim. The debate arises around the premise that the phonological deficits are the sole causal agent involved in reading disorders. The phonological core theory does have the benefit of a large body of research supporting this claim (Ball & Blachman, 1988; Bradley & Bryant, 1985; Bryant, Bradley, MacLean, & Crossland, 1989; Ehri, 1987; Ellis & Large, 1988; Gathercole, Willis, & Baddeley, 1991; Lundberg, Frost, & Petersen, 1988; Perfetti, Beck, Bell, & Hughes, 1987; Stanovich, 1986; Treiman, 1991; Tunmer & Nesdale, 1985; Wagner, 1988; Wagner & Torgesen, 1987).

In order to address the issue of causality in developmental disorders, Karmiloff-Smith (1998) recommended the application of three criteria when explaining developmental disorders. The first question that must be addressed is: what is the role of normal variation in the assumed causal factors on development? This question has

been addressed regarding the phonological core deficit hypothesis in many studies.

Across numerous languages, studies have shown that there is a robust link between

children's phonological skills and their subsequent reading abilities. More specifically,

phonological awareness has been found to be a highly accurate predictor of future

reading abilities (see Wagner et al., 1997 for a review). In addition, phonological skills

do in fact evolve and develop in the learning reader. As previously stated, it has been

shown that children's phonological abilities follow a progression from phonologically

larger units to phonologically smaller units (Goswami, 2003). Reading disordered

children have been shown to have persistent deficits at each stage of learning to read

(Wagner & Torgesen, 1994, Wagner et al., 1997). Therefore, the phonological core

deficit hypothesis is capable of addressing the first of Karmiloff-Smith's (1998)

questions.

The second question which guides Karmiloff-Smith's analysis (1998) is whether

experimental tasks been devised that differentiate behavior from cognitive processes,

and are appropriate control groups used? This question led Goswami (2003) to ask

what constitutes an appropriate control group. Goswami argued that using age-

matched control groups as the sole group for comparison is inappropriate. The author

claimed that performance at each of Chall's (1983) reading stages can be poor for

several reasons. For example, consider the differences between dyslexic children with

lower intelligence quotients (IQ) and those with average to above average IQs. In a

study utilizing picture naming tasks and a series of phonological tasks, Swan and

Goswami (1997) found that both groups of disordered readers had impoverished

phonological abilities. However, they concluded that although these phonological

representations may be deficient, they were deficient due to different developmental causes. They indicated that the lower IQ group (garden variety poor readers) exhibited deficient abilities due to impoverished vocabularies which led to poor performance on the phonological tasks. This conclusion was based on the findings that the lower IQ group was actually capable of manipulating phonological structure quite efficiently for words that they actually knew, whereas they exhibited tremendous difficulty with novel or nonsense words. Results such as these suggest that simply comparing experimental groups based on age levels may not accurately describe the cognitive processes that are deficient in dyslexia. By utilizing both an age matched and an ability matched control group, researchers can more effectively study the reading profiles of an individual with dyslexia from a systems perspective.

Research guided by the phonological core deficit hypothesis has shown that dyslexic individuals' phonological abilities are not only poorer than age matched individuals, but also poorer than reading level matched individuals (Greenberg, Ehri, & Perin, 1997). Greenberg et al. examined the word reading processes of adult literacy students and reading age matched fourth and fifth graders. The reading level control group was identified based upon the results of the *Woodcock Reading Mastery Tests-Revised* (Woodcock, 1987). In this study, both groups completed a battery of tasks designed to assess sight word decoding, phonological decoding, blending, elision, segmenting, spelling, rhyming, and vocabulary. The researchers found differences between groups in almost all tasks, but especially in phonological tasks (phonological decoding, blending, elision, segmenting, and rhyming). The authors claimed that when the cognitive profiles of two groups do not match in a reading level study, it is an

indication that the course of development in achieving this level differed between the groups. The cognitive profiles of the adults and children did indeed differ. The adults performed worse on several measures and exhibited a larger discrepancy between orthographic and phonological skills than children. Results from this study help to address the second question posed by Karmiloff-Smith (1998). Cognitive processes and behavioral processes have been effectively differentiated via appropriate control groups in studies that provide supportive evidence for the phonological core deficit theory.

The third question that must be answered according to Karmiloff-Smith is: how do differences in the nature and timing of environmental inputs affect the development of the assumed causal factors? The answer to this question can be found by examining results of longitudinal studies that have been conducted on children who were considered at risk for dyslexia by virtue of having two parents with diagnoses of dyslexia. In a study that followed infants belonging to dyslexic parents (Richardson, Leppänen, Leiwo, & Lyytinen, 2003), differences were found in the rate and nature of phonological productions such as babbling as well as deficits in sound categorization. In addition, a three year longitudinal study was conducted by Pennington and Lefly (2001) in which phonological skills and literacy skills were assessed at four different points during the study of children who were considered at high family risk for dyslexia and those who were not at high risk. At the beginning of the study, the mean age of the high risk group was 5.4 years and the mean age of the low risk group was 5.3 years. The researchers found that those who were eventually diagnosed with a reading disorder (either before or after 2nd grade) exhibited deficits in phonological abilities at all

four points during the study. Both risk groups underwent a similar developmental shift from letter-name knowledge to phoneme awareness as the main predictor of later literacy skill. This shift, however, occurred two years later in the high risk group. These two studies provide sufficient evidence in response to Karmiloff-Smith's third question regarding the relationship between environmental influences and causal factors.

The neurological basis of the phonological core deficit hypothesis.

The notion that dyslexia has a neurological basis is not a novel idea... Although there are reports of neurological dysfunction in dyslexic individuals dating back to the 1800's (Hinshelwood, 1895; Morgan, 1896), these assumptions remained unconfirmed until 1968 when the first description of brain morphology relative to a dyslexic boy who died from a brain hemorrhage was offered (Drake, 1968). An examination upon autopsy revealed molecular ectopias in the left inferior parietal region, among other malformations. Although caution should be used when considering this child's brain as a "normal" dyslexic brain due to the hemorrhage and history of migraines, these results are not at odds with current findings using neuroimaging technology. The most common neuroanatomical anomalies that have been identified in the literature include the classical perisylvian language regions (including Broca's and Wernicke's areas) and the symmetry between the left and right hemisphere planum temporale in the temporal lobe. As such, much research has been dedicated to describing the level of symmetry and activations between the two hemispheres in these areas. For example, it has been found that a large proportion of dyslexic brains lack the typical left > right asymmetry in the planum temporale (Galaburda & Habib, 1987). At the time, this led the authors to state that this asymmetry was a necessary aspect of dyslexia. However, there is an

approximate incidence of 33% of this asymmetry in the normal population as well (Habib, 2000). Therefore, although the asymmetry may be necessary, it is not sufficient in order to result in dyslexia. Furthermore, the case for necessity also has come under some criticism. The symmetry results using more modern techniques of morphological brain MRI are highly inconsistent (Beaton, 1997; Larsen, Høien, Lundberg, & Ødegaard, 1990; Morgan & Hynd, 1998; Shapleske, Rossell, Woodruff, & David, 1999).

Larsen et al. (1990) was the first study that claimed that the dissimilarities observed in the dyslexic brain were specifically linked to phonological deficits. In this study, MRI techniques were used to evaluate the hemispheric symmetry of the planum temporale in nineteen dyslexic children. The dyslexic group was defined by word recognition scores. The control group consisted of nineteen individuals with average word recognition scores who were age and intelligence matched with the dyslexic group. Via MRI imaging, the authors showed that the dyslexic subgroup that exhibited primary deficits in nonsense word reading had symmetrical planum temporales, whereas the dyslexic subgroup who exhibited primary deficits in word recognition did not differ relative to the same anatomical measures obtained on the control group. Nonsense word reading is believed to be an accurate measure of the phonological system. This is based on the exclusion of nonsense words in the mental lexicon. If words are not represented in the mental lexicon then the assumption is that they cannot be read holistically, or by sight. Therefore, the decoding of these words relies heavily on the underlying phonological processes that subserve the phonological route of decoding according to the dual-route theory of decoding (Coltheart, et al., 1993). Deficient nonsense word decoding skills often indicates significant phonological deficits.

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In addition to studies which have focused on the anatomical differences associated with dyslexia, there also have been many in vivo studies that have focused more on the neurophysiological aspects of the disorder. These studies have frequently revealed evidence supporting both a posterior and an anterior cortical reading circuit (Pugh et al., 2001). The posterior circuit is believed to consist of both a dorsal and ventral component. The dorsal component is located in the temporo-parietal region whereas the ventral component is located in the occipito-temporal region. The dorsal region contains the angular gyrus, the supramarginal gyrus, and the posterior aspect of Wernicke's area. These regions have long been implicated in a number of reading and writing disorders, including those that are of an acquired nature (Damasio & Damasio, 1983; Friedman, Ween, & Albert, 1993; Henderson, 1986). Studies have shown that this region is crucial for mapping the visual percepts of print onto the phonological structures of language (Benson, 1994; Black & Behrmann, 1994). In vivo methods have shown that this region is often impaired in reading related tasks when decoding and other linguistic analyses are heavily taxed (Flowers, Wood, & Naylor, 1991; Gross-Glenn et al., 1991; Horwitz, Rumsey, & Donohue, 1998; Pugh et al., 2000; Rumsey et al., 1992, 1997; Salmelin et al., 1996).

Functionally, it is believed that the dorsal circuit operates slowly, requiring much attention. The dorsal circuit is involved in the phonological decoding aspect of the dual-route decoding hypothesis (Coltheart et al., 1993) and therefore; it is associated with a rule-based analysis of the printed word. In fact, the dorsal system has been shown to be activated at a greater level than the ventral system relative to nonsense words and low-frequency words (Frackowiak, Friston, Frith, Dolan, & Mazziotta, 1997). This

system is believed to be crucial for extracting and learning the relationships between orthography and its phonological forms (Pugh et al., 2001). With repeated exposure to a specific word, all these elements become bound into highly integrated representations of lexical items (whole words). In summary, basic decoding and learning to read rely heavily on the dorsal system. This aspect of the system makes it a likely basis for dysfunction in reading disorders.

The counterpart to the dorsal system in the posterior region is the ventral circuit. As previously stated, the ventral circuit is also known as the occipito-temporal circuit and is situated between the ventral visual stream and the middle to inferior temporal lobe. Whereas the dorsal circuit requires cognitive effort and attention, the ventral circuit is more automatic in nature. The ventral system operates at a more rapid pace (Pugh et al., 2001). As readers mature, this area is implicated in word identification (Shaywitz et al. 2002). Studies have shown that the ventral system displays higher activation to familiar words than it does for unfamiliar or nonsense words (Tagamets, Novick, Chalmers, & Friedman, 2000). Shaywitz et al. (2002) suggested that the information processed by the ventral system is coded in a linguistic-orthographic form. In other words, although the ventral system processes information that is orthographic (visual), the information is perceptually structured in linguistic terms, i.e., in orthographic units that correspond to the phonological and morphological units of the speech form of the word. The authors concluded that such sensitivity to phonological and morphological structure could be the legacy of a slower dorsal system decoding process which originally learned how to recognize a word. In summary, the authors propose that the earlier developing dorsal system guides and shapes the development of the ventral

circuit. Therefore, the development of the ventral circuit may be dependent on the integrity of the development of the dorsal system which is required for phonological processing abilities.

The anterior cortical circuit that is involved in reading consists of sites centered around Broca's area in the inferior frontal gyrus of the left hemisphere. These areas are believed to be associated with fine-grained articulatory and phonological recoding. This area functions in both silent and oral reading and has been implicated in reading disorders (Brunswick et al., 1999; Paulesu et al., 1996; Rumsey et al., 1997; Shaywitz et al., 1998, 2002). Several findings suggest that the anterior system appears to be more heavily used by RD than normal readers, perhaps in compensation for their failure to develop the posterior reading system adequately (Pugh et al., 2000; Shaywitz et al., 1998).

Several neuroimaging studies have attempted to identify the brain regions that show differential activation in normal and dyslexic readers, and much evidence has been provided for a disruption in the anterior and posterior cortical reading circuits (Horwitz et al., 1998; Pugh et al., 2000; Rumsey et al., 1992; Shaywitz et al., 1998). However, studying these anomalies in isolation has not provided a complete profile. Specifically, the issue of functional connectivity cannot be addressed by these circuits alone. Functional connectivity refers to the relations between distinct brain regions which should function cooperatively to process the information made available during reading. In this circumstance, the term is referring to the relationship between both the dorsal and ventral aspects of the posterior reading circuit and the anterior reading circuit.

In examining activation levels in the left hemisphere angular gyrus and other brain sites during an oral reading task, Horwitz et al. (1998) found strong correlations between LH angular gyrus and LH occipital and temporal lobe sites in a non-impaired group, whereas nonsignificant correlations were found between these two areas in a reading disordered group. The authors claimed that these results represent a breakdown in functional connectivity across the major components of the posterior reading system. These results also have been extended to a study that used a set of tasks that systematically increased the demands made on the phonological system (Pugh et al., 2000). More specifically, Pugh et al. found reading disordered readers' functional connectivity was weaker on word and nonsense word tasks, although no differences were revealed in the tasks that assessed complex visual-orthographic coding only. The authors claimed that a breakdown in left hemisphere posterior systems manifests only when orthographic to phonological assembly is required. Furthermore, evidence was found of possible maladaptive compensatory mechanisms in the right hemisphere homologues in the reading disordered group. This finding is similar to those observed by Shaywitz et al. (1998) who found a significant interaction between groups and hemisphere. The reading disordered group showed greater right hemisphere than left hemisphere activation in the angular gyrus and the middle temporal gyrus. Both of these areas have been implicated in accessing word meaning during reading (Pugh et al, 2001). The control group exhibited greater activation in the left angular gyrus and left middle temporal gyrus than they exhibited in their right hemisphere homologues. In addition to these findings, strong correlations have been found between right hemisphere activation in the temporo-parietal region and standard

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measures of reading performance (Rumsey et al., 1997; Shaywitz et al., 2002). Pugh et al. (2001) claimed that this right hemisphere shift represented the possible development of an additional word recognition process that is visual-perceptual. Graphemic patterns in text are associated directly with entries in the reading disordered individuals' mental lexicon. As a result, the reading disordered individual does not code the phonological or morphological information that the non-impaired reader does, but instead, represents single words as non-linguistic visual-semantic icons.

Maladaptive mechanisms have not only been found inter-hemispherically, but also within the left hemisphere. Reading disordered individuals have been found to exhibit greater activation in the left inferior frontal gyrus (Broca's area) (Brunswick et al., 1999; Pugh et al., 2000; Rumsey et al., 1997; Richards et al., 1999; Salmelin et al., 1996). Results of these studies converge to suggest that both a left hemisphere posterior anomaly is accompanied by compensatory shifts to left hemisphere frontal sites or right hemisphere reading homologue sites in reading disorders.

Thus, the phonological core deficit's neurological explanations for dyslexia reveal disruptions in posterior and anterior reading circuits in the form of reduced activation and disrupted functional connectivity. In the normally developing child, the ventral reading circuit is reliant on the organization of phonological abilities in the dorsal circuit. If the dorsal circuit fails to appropriately develop, it will be rendered incapable of adequately supporting the ventral system. An over-reliance on the inferior frontal gyrus represents a compensatory mechanism designed to recruit phonological recoding in order to cope with deficient phonological analyses of words. As a result of a deficient

phonological system, the reader is unable to store words as linguistic units, and resorts to storing them as icons instead.

The double deficit hypothesis for the developmental dyslexias.

The most recent of the theories is the double-deficit hypothesis for the developmental dyslexias (DDH). This theory has gained attention since its inception by Wolf and Bowers (1999). The aim of the DDH is not to provide a wholly encompassing explanation of all the deficits exhibited in dyslexia. Instead, as the authors stated, its goal is that of a "vehicle to push researchers' understanding of the heterogeneity of readers beyond unitary models and solely linguistic explanations toward more encompassing models of reading breakdown and reading intervention" (p. 432). As this explanation would indicate, the constituent tenets of this theory are not new ideas, but rather a culmination of other previously established theories (e.g. the phonological core deficit and magnocellular defect theories).

The main argument of the DDH is that phonological deficits are not the only causal source of reading impairment in dyslexia. The DDH indicates that naming speed deficits represent a second core deficit in addition to phonological deficits. Naming speed deficits refer to deficits in the processes underlying the rapid recognition and retrieval of visual stimuli. There are numerous investigations that support the existence of naming speed deficits in the reading disordered population (Ackerman & Dykman, 1993; Badian, 1995, 1996; Bowers, Steffy, & Tate, 1988; Denckla & Rudel, 1976a, 1976b; Lovett, 1992,1995; McBride-Chang & Manis, 1996; Meyer, Wood, Hart, &

Felton, 1998a, 1998b; Snyder & Downey, 1995; Spring & Capps, 1974; Spring & Davis, 1988; Wolf, Bally, & Morris, 1986; Wolff, Michel, & Ovrut, 1990a, 1990b; Wood & Felton, 1994). Naming speed is a multi-faceted measure that consists of several distinct processes. The task that is most typically used to assess this ability is rapid automatized naming (RAN). RAN tasks involve the naming of common symbols such as letters (RAN-L), digits (RAN-D), colors (RAN-C), and objects (RAN-O). These tasks generally consist of the individual attempting to rapidly and accurately name 5 rows and ten columns of the repeating symbols (Wile & Borowsky, 2004). The RAN-L and RAN-D tasks have been shown to have strong correlations with lexical decoding measures (Bowers, Golden, Kennedy, & Young, 1994; Wile & Borowsky, 2004), although Wile and Borowsky found that RAN-L has a stronger correlation than RAN-D. This is hypothesized to be due to the more inherently linguistic nature of the alphabet versus numerical stimuli (Neuhaus, Foreman, Francis, and Coleman, 2001).

RAN tasks also have been shown to differentiate dyslexic readers from average readers (see Wolf & Bowers, 1999 for a review), non-discrepant (garden-variety) poor readers (Wolf & Obregón, 1992), and readers with other learning disabilities (see Wolf, Bowers, & Biddle, 2000 for a review). This interesting capability is perhaps due to the overall cognitive speed of processing deficits that have been found in numerous studies. A serial naming task is reliant on numerous cognitive processes which must occur in a sequential and timely manner. However, there is ample evidence that has shown that dyslexic individuals lack this efficiency. Specifically, it has been shown that dyslexic individuals exhibit deficits in speed of processing in the visual domain (Breitmeyer, 1993; Chase & Jenner, 1993; Farmer & Klein, 1995; Greatrex & Drasdo, 1995;

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Lehmkuhle, 1993; Lovegrove, 1993), in the auditory domain (Farmer & Klein, 1993; Godfrey, Syrdal-Lasky, Millay, & Knox, 1981; Tallal, Miller, & Fitch, 1993; Werker & Tees, 1987), and in motoric tasks (Gardiner, 1987; Nicolson & Fawcett, 1990; Wolff, 1993; Wolff, Michel, & Ovrut 1990a, 1990b).

Research that is guided by any of the major competing theories does not dispute the claim that naming speed deficits are often present in the reading disordered population. However, critics do often dispute the independence of these naming speed deficits from the phonological realm (Chiappe, Stringer, Siegel, & Stanovich, 2002; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997; Vukovic, Wilson, & Nash, 2004; Wagner & Torgesen, 1987; Wagner, Torgesen, & Rashotte, 1994). These latter researchers tend to conclude that naming speed deficits are likely the result of deficits in phonological processing. This conclusion is partly due to the mixed results that have been observed. Specifically, this line of research typically utilizes phonological processing and naming speed measures in a regression type analyses in order to account for the variance exhibited in reading abilities. When these types of analyses are accompanied by highly different experimental measures (such as outcome measures and the tasks themselves), then it is reasonable to expect a large degree of variance in the conclusions that are drawn regarding naming speed deficits.

The DDH addresses claims that phonological processing and rapid naming are not independent skill sets. The first argument for the independence of these two skills proposed by the DDH is based upon the cognitive requirements of naming speed as measured by RAN tasks. Visual naming requires components of attention, perception, conception, memory, lexical processes, and articulatory processes. In a step by step

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manner, Wolf et al. (2000) guides the reader through these processes. Initially, attentional resources must be activated, which in turn activate bi-hemispheric visual processing at different levels. Those components responsible for lower spatial frequencies provide information about the holistic shape of the stimulus. This occurs within 60 to 80 ms after stimulus presentation (Chase, 1996). Visual components that react to higher spatial frequencies provide information about the finer details of the stimulus which allows for identification of recognition processes that integrate information about the stimuli with already established mental representations, thus influencing the speed of processing (Perfetti, 1992).

In the DDH, the lexical process consists of integrating morphological, phonological, and semantic aspects of the stimuli with cumulative information (Wolf et al., 2000). The culmination of these processes results in the motor process of articulation which requires the individual to verbally name the object. Note that the authors have included phonological processing into this task, but also note that there are numerous other processes that also are occurring. Wolf and Bowers (1999) state that "the phonological processes' role in naming-speed tasks is essential—activating stored phonological representations and the access and retrieval of phonological labels" (p. 418). They suggest that although other tasks such as semantic fluency and expressive vocabulary also require phonological processes, they are rarely included as phonological tasks. Therein lies the DDH's argument that the rapid naming task is too complex to be simply placed into the realm of phonological abilities. Wolf et al. (2000) state that "The complexity of this underlying structure, the ordinary processing speed demands, and the addition of rapid rate and seriation to processing-speed requirements

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make naming speed a different cognitive task from phonology" (p. 393). In other words, if naming speed consists of many processes including phonological processes, but an individual can present with reading deficits (mostly in comprehension and reading fluency) without any apparent phonological processing deficits, then there must be at least one other explanatory process accounting for the reading profiles of reading disordered individuals. The DDH claims that these deficits most likely are either the result of a defective magnocellular system or general speed of processing deficits. If the deficits are the result of a defective magnocellular system, then the processing of the lower spatial-frequency components will be slowed. This visual processing is one of the initial steps that must occur in for the completion of a naming task. The slowing of this stage is hypothesized to lead to slower visual processes including letter and letter pattern identification. The downstream effects of these deficits likely will result in slow serial naming speed and difficulty in forming links and connections between letters that occur frequently in the language's orthography (Seidenberg & McClelland, 1989). If naming speed deficits are the result of a more general speed of processing deficit, then it is possible that a number of deficient processes may be the source of slow naming speed behaviors that are clinically observed. The DDH does not offer specific claims, but states that the naming speed deficits may be the result of slow processing speed in one, a combination of several, or all of the lower level perceptual and motoric processes that are involved in naming tasks. Both of these hypotheses offered by the DDH indicate that the deficits in lower level processes underlying naming tasks prevent increases in fluency in word identification which has a negative impact on reading

comprehension. It is in these processes that Wolf and Bowers believe naming speed

differentiates itself from phonological abilities.

The DDH's second argument for the separation of naming speed and

phonological processing abilities lies in the relationships between the two variables, and

the individual predictive nature of the two variables relative to reading abilities. The

DDH indicates that there are modest interrelationships between naming speed and

phonological processing abilities. The strength of the correlation between visual naming

speed and phonological awareness has typically been between 0.10 to 0.40, depending

on the sample (Cirino, Israelian, Morris, & Morris, 2005). These findings would suggest

the relative independence of these two variables. However, sample heterogeneity

makes comparative research highly difficult. Sample selection variables that can have

an effect on the outcomes of these studies consist of sample size, participant age,

participant's reading proficiency, diagnostic criteria, recruitment methods, and the

experimental tasks (especially timed versus untimed tasks).

The DDH's third main argument for separating naming speed from phonological

processing is based on the findings of differential contributions to specific aspects of

word recognition. For example, it has been found that phonological processing abilities

are strongly predictive of word and nonsense word reading, but not highly predictive of

word or text reading speed (Bowers, 1993; Bowers et al., 1988; Bowers & Swanson,

1991). Although these studies did not find naming speed to be an accurate predictor of

real word reading, other studies have shown naming speed to be highly predictive of

word identification tasks that are designed as an index of sight word decoding, while

unable to predict nonsense word reading (Young & Bowers, 1995). McBride-Chang and

Mannis (1996) found that naming speed may only be associated with word reading in poor readers, whereas Torgesen et al. (1997) found naming speed to be a reduced contributor in poor readers. As is typically the case in the DDH literature, this issue seems to be dependent upon the sample criteria. However, Cirino et al.'s (2005) study may clarify this issue to some degree. This study utilized one hundred forty-six readers who had been referred to a university assessment center for suspected reading difficulties. Cirino et al. found that the relative contributions of phonological awareness and visual naming speed were dependent upon two variables pertaining to the reading outcome measure: item content and item nature. Item content in this study referred to either word or nonsense word decoding tasks whereas item nature referred to time versus untimed tasks. Phonological awareness was found to be a significantly stronger predictor than naming speed in an untimed decoding task, regardless of whether the decoding task required phonological or sight word decoding. However, the authors also found that, in timed decoding tasks, phonological awareness and naming speed were equally predictive of nonsense word decoding, whereas naming speed was more predictive of sight word decoding ability. Cirino et al. claimed that these results were evidence that naming speed's contribution toward word recognition increases as time decreases.

The authors of the DDH present a compelling argument relating to the clinical ramifications of utilizing the DDH as a clinical tool. The most discussed (and possibly most controversial) of the claims that the DDH makes is the identification of four distinct subtypes existing in the population. The first subtype is the normal reading population that exhibits no deficits in phonological processing or naming speed. The second and

third subtypes of the DDH include those individuals with isolated deficits in either phonological awareness or naming speed. The fourth hypothesized subgroup, also known as the double-deficit subgroup, consists of those individuals who exhibit deficits in both phonological awareness and naming speed. Wolf and Bowers (1999) stated that these four subgroups typically exhibit differential patterns of reading deficit severities. The no deficit subgroup exhibits deficits in neither phonological awareness or naming speed. The naming speed single deficit subgroup is believed to exhibit the mildest form of dyslexia followed closely by the phonological processing single deficit subgroup which exhibits slightly more severe reading symptoms. Finally, the double-deficit subgroup is believed to be the most profoundly impaired readers of this classification system. Wolf and Bowers state that the double-deficit children utilized in their sample performed at least 2 ½ years below age matched peers in phonological abilities, naming speed, and other reading variables.

Although Wolf and Bowers present a compelling argument for the existence of these four subtypes in their sample, the question remains as to whether these distinctions can be made in the general public. Lovett (1995) found that out of the 76 children utilized in her study conducted on profoundly disabled readers; these distinctions were evident. Lovett's participants were between 7 and 13 years old with a mean age of 9.6 years. Seventy-nine percent of her participants could be characterized as members of the double-deficit subgroup. 2.3% of the sample was included into the naming speed deficit subgroup and 2.2% of the sample was included into the phonological deficit subgroup. It should be noted that the sample utilized in this study consisted of children that were mostly reading at the fifth percentile or lower based on

standardized scores. 15% of Lovett's sample could not be categorized according to the criterion laid out by the DDH. The most profoundly dyslexic individuals in Lovett's study were typically classified as double-deficit. In slight contrast, Vukovic et al. (2004) found that although the subgroups of the DDH could be identified, the severity profiles of these subgroups did not match those hypothesized by Wolf and Bowers. In fact, the authors found that the double-deficit subgroup did not have the most severe deficits in reading comprehension, which is contrary to the findings that were cited by Wolf and Bowers (1999) that lead to the claim that the double-deficit subgroup should exhibit the most profound deficits in reading abilities (Badian 1996a, 1997; Berninger et al. 1995; Bowers, 1995; Goldberg, Wolf, Cirino, Morris, & Lovett, 1998; Krug, 1996; Wolf, 1997).

Although the ultimate goals of remediation therapies that are guided by the DDH are accuracy and fluency, there is still some degree of confusion regarding what the RAN task actually measures, and how these tasks relate to fluency. There is a growing literature providing more data on what abilities RAN tasks measure, and what manifestations of weakness in these skills contribute to the process of reading. These studies might prove crucial to the understanding of textual reading, as the multi-process nature of RAN more closely resembles textual reading than does other tasks that are focused more on single word decoding or phonological processing abilities (Misra, Katzir, Wolf, & Poldrack, 2004; Wolf & Bowers, 1999, Wolf, Bowers, & Biddle, 2000). As previously stated, the RAN task is reliant on a) attentional processes; b) bi-hemispheric visual processes responsible for feature detection, visual discrimination, and letter/letter pattern identification; c) integration of visual features with stored orthographic representations; d) integration of visual features with stored phonological

representations; e) access and retrieval of phonological labels; f) activation and integration of conceptual information; and g) motoric activation leading to articulation (Misra et al., 2004; Wolf & Bowers, 1999).

RAN measures also have been shown to have strong correlations with reading fluency (Miller et al., 2006; Morris et al., 1998; Vukovic et al., 2004; Wolf & Bowers, 1999; Wolf, Pfeil, Lotz, & Biddle, 1994) and reading comprehension (Torgesen et al., 1997; Vukovic et al., 2004), although the findings on reading comprehension have been mixed (see Vukovic et al. for a review on this matter). As dyslexia is increasingly considered in terms of fluency and accuracy as opposed to accuracy alone, it is important to consider the relationship between fluency and RAN tasks (Breznitz, 2005b). Research has explained RAN deficits in many ways. As stated previously, phonological abilities have been proposed for the naming speed deficits exhibited in RAN tasks (Wagner et al., 1997). It also has been proposed that slow articulation is at the core of these deficits (Baddeley, 1986), although Obregón (1994) found no deficits in articulation rate but instead found increased length of pauses between articulation segments to be the most accurate predictor of RAN abilities in children with dyslexia. Other studies have shown that naming speed deficits are the result of deficient memory processes (Baddeley, 1986; Bowers, Steffy, & Swanson, 1986). Another possible avenue that seems promising is that these deficits are the result of more general speed of processing problems (Breznitz, 2005a; Kail & Hall, 1994).

Word reading studies have shown that the speed of processing of the modalities (visual and auditory) and systems (phonological and lexical) involved in word reading are crucial for effective and fluent word reading (Breznitz, 2001; Breznitz, 2002; Breznitz

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& Meyler, 2003; Breznitz & Misra, 2003). The link between word reading and RAN

tasks is quite strong due to the shared characteristics of each task. Specifically, both

tasks require attention to stimulus and modality-specific perceptual and identification

processes. Both require evaluation, classification, and updating in working memory as

well as retrieval and integration of information with lexical information. Furthermore,

both tasks require motoric activation which leads to actual vocalization of the object

name (Wolf, 1982; Wolf, 1997). Breznitz (2001) and Breznitz and Misra (2003) found

that dysfluency exhibited by dyslexic individuals was especially related to slow speed of

processing during stimulus evaluation and identification.

Asynchrony in processing time between visual and auditory-acoustic systems at

the above stages also impairs word reading. It is hypothesized that the wider the time

gap between these two processes, the more severe the dyslexia (Breznitz & Misra,

2003). Breznitz (2005a) conducted an ERP study designed to investigate whether the

same speed of processing deficits that are present in word naming are present in RAN

tasks. Two separate naming tasks were utilized in her study. One task involved

reading single words, and the second task was a RAN task that had been adapted in

order to be completed under the ERP procedure. The authors found that the dyslexic

individuals exhibited slower reaction times when processing all of the tasks. The author

claimed that the results indicated that dyslexic individuals may exhibit a more domain

general slowness in speed of processing, which effects the processing of cognitive

information in general and naming tasks in particular. The results also indicated a

longer P300 in the dyslexic individuals. The P300 is believed to be associated with

stimulus classification and retrieval, as well as working memory processing (Barnea,

Lamm, Epstein, & Pratt, 1994). The authors hypothesized that the larger gap between

the end of the P300 component and reaction time when processing the RAN tasks

suggests a longer and non-automatic search for correct naming pattern representations

in the mental lexicon, which in turn, prolongs the retrieval process. This conclusion

directly leads to the links between RAN tasks and fluency. In the control group of

Breznitz study (2005a), it appeared as though the RAN tasks were completed with

automaticity. In contrast, the dyslexic readers were forced to rely on memory processes

to search for correct answers, which is a slower and far less automatic process

(Breznitz, 1987; 1997a; 1997b).

　　　　The neurological basis of the double-deficit hypothesis.

　　　　Neurological research supporting the double-deficit hypothesis is limited. One

obvious reason for this disparity is that the DDH has not been formulated for as long as

the phonological core deficit theory. A second reason stems from the DDH's reliance

on neurological research that has already been conducted to support the phonological

core deficit and the magnocellular defect hypotheses. The DDH does not posit any new

cognitive processes or deficiencies that have not already been described in the

literature. Specifically, the DDH makes no argument against the well-established

literature as to the neural correlates of a phonological disorder. As mentioned, the

proposed phonological deficits exist in the posterior and anterior reading circuits as

evidenced by both reduced activation and disrupted functional connectivity between the

posterior and anterior circuits. Furthermore, in the normally developing child, the ventral

reading circuit is reliant on the organization of phonological abilities in the dorsal circuit.

If the dorsal circuit fails to develop appropriately, it will be rendered incapable of

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adequately supporting the ventral system. An over-reliance on the inferior frontal gyrus represents some form of compensatory mechanism designed to recruit phonological recoding in order to cope with deficient phonological analyses of words. The authors of the double-deficit neither confirm nor dispute these findings (Wolf & Bowers, 1999). Therefore, one is left to assume that the phonological deficit subgroup is believed to cognitively operate with the same cognitive deficits in the phonological system as discussed previously.

In order to address the naming speed deficit subgroup, Wolf and Bowers have borrowed from previously established theories of cognitive dysfunction. Their explanation for naming speed deficits can be directly traced to earlier versions of the magnocellular defect theory which suggests that dyslexia is the result of defected cells that are devoted to luminance contrasts in the visual pathway. A deeper explanation of magnocells and the magnocellular defect theory will be provided in this dissertation. The DDH's claim stems from neurophysiological work completed by Chase (1996) and Livingstone, Rosen, Drislane, and Galaburda (1991). Results from these studies have shown that after a visual stimulus presentation, there is an automatic analysis of constituent, low frequency features that is accomplished by the magnocellular system. The magnocellular system consists of regions from the retina through subcortical visual areas in the thalamus, including the lateral geniculate nucleus (LGN) (Wolf & Bowers, 1999). The LGN is believed to be responsible for coordinating visual processing. Galaburda, Menard, and Rosen (1994) claimed that the reduced axon size and decreased cell number in the LGN would lead to decreases in the processing speed of visual information for individuals with dyslexia. The DDH claims that those individuals

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who can be categorized in the naming speed deficit subgroup, may in fact exhibit defects in their magnocellular system.

A second possible explanation for naming speed deficits offered by the DDH is that processing speed deficits exist in the perceptual, motoric, and linguistic domains of the dyslexic individual. It should be noted that most studies find no differences in basic level tasks between control and dyslexic groups. The differences only become apparent as task demands increase. Perceptual findings in the dyslexic population include deficits in flicker fusion tasks (Chase, 1996), deficits in both auditory (Farmer & Klein, 1993; Godfrey, Syrdal-Lasky, Millay, & Knox, 1981; Tallal et al., 1993; Werker & Tees, 1987) and visual (Farmer & Klein, 1995) individuating tasks, and auditory and visual temporal order judgment tasks (Kinsbourne, Rufo, Gamzu, Palmer, & Berliner, 1991). Motoric findings include balance difficulties (Nicolson & Fawcett, 1990) and problems on finger tapping tasks (Wolf 1993, Wolff et al. 1990a, 1990b).

Aside from research by Wolf and colleagues (Misra, Katzir, Wolf, & Poldrack, 2004; Wolf & Bowers, 1999, Wolf, Bowers, & Biddle, 2000), there is limited published literature addressing the physiological claims of the DDH. Paradigmatic loyalty might explain this lack of reinforcing research. Phonological core deficit supporters found further evidence for cognitive phonological processes, magnocellular defect supporters found further evidence for magnocellular system dysfunction, and the same can be said for supporters of the cerebellar deficit hypothesis. Specifically, McCrory, Mechelli, Frith, and Price (2005) conducted a word and picture naming task while utilizing positron emission tomography (PET). The authors' intent was to replicate previous findings of differential activation in the left occipito-temporal area (posterior ventral reading system)

in dyslexic individuals (Brunswick et al., 1999; Paulesu et al., 2001; Rumsey et al., 1997; Salmelin et al., 1996; Shaywitz et al., 2002). The authors claimed that although all of these studies had found similar differences between groups, they also shared something else in common: they used orthographic stimuli. McCrory et al. (2005) indicated that this led to problems excluding the possibility that reduced activity in this area reflected orthographic rather than phonological processing. The authors found reduced activation in the left occipito-temporal region in both picture and word naming tasks. They claimed that these findings suggested that the abnormal activation in this region may underlie the reading and naming speed deficits observed in developmental dyslexia. They went on to say that "the dyslexic's difficulties in lexical retrieval are most parsimoniously accounted for by a single underlying cognitive deficit, without the need to postulate additional deficits" (McCrory et al., 2005, p. 265).

Another neurophysiological study examining naming speed deficits comes from the cerebellar deficit literature. The cerebellar deficit theory indicates that the behavioral symptoms of dyslexia can be characterized as difficulties in skill automatisation with the major causal factor being impaired implicit learning as a result of cerebellar abnormality (Nicolson et al., 2001). Eckert et al. (2003) completed a structural MRI study on eighteen dyslexic individuals and thirty-two control participants. The authors attempted to classify dyslexic individuals according to the DDH, although the classification system led to very few individuals fitting into the single deficit subgroups. There was an especially high preponderance (94%) of naming speed deficits, including those included in the naming speed only and double-deficit subgroups. The authors found that the right cerebellar anterior lobe and the inferior

frontal gyrus distinguished dyslexic participants from the control group with high probability. Eckert et al. claimed that it is possible that these cerebellar anomalies could produce downstream effects on the architecture and function of the more frontal regions that are hypothesized as causal agents in the phonological deficit and magnocellular defect hypotheses. It also was found that the pars triangularis of the inferior frontal gyrus was undersized in the dyslexic group. The authors concluded that the anatomical findings suggest that impairments in a frontal-cerebellar network may play a role in dyslexia. They also claimed that this network may be critical to the precise timing mechanism that Wolf and Bowers (1999) hypothesized to underlie naming speed deficits.

Neural level theories.

The cerebellar deficit hypothesis.

The phonological core deficit hypothesis (Liberman, 1973) and the double-deficit hypothesis (Wolf & Bowers, 1999) both make strong arguments for their explanatory capabilities at the cognitive level. However, two prominent neural level theories also exist which attempt to explain the cognitive level deficits (e.g. slow and inaccurate word reading and poor reading comprehension) at a more fundamental neurological level.

The cerebellar deficit hypothesis, mentioned above, indicates that cognitive level reading deficits can be explained by cerebellar dysfunction (Nicolson, Fawcett, & Dean, 2001). The cerebellum is specialized for automatic preprogrammed timing of muscle contractions for optimizing motor performance. It is known to be involved in the coordination of smooth movements, maintenance of balance and posture, visually guided movements, and motor learning (Dow & Moruzzi, 1958; Holmes, 1939; Ito, 1984;

Stein, Riddell, & Fowler, 1986). As the cerebellum plays a role in motor control, it definitely plays a role in speech articulation. Also, the cerebellum plays a role in the automatisation of over-learned tasks such as driving a car, typing, or reading. The cerebellar deficit theory hypothesizes that difficulties in the automatisation of skills leads to the myriad of deficits observed in the dyslexic population, such as learning the grapheme-phoneme connection.

There are four main claims of the cerebellar deficit hypothesis. The first claim is that the behavioral symptoms of dyslexia can be characterized as difficulties in skill automatisation. Skill automatisation is the process by which, after long practice, skills become so fluent that they no longer need conscious control (Nicolson, Fawcett, & Dean, 2001). Proponents of the cerebellar deficit hypothesis claim that it is misguided practice to narrow the scope of dyslexia research to literacy deficits alone. Nicolson and Fawcett (1994a, 1994c) showed that dyslexic children exhibited difficulties not only in phonological and literacy skills, but also in information processing speed, memory, motor skills, and balance. Furthermore, the authors found that 90% of the dyslexic children in these studies performed at least one standard deviation below normal in three separate tasks that are not typically identified as accompanying dyslexia. The three tasks were balance, phonemic segmentation, and picture naming speed. Thus, the authors concluded that these findings provide evidence of a deficit in automatisation skills, regardless of whether the skill was in the literacy domain.

The second claim is that the cerebellar deficit hypothesis can predict the pattern of deficits in cognitive, information processing, and motor skills. Specifically, it has been shown that patients with acute cerebellar damage show dissociations between time

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estimation and loudness estimation, with loudness estimation performance existing in the normal range (Ivry & Keele, 1989). Nicolson and Fawcett (1995) also found that this same dissociation was evident in a dyslexic sample of children. Furthermore, Fawcett, Nicolson and Dean (1996) have shown that dyslexic children exhibit significant characteristics of dysfunction including dystonia and dyscoordination on classical clinical tests of cerebellar function when compared to both reading and age matched control groups. The participants in this study were divided into three dyslexia groups and three control groups based upon age. The average age of the three dyslexia groups was 10.7, 14.4, and 18.6. The control group was age matched. There were twelve participants in the first group, nine in the second, and eight in the third. Participants were diagnosed with dyslexia based upon discrepancy criteria. All children were required to obtain an IQ measure above 90 while exhibiting at least 18 months of reading delay according to standardized measures. The experimental procedure consisted of a battery of cerebellar tasks and measurements such as balance time, postural stability, static tremor, arm displacement, weight time, hand declination, limb shake, muscle tone, breaking distance, past pointing, finger to finger, diadochokinesis, finger to thumb, and toe tapping. The dyslexic groups were significantly impaired in each of these tasks compared to both age and reading matched peers.

The third claim of the cerebellar deficit hypothesis is that dyslexic adults showing the behavioral manifestations of cerebellar impairment also show direct neurobiological evidence of cerebellar impairment. In order to demonstrate the indirect behavioral results that have indicated cerebellar deficits, Nicolson et al (1999) conducted a study that would provide more direct evidence for cerebellar dysfunction in dyslexia via

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functional imaging. The authors conducted a PET study on six adult dyslexic individuals and six control group adults. They found that brain activation was significantly lower in the right cerebellar cortex when executing either a pre-learned motor sequence or a novel motor sequence. The authors claimed that these differences correspond to two major functions of the cerebellum: execution of acquired skills and learning of new skills. The authors further stated that "it is not surprising, therefore, that for dyslexic children; deficits are found not only across the board for primitive skills, but also especially in cumulative, coordinative skills such as reading" (p. 1666). The authors based this statement on the premise that reading depends on the fluent and coordinated interplay of a range of sub-skills which must be executed, but most importantly, learned. Nicolson et al. hypothesized that these deficits in cerebellar activity represent an abnormality that has existed since birth and have disrupted learning processes from the beginning of the child's life.

The fourth claim of the cerebellar deficit hypothesis is that it is possible to present an ontogenetic causal model for the development of the reading-related problems of dyslexic children with the major causal factor being impaired implicit learning due to cerebellar abnormalities (Nicolson, Fawcett, & Dean, 1999). Cumulative data gathered by Nicolson and colleagues (Fawcett & Nicolson, 1999; Fawcett, Nicolson & Dean, 1996; Nicolson & Fawcett, 1994a, 1994c; Nicolson & Fawcett, 1995; Nicolson et al, 1999; Nicolson, Fawcett, & Dean, 2001) have shown significant correlations between dyslexia and abnormal cerebellar function. In fact, they have shown that approximately 80% of the participants in their studies have exhibited some form of cerebellar dysfunction. However, correlation does not equate with causation and the authors of

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the cerebellar deficit theory are left to hypothesize potential causal roles of the cerebellum in dyslexia. The authors outline a potential ontogenetic causal chain which links cerebellar problems to phonological difficulties and eventual problems in reading, spelling, and writing. The hypothesized chain accounts for each of these typical deficits in a different manner. The authors indicate that both direct and indirect causation occurs via the cerebellum. The hypothesis states that cerebellar deficits can provide a direct explanation of the poor handwriting frequently exhibited by dyslexic children. The hypothesis also states that cerebellar dysfunction can lead to articulatory representation difficulties which might lead to impaired sensitivity to onset, rime, and the phonemic structure of language. In reading, the cerebellar deficits could account for over-effortful reading due to lack of automatisation.

The magnocellular defect hypothesis.

The magnocellular defect theory is positioning itself as the unifying theory that ties together the phonological core, the double-deficit, and the cerebellar deficit hypotheses. The magnocellular defect theory indicates that abnormal development of the visual, auditory, and motoric magnocellular systems underlie the variety of sensory and motoric temporal processing deficits seen in dyslexia, which has a cumulative effect on literacy skills that rely on such processes (Stein, 2001). Earlier versions of this theory addressed only the visual magnocellular system. As such, this hypothesis previously stated that dyslexia was a visual problem, as opposed to a visual and/or auditory problem. However, with the mounting evidence supporting the rapid auditory processing deficit theory (Tallal, Miller, Jenkins, & Merzenich, 1997 for a review), the magnocellular theory has been adapted to include auditory magnocellular defects. The

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magnocellular defect theory goes beyond the visual and auditory levels and continues to evolve, sharing many similarities with the cerebellar dysfunction theory. As a result, the magnocellular theory has now become a more general theory that attempts to explain the perceptual, linguistic, motoric, and sensory deficits exhibited in dyslexia. Therefore, it is currently quite difficult to separate these theories.

      To understand the magnocellular defect theory, a basic review of the visual processing system is warranted. Beyond the occipital cortex, visual processing divides into two circuits. A ventral route is dominated by magnocellular neurons which specialize in detecting motion. This route is devoted to controlling both eye and limb movements and travels into the supramarginal and angular gyri (Skottun & Skoyles, 2000). The dorsal pathway is specialized for identifying visual form and projects into the temporal cortex. This pathway is composed of parvocells. These two processing systems remain largely segregated and independent within the visual system. Although these subdivisions originate in the retina, they are most apparent in the lateral geniculate nucleus (LGN) where the ventral (magnocellular) cells are larger than the dorsal (parvocellular) cells. The magno and parvo subdivisions differ in four distinct manners: 1) magno cells are more sensitive to luminance contrast, 2) magno cells respond faster and more transiently, 3) parvo cells are color coded, and 4) magno cells have slightly lower spatial resolution (Cornelissen et al., 1995). The magnocellular system compiles 10% of the ganglion cells whose axons provide the signals from the eye to the rest of the brain. Larger size means these cells can gather more light from a larger area so that they are more sensitive and faster reacting over a larger area, but not sensitive to fine detail or color (Skottun & Skoyles, 2008).

Studies have shown that dyslexic individuals exhibit a decreased sensitivity to visual contrasts (Lovegrove, Martin, Blackwood, & Badcock, 1980) especially at the low spatial frequencies that are mediated by the magnocellular system. Lovegrove et al. also found that dyslexic individuals actually exhibited greater sensitivity than a control group to high spatial frequencies that are governed by the parvocellular system. This distinction shows that the dyslexic participant's performance on vision tasks was not based on overall bad vision, but bad vision within a specific system. Multiple studies also have shown that dyslexic individuals perform more poorly than controls in flicker fusion tasks (Martin & Lovegrove, 1987; Talcott et al., 1998). Other studies also have examined magnocellular system processes such as visual attention, eye movements, and visual search in the dyslexic population. All three of these components have been shown to be worse in dyslexic individuals (Everatt, 1999; Iles, Walsh, & Richardson, 2000; Stein & Walsh, 1997).

Behavioral dyslexia research conducted on the visual magnocellular system has tended to use measures of visual motion sensitivity in order to study the functionality of this system. The task that is typically employed is known as an RDK task (random dot kinematograms). Stein (2001) states that this task is a sensitive test for probing the entire magnocellular system. In this task, two panels of randomly moving dots are presented side by side. In one panel, the dots begin to move coherently so that they look like a "cloud of snowflakes blown in the wind" (p. 18). Participants are asked which cloud appears to be moving. The proportion of dots that appears to be moving together is then reduced until the participant is no longer able to correctly complete the task. Stein defines this threshold as the proportion of dots that have to move together for the

participant to be able to accurately complete the task on 75% of the trials. By utilizing

this RDK task, Stein and colleagues have found that both children and adults with

dyslexia require significantly higher proportions than normal reading, IQ matched control

individuals (Cornelissen et al., 1994, 1995; Talcott et al., 1998, 2000b). Similar results

have been found in other labs conducting psychophysical studies (Demb, Boynton,

Best, & Heeger, 1998; Eden et al., 1996), electrophysiological studies (Lehmkuhle &

Williams, 1993; Livingstone et al., 1991; Maddock, Richardson, & Stein, 1992), and also

functional imaging studies (Demb, Boynton, & Heeger, 1997; Eden et al., 1996).

Direct evidence, via post-mortem examination, also has indicated impaired

magnocellular system development in the dyslexic population. The brains of seven

dyslexic individuals (four males) were examined and it was found that the magnocellular

layers of the LGN of the thalamus were approximately 30% smaller than those found in

brains of controls (Galaburda & Livingstone, 1993: Livingstone et al., 1991). These

differences are believed to arise during the phase of rapid neuronal growth and

migration during the fourth and fifth month of fetal development (Stein, 2001).

It is not immediately obvious how the above identified differences may contribute

to the manifestations of dyslexia. In fact, these findings seem to have nothing to do with

reading, as magnocells are crucial for motion and the texts that are being read are

generally stationary. To provide information on the relationship between magnocellular

defects and reading abilities, visual motion sensitivity of normal and dyslexic individuals

was compared with the ability to spell irregular words (Talcott et al., 2000b) which is

thought to represent orthographic skills. It was found that participants' visual motion

sensitivity correlates best with their ability to spell irregular words. Visual motion

sensitivity accounted for as much as 25% of the variance. To elaborate on these

findings, Talcott et al. (2000a) conducted a second study which consisted of a second

measure of orthographic skill: the pseudo-homophone task. In this task, the participant

is presented with two words that sound the same but are spelled differently. However,

only one of the spellings is correct. This task is thought to isolate orthographic skills

since a phonological decoding method would not yield the same end result. Once

again, the participants' visual motion sensitivity accounted for a strong proportion of the

variance. However, the main difference in this study is that the authors also obtained

measures of phonological awareness abilities. Correlational analyses revealed that

visual motion sensitivity continued to account for a high proportion of the variability

independently from phonological abilities.

Although evidence suggests that magnocellular defects are present in at least a

proportion of the dyslexic population, the theory also must address why magnocellular

defects affect orthographic reading skills. The first explanation that is offered is that

most children with reading problems have unsteady binocular fixation. Binocular

fixation problems occur when unintended eye movements cause the two eyes not to be

linked in their fixation points. When the two eyes are not linked, lines of sight can cross

each other which also causes the object in sight to be crossing.

The second explanation is based on the findings that dyslexic individuals exhibit

poor visual localization. Visual localization is the steadiness by which individuals can

fixate with their two eyes. This ability correlates highly with visual motion sensitivity

(Stein, 2001). In a study designed to assess this ability, Cornelissen et al. (1997) found

that children with magnocellular dysfunctions were slower and made more errors in

judging the correct order of letters in words when accompanied by briefly presented

neighboring letter anagrams (rain vs. rian). However, possibly the most convincing

argument for the existence of magnocellular defects relative to dyslexia comes from a

series of studies conducted by Stein and colleagues in which it has been found that

occlusion of one eye can lead to increases in reading abilities for children with binocular

fixation deficits (Cornelissen, Bradley, Fowler, & Stein, 1992; Stein & Fowler, 1981,

1985; Stein, Richardson, & Fowler, 2000). The authors claim that simply blanking the

vision of one eye can help ameliorate the visual confusion and help children see letters

more clearly. In a double blind controlled trial that investigated monocular occlusion in

dyslexic children, Stein, Richardson, and Fowler (2000) were able to increase the

reading abilities of those children who received the treatment almost to the reading level

of their peers. Furthermore, it was found that after three months of occlusion, the

binocular stability had also increased to the point where the eye patch was no longer

necessary.

The magnocellular defect theory no longer attempts to explain all manifestations

of dyslexia as visual problems, as it once did. As previously mentioned, there has been

a recent coupling of the magnocellular defect theory with the rapid auditory processing

theory.   The magnocellular defect theory has evolved into somewhat of a double-deficit

(or perhaps even multiple deficit) theory. The previously discussed visual magnocellular

defects are conceived to be responsible for orthographic skill deficits in dyslexia

whereas rapid auditory processing deficits are believed to be responsible for

phonological skill deficits in dyslexia. The rapid auditory processing theory (Tallal,

1980; Tallal et al., 1993) claims that phonological deficits lie in the perception of short or

rapidly varying sounds. The primary tenet of this theory is that higher cognitive

functions are built upon more basic underlying neurobiological processes (Tallal et al.,

1997). The authors state that "in order to better understand phonological processing

disorders, it is important to understand which component acoustic processes are critical

to analyzing the complex acoustic wave form of speech" (p. 50). Evidence exists that

supports the theory that dyslexic and specific language impaired (SLI) children show

severe deficits in higher order auditory processing. More specifically, these deficits tend

to be found in tasks that measure rapid temporal integration of acoustic varying signals

and serial memory (Cowan, 1992; Farmer & Klein, 1995; Hari & Kielsila, 1996; Stark &

Tallal, 1988; Tallal et al., 1993). The rapid auditory processing deficit theory states that

these deficits occur for both non-speech and speech stimuli and they impact central

auditory processing in the tens of milliseconds (ms). To demonstrate these minute

differences, Tallal et al. (1997) refers to the syllables /bæ/, /dæ/, and /gæ/ which differ

only in approximately the first 40 ms. During this time, the articulators move rapidly

from the initial place of articulation into the correct position for the oncoming vowel.

These movements cause rapid frequency changes and are known as formant

transitions. Most individuals can easily perceive these differences. However, it has

been shown that SLI and dyslexic children have difficulties in perceiving these

transitions, and it has been found that these difficulties correlate highly with many of the

most severe aspects of these children's language and reading deficits (speech

perception, speech production, receptive language, and decoding) (see Stark & Tallal,

1988 for a review).

The original version of the rapid auditory processing theory did not make any particular claims at the biological level, but it is now specified within the magnocellular defect theory. As previously stated, there are magnocellular systems in both the visual and auditory systems. Furthermore, the previously mentioned Galaburda and Livingstone (1993) study that was conducted on the brains of dyslexic individuals post-mortem, found not only defects in the visual magnocellular system, but also in the auditory magnocellular system. Whereas the defects in the visual magnocellular system were mostly contained within the LGN, the auditory magnocellular defects were mostly contained within the medial geniculate nucleus (MGN). The MGN is located within the thalamus and serves as a relay between the inferior colliculus and the auditory cortex. It is thought to be primarily responsible for relaying the frequency, intensity, and duration of a sound in addition to relaying binaural information to the cortex.

Sensitivity of the auditory magnocellular system has been examined, similarly to the visual magnocellular system. In the majority of these studies, the stimuli consist of sinusoidal amplitude modulations (AM) and frequency modulations (FM) of a tone. The basic task is much like the visual tasks, where the investigators measure how much the frequency or amplitude of the tones has to be adjusted in order for the listener to distinguish the modulated tone from a pure tone. Several studies have found that dyslexic individuals are significantly worse at detecting these transients than are normal reading control groups, meaning they require larger frequency or amplitude modulation in order to complete the tasks accurately (Dougherty et al., 1998; Han, Saaskilahti,

Helenius, & Uutela, 1999; McAnally & Stein, 1996; Menell, McAnally & Stein, 1999; Stein &McAnally, 1996; Talcott et al., 1999, 2000a; Witton et al., 1997, 1998).

Close associations between sensitivity to auditory transients and phonological skills has been demonstrated. High correlations have been found between FM and AM sensitivity and nonsense word reading, which is a measure of phonological decoding (Talcott et al., 1999, 2000a; Witton et al., 1998). Witton et al. (1998) found that 2 Hz FM sensitivity accounted for 36% of the variance in phonological decoding and Talcott et al. (1999) found that the same sensitivity accounted for 64% of the variance in 10 year old children. Additional studies have been conducted in order to address FM sensitivity's predictability of phonological measures independently from orthographic skill and IQ. It was found that after removing the common variance shared by the three factors, FM sensitivity still continued to account for 25% of the variance in phonological skills (Talcott et al., 2000a).

As previously mentioned, the magnocellular theory is difficult to separate from the cerebellar dysfunction theory. This is because the cerebellum receives massive input from magnocellular projections from all sensory and motor centers. Also mentioned previously, the cerebellum is specialized for automatic preprogrammed timing of muscle contractions for optimizing motor performance. It is involved in the coordination of smooth movements, maintenance of balance and posture, visually guided movements, and motor learning. It has been hypothesized that the quantitatively largest output of the dorsal visual magnocellular route is to the cerebellum via the pontine nuclei, which store the memory of intention during motor activities. Furthermore, the Purkinje cells that are found in abundance in the cerebellum stain

heavily with magnocellular markers (Stein, 2001). Stein stated that the "cerebellum not

only receives timing signals from the magnocellular system in other parts of the brain,

but also it can be considered itself, perhaps the most important part of the

magnocellular timing system of the brain" (p. 27). The main difference between the

magnocellular defect theory and the cerebellar theory is in the proposed origin of the

dysfunction. The magnocellular theory hypothesizes that there are more general

deficits that arise from the magnocellular system, including the cerebellum. The

cerebellar theory claims that these general deficits originate in the cerebellum alone.

The asynchrony theory.

The asynchrony theory may be considered a unifying theory of all the previously

mentioned theories. It is a recently proposed theory (Breznitz & Misra, 2003) and has

not been subjected to any scientific scrutiny at the time of this review. However, its

merits lie in the ease at which it can be integrated and applied within the framework of

the majority of the currently accepted theories regarding the etiology of reading

disorders. The claims associated with the asynchrony theory are not at odds with any

of the previously mentioned theories.

Presentation of the asynchrony theory requires a discussion of speed of

processing (SOP) as it relates to the reading process. SOP is essentially the duration

that passes from the presentation of a stimulus to the behavioral response (Breznitz,

2002). During this time, the information moves through several distinct processing

stages (Atkinson & Shiffrin, 1971) while operating within the confines of a limited

capacity working memory which exhibits a high rate of decay (Baddeley, 1986). Due to

these constraints, word reading effectiveness is structured by the efficiency of the

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processes (orthographic and phonological) that are required for accurate word identification.

Also critical to an understanding of the asynchrony theory is a brief review of the different systems involved in word recognition. As previously stated, word recognition is reliant on two systems: the auditory based phonological system and the visual based lexical (orthographic) system (Catts & Kamhi, 2005). The auditory based phonological system is reliant on sequential processing since the auditory signal must unfold over time whereas the visual system is believed to operate at a more holistic and instantaneous level (Coltheart et al., 1993). Research has shown that both phonological and orthographic representations contribute to reading proficiency (Coltheart & Coltheart, 1997). Each of the corresponding orthographic and phonological patterns must be recognizable for word recognition to occur (Adams, 1990; Bowers, Golden, Kennedy, & Young, 1994). Breznitz (1997c, 2001) has indicated that mismatches may result if the timing, coordination, or integration of the information arriving from each system is impaired. It also has been hypothesized that only when the phonological, orthographic, and semantic aspects of a word have been fully amalgamated in memory can word recognition become automatic (Bowers & Wolf, 1993).

Individuals with reading disorders have been shown to have SOP deficits in a variety of areas that are related to reading such as working memory (Breznitz, 1997a; Breznitz & Share, 1992), word retrieval (Breznitz, 1987), naming speed (Bowers & Wolf, 1993; Nicolson & Fawcett, 1994b; Wolf, 1991; Wolf & Bowers, 1999; Wolf, Bowers, & Biddle, 2000); cross-modality integration (Breznitz & Meyler, 2003; Meyler & Breznitz,

2003; Nicolson & Fawcett, 1993; Tzeng & Wang, 1984; Yap & van der Leij, 1993),

phonological abilities (Breznitz, 2003), visual temporal processing (Corcos, Kruk, &

Willows, 1993; Eden, Stein, & Wood, 1993; Lovegrove & Staghuis, 1989; Wright &

Groner, 1993) and in auditory temporal processing (Cowan, 1992; Farmer & Klein,

1995; Hari & Kielsila, 1996; Stark & Tallal, 1988; Tallal et al., 1993; Watson, 1988,

1992; Watson & Miller, 1993). Although reading related SOP deficits in isolation may

intuitively explain some of the hallmark features of dyslexia such as slow reading speed

and poor reading comprehension, it cannot account for inaccurate decoding. A slowing

of processing should slow down the identification of graphemes and the subsequent

translation into phonemes, but theoretically it should not affect the accuracy of the word

identification. Therefore, Breznitz and colleagues (Breznitz, 2002; Breznitz & Meyler,

2003; Breznitz & Misra, 2003; Horowitz-Kraus & Breznitz, 2010, 2011; Meyler &

Breznitz, 2003,2005) have claimed that an asynchrony must exist between the SOP

characteristics of the two systems (visual and phonological) that are responsible for

word recognition. Breznitz (2002) states that "it can be argued that accurate word

recognition requires that exact connections be made between visual representations of

letters and words and their acoustic counterparts at both lower and higher levels of

processing. That is, at the level of graphemes and phonemes" (p. 16). She further

explains that for an accurate match to be made between the two systems there must be

a coordination of information at each stage of processing. As previously stated, the

visual (orthographic) system operates more holistically while the auditory (phonological)

system must operate in a sequential manner.   Therefore, higher level visual processing

systems may arrive faster than input to phonological processing systems (Breznitz,

1997a, 1997b, 1997c). However, it has been found that incoming lower level visual information arrives at the visual cortex approximately 70 ms post-stimulus presentation (Schmolesky et al., 1998) whereas lower level auditory information arrives in the auditory cortex approximately 30 seconds post-stimulus presentation (Heil et al., 1999). As reading requires successful integration between these two systems at both high- and low-levels of processing, it is likely that speed synchronization must occur between modalities. Breznitz and Misra (2003) claim that this integration is reliant on both the phonological and orthographic systems operating at an appropriate pace.

Claims associated with the asynchrony theory are mostly based upon a series of event-related potential (ERP) studies that have been completed in Breznitz's lab (Breznitz, 2002; Breznitz & Meyler, 2003; Breznitz & Misra, 2003; Horowitz-Kraus & Breznitz, 2010, 2011; Meyler & Breznitz, 2003; 2005). Breznitz (2002) indicates that behavioral measures such as reaction time and response accuracy are only capable of providing information regarding the conclusion of a cognitive event after it has proceeded through sensory, cognitive, and motor processes. She states that in order to gain information regarding timing and amplitude characteristics of stimulus evaluation, lexical integration, and response selection, an online technique must be employed in addition to behavioral methods.

ERP methodologies are designed to provide real-time imaging of the neural system's response to incoming sensory stimulation while providing data regarding the timing of various cognitive activities during the process of word recognition (Bentin, 1989). Two components of interest in the majority of Breznitz and her colleagues' ERP studies are the P200 and the P300. The P200 component is a positive component that

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is evoked at about 200 ms post stimulus onset. It is thought to reflect endogenous

cognitive processing (Dunn, Dunn, Languis, & Andrews, 1998) such as feature

detection (Luck & Hillyard, 1994), selective attention (Hackley & Valle-Inclan, 1998), and

working memory function (Smith, 1993). The P300 is also positive but it appears

between 280 and 600 ms after the onset of a stimulus (Breznitz, 2002). It has been

suggested that the P300 reflects the central activation of information processing

(Palmer, Nasman, & Wilson, 1994), updating in working memory (Donchin & Israel,

1980), cognitive resource allocation (Kramer, Strayer, & Buckley, 1991), and mental

effort (Wilson, Swain, & Ullsperger, 1998. The latency of the P300 has been

hypothesized to reflect higher order cognitive processing such as stimulus evaluation

and categorization (Polich, 1987; Polich & Heine, 1996) and also has been used as a

temporal measure of neural activity underlying the speed of attentional allocation and

immediate memory operation (Cohen & Polich, 1997; Polich & Heine, 1996).

Meyler and Breznitz (2005) utilized ERP methodology in a study designed to

investigate the asynchrony theory in a group of thirty three adult university students.

Seventeen of these adults were diagnosed with dyslexia as children and again by

student support services at the university. The average age of the participants was 26

years, 9 months. The experimental tasks in this study consisted of an orthographic

decision task where the participant was presented a word and a nonsense word side by

side on a computer screen. The participant was required to decide which item was

spelled correctly and pressed a button that corresponded to the correct item. In

addition, a phonological decision task was completed in which the participant was

required to make a decision on which of two nonsense words sounded like a real word.

Twenty two channels of ERP data were recorded and analyzed focusing on the latency

and amplitude of the P200 and P300 components. A series of MANOVAs were

completed on the ERP data and the authors found that dyslexic individuals exhibited

P200 components with later latencies and lower amplitudes only in the phonological

tasks whereas the P300 components were found to be late and with less amplitude in

both the phonological and orthographic tasks.

Meyler and Breznitz (2005) also found time gaps between different stages of

information processing. Their data showed that the time gaps between the P200 and

P300 were more elongated among the dyslexic group compared to the control group.

They proposed that this was evidence of a slower rate of transfer of encoded

information into working memory. The combination of the latency, amplitude, and gap

duration results led the authors to conclude that the efficient synchronization of SOP for

phonological and orthographic information did not occur in the group of individuals with

dyslexia. They further claimed that "impaired SOP in either route to the mental lexicon

may impede successful cross-modal integration because…the neural networks

responsible for phonological and orthographic processing must be coordinated in time

so that each arrives at a stable configuration (lexical representation) simultaneously" (p.

234). The slower SOP exhibited by both of the systems caused a time gap between the

phonological and orthographic system, which in the asynchrony theory, represents the

etiology of reading disorders. Breznitz and Meyler (2003) elaborated upon the effects of

such a time gap. They indicated that information arriving from one system earlier than

the corresponding information from the other system is subject to decay due to the

constraints of working memory. As a result, information regarding the same stimuli that

is retrieved from the phonological system may not match the information from the orthographic system if the earlier arriving information being held in working memory has already begun to decay. A growing number of mismatches might result in the impairment of the formation of any accurate and stable representations of the stimulus in memory.

Although the previously mentioned study (Meyler & Breznitz, 2005) showed that SOP deficits exist in adults, the effects of reading disorders are apparent far before adulthood. Any theory of reading disorders must provide evidence that the core deficits are not only present in adults, but also present in children. This is especially important considering that there are findings that suggest there are developmental aspects to SOP (Kail, 1991). Kail collected seventy two published studies which yielded 1,826 pairs of response times. A pair consisted of adults' mean reaction times and a corresponding mean reaction time for a younger group. The children's and adolescents' reaction times increased linearly as a function of adult reaction time. Therefore, if SOP is not constant throughout the lifespan then it is imperative to investigate whether or not the deficits that are apparent in the adult population are also evident in the younger population.

Breznitz (2002) conducted an ERP study that utilized twenty male children with dyslexia and 20 chronological age-matched children. The mean age of the children was 10 years, 3 months. The experimental tasks in this study consisted of lower-level auditory and visual tasks (both linguistic and non-linguistic), and higher-level operations (phonological and orthographic processing tasks). The phonological tasks consisted of a homophone decision task in which the child was required to select whether the two

simultaneously presented words sounded alike. A rhyme decision task also was

employed in which the child was required to decide whether or not two simultaneously

presented words rhymed. The orthographic task consisted of a homograph decision

task in which the child was required to decide whether two simultaneously presented

words looked the same. As was the case in the previously mentioned adult study

(Meyler & Breznitz, 2003), Breznitz (2002) focused on the P200 and P300 components

of the ERP. The results were similar to those of adults, with SOP deficits in both

phonological and orthographic tasks as represented by delayed latencies and

decreased amplitudes of the ERP data in conjunction with slower reaction times.

However, the phonological deficits were more pronounced than the orthographic deficits

in this sample of children, which is a different finding than Meyler and Breznitz (2003)

who found no significant difference between tasks, only between groups. However,

there was a case in which this finding was reversed, which Breznitz (2002) claimed

might represent the possibility of a dyslexic subtype similar to the naming speed deficit

subtype defined by the double-deficit hypothesis (Wolf and Bowers, 1999).

Assessment and Intervention

      Assessment.

      Assessment is arguably the most critical step in the intervention process. An

assessment should be thorough and dynamic; in other words, it should emphasize not

only test scores, but the language and learning skills and strategies employed by each

individual person (Reid & Wearmouth, 2002). As evidenced by the previous discussion

on the different reading processes, there are many components related to reading

success. Therefore, a thorough investigation into each component is warranted as a

breakdown at any of the stages of processing (perceptual analysis, word recognition, or word-to-text integration) can result in difficulties in reading accurately with understanding. Due to the heterogeneity of reading abilities across the lifespan, it is unlikely that the perfect reading assessment battery will ever be assembled. If it were ever assembled, it is likely that no professional would have enough hours in the day to assess their caseloads with such a comprehensive evaluation. However, at the bare minimum a reading assessment should utilize tasks that measure decoding and comprehension. A more in depth assessment (which is recommended here) would include an investigation of phonological abilities, single word and textual decoding accuracy and rate, comprehension, and memory.

     Phonological awareness.

     As phonological awareness is believed to be fundamental to developing decoding skills, deficits in this area should be initially investigated. Phonological awareness involves access to the "phonological structure of spoken words, rather than just to their meanings and syntactic roles" (Scarborough, 1998, p. 85). If deficits are found in this area, it is likely that deficits in decoding and comprehension also will be present. McBride-Chang, Wagner, and Chang (1997) states that "phonological awareness is one of the two strongest longitudinal predictors of reading…. an even better predictor of subsequent reading success than is general cognitive ability, typically measured using an IQ score" (p. 621). Phonological awareness may be assessed through various tasks; however, all phonological awareness tasks require that participants recognize and manipulate the sound structure of language (McBride-Chang et al). More specifically, tasks that assess phonological awareness abilities include

rhyming words, matching initial word sounds, or counting the number of phonemes (sounds) included in single words. Being able to identify separate words in a spoken sentence, separating the two words in a compound word, or hearing and separating syllables in words all require phonological awareness. Phonemic awareness, which is a distinct aspect of phonological processing, is the "insight that every spoken word can be conceived as a sequence of phonemes" (National Research Council, 1998, p. 52). For example, cat is one word, but is composed of three phonemes: /k/, /a/, and /t/. Tasks involving the blending, deleting, substituting, or moving of individual phonemes within or between words require phonemic awareness or the ability to detect and manipulate individual sounds.

Decoding.

Decoding, which occurs during the word recognition stage, is a foundational ability that is relied upon by subsequent word-to-text integration stage of reading. However, decoding abilities represent a multifaceted area that must be examined with different contexts and approaches. Decoding measures such as accuracy and rate should all be assessed.

Single word decoding is the most frequently used task to assess decoding proficiency.   These tasks typically remove the contextual or pictorial cues that may be present in reading material and seek to investigate word recognition without the aid of other cues. Both standardized and non-standardized decoding tasks typically assess decoding in two manners. These two manners correspond to the two methods of decoding words according to dual route theories of decoding (Coltheart et al., 1993). Phonological decoding is assessed through the decoding of nonsense words (word

attack) while sight word decoding is assessed using real words, especially nonphonetic words (word identification). Phonological decoding refers to the ability to know the sounds of the language, know what letters those sounds correspond with, and blend together those individual sounds into a word. The rationale behind utilizing nonsense words is to attempt to eliminate the use of sight word recognition. The basic premise is that an individual should not have a nonsense word in their sight vocabulary (lexicon) and therefore must rely on sounding the word out. The rationale behind utilizing non-phonetic words in a word identification task is to limit the amount an individual can sound out the words via phonological rules. For example, if one were to attempt to sound out the word "laugh" by its constituent sounds, the end result would be something far different than the correct pronunciation. When these tasks are utilized in an evaluation, much can be learned relative to an individual's reading abilities. Assuming the results of the evaluation reveal deficits in decoding abilities, the investigator should then discern whether any discrepancies exist between sight word decoding and phonological decoding as this information can help guide the intervention process. The investigator should also ascertain the strategies that were used during unsuccessful decoding. This can be accomplished by doing error type analyses.

Caution should be taken when interpreting single word decoding tasks. It has been found that numerous factors can have a significant impact on the results of decoding tasks (Carter, Walker, Rastatter, & O'Brien, 2008). The study conducted by Carter et al. was designed to address the authors' perceived limitations of a well-established single word decoding tool. The *Woodcock Reading Mastery Tests – Revised* (WRMT-R) (Woodcock, 1987) contains two single word decoding tasks (word

identification and word attack) in which the participant is given up to 5 seconds to decode a single word before proceeding to the next stimulus item. The authors claimed that given the amount of time allotted for each response, the individual could be code-switching between the two decoding methods for the Word Identification subtest which would render it as a flawed measure of sight word decoding. As previously mentioned, the lexical decoding route is believed to be the r more rapid and efficient decoding strategy. Therefore, the authors conducted a study in which they presented the word identification and word attack subtests of the WRMT-R to a control (n=20) and an experimental group with a diagnosed reading disorder (n=16) at durations of 25 and 100 ms while allowing the participants 3000 ms to verbally decode the presented word. The most notable finding was that the more rapid presentation durations resulted in more accurate sight word decoding for reading disordered individuals. Furthermore, the distinction between the classification groups began to become less clear. Seven of the participants exhibited the opposite decoding pattern when the factor of stimulus presentation duration was introduced. The authors concluded that the findings bring into question whether the WRMT-R can accurately identify and classify reading disordered individuals based upon strengths or weaknesses in either phonological or visual decoding. This finding is of importance in regards to intervention when the plan is often tailored to address deficits in either phonological decoding or lexical decoding.

A different context in which decoding should be examined is during the reading of text. These measures are typically obtained simultaneously while oral comprehension measures are being obtained. These measures are designed to assess the accuracy, rate, prosody, and decoding strategies that are used during textual reading. Textual

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decoding accuracy may differ from single word decoding accuracy in that the individual is able to utilize contextual cues from the text (Catts & Kamhi, 2005). Inaccurate word reading has been considered the hallmark feature of dyslexia (Breznitz & Misra, 2003). Furthermore, textual decoding rate is becoming more important as the value of fluency continues to increase in the reading assessment realm (Breznitz, 2005b). Reading fluency has been defined as the "ability to read text quickly, accurately, and with proper expression (National Reading Panel, 2000, pp. 3-5). Therefore, accuracy and reading rate represent two-thirds of this mostly standard definition of reading fluency, although in practice they represent closer to 100% of the definition. The third aspect of this definition includes expression, or prosody. However, few, if any, of the available standardized measures offer any measure of this fluency component. Non-standardized measures have been developed, but each of these uses their own qualitative criteria and no consensus has been reached regarding their validity. Therefore, most standardized measures tend to ignore the prosody aspect and focus on accuracy and rate measures while simultaneously claiming that they are accurately measuring fluency. However, much can still be learned about the strategies that are being employed during reading by the rate at which one reads. If the reader reads at an appropriate pace, then that individual is most likely reliant upon sight word decoding as opposed to phonological decoding. As previously mentioned, a reliance on sight word skills is the mark of an automatic reader. A reader who continues to decode text in a phonological manner though his age suggests that he should be more automatic is most likely going to struggle with the end goal of reading: comprehension. As previously

stated, the phonological decoding method utilizes more energy and attention that could otherwise be focused toward comprehending the text.

Another non-standardized manner of interpreting textual decoding is by attempting to code and classify the error types that are made by the individual. By completing this inventory, the clinician can describe in words what it is that the individual is actually doing with far more detail than could ever be gleaned from any standardized score. Error classification categories differ between methodologies, but most of them generally include phonological errors, visual errors, and errors of omission. A phonological or sound based error can occur when the reader tries to use letter-sound mappings that are inaccurate. The mappings may be inaccurate due to lack of knowledge (e.g. not knowing what sound the "f" letter makes). They may be inaccurate due to over-generalizing of phonological rules onto non-phonetic words (e.g. trying to sound out the word "laugh"). Or they may be inaccurate due to poor blending skills which would be highly noticeable at syllable junctures and at the boundary between the two roots of compound words (Goulandris, 1996). A visual error typically occurs when the individual confuses one word with a visually similar word (chair for choir) or a word that agrees with the individual's perceived meaning or context of the text. The latter type of error can be further classified as an anticipatory visual error. The final type of errors is an error of omission which occurs when an individual skips a word either intentionally or unintentionally. Although this classification system is easy to describe, the errors in real life situations often do not conform to such simple divisions. However, with enough detective work and reasoning, frequently a likely explanation can be arrived at which may prove invaluable to the reading practitioner.

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In addition to better describing the processes that are occurring during textual decoding, the investigator will be able to witness firsthand the detrimental effects of a participant's encounter with an incorrectly decoded word. The investigator can note how long is spent on a word that is difficult for the reader. Textual decoding tasks also allow the investigator to make inferences about the amount of mental effort and attention that is being devoted to the task. When listening to one read aloud, it becomes more apparent as to whether or not that person is attempting to read accurately or if they are just moving through the text as hurriedly as possible with little regard to actually processing the information. These qualitative measures may prove to be highly beneficial when designing the subsequent treatment plan for an individual with a reading disorder. Textual decoding is a more naturalistic situation than single word decoding and it often can provide valuable information.

Reading comprehension.

Reading comprehension is the end goal of nearly all reading activities. As such, the results of a reading evaluation must be able to address the comprehension level that the individual is portraying. Phonological abilities, decoding abilities, and working memory are all assessed to determine why comprehension deficits exist. If no comprehension deficits exist, it is unlikely that an individual will ever be referred for a reading evaluation. However, assessing reading comprehension is not as simple as placing a text in front of an individual and asking them questions after they have read the material. Many aspects of reading comprehension should be assessed. Perhaps it is for this reason that some well known reading comprehension tools have been found

to lack scientific rigor (Coleman, Lindstrom, Nelson, & Gregg, 2010; Keenan & Betjemann, 2009; Keenan, Betjemann, & Olson, 2008).

Reading comprehension should be assessed both silently and orally. If one is only administered silent reading tasks, then no statement can be made regarding textual decoding accuracy. If only oral reading tasks are administered, then it is impossible to quantitatively state if the reader is more adept at reading aloud or silently. In order to gain the most information possible from the amount of time allotted for an evaluation, both oral and silent reading comprehension should be assessed.

As is the case with single word decoding tasks, one must take caution when utilizing standardized reading comprehension tasks. The *Gray Oral Reading Tests 4th Edition* (GORT-4) (Wiederholt & Bryant, 2001) is a nationally normed reading comprehension tool that allows the user to obtain standardized measures of textual decoding accuracy, reading rate, fluency (a composite between accuracy and fluency), and reading comprehension. The stimuli for the test are comprised of thirteen passages that are designed to increase in difficulty as the test proceeds. Five multiple choice comprehension questions are administered after reading each passage. Keenan and Betjemann (2006) investigated the passage dependence of these questions. They found that 86% of the questions on the GORT-IV could be answered 25% of the time without ever reading the passage. One fourth of the questions could be answered with 75% or more accuracy. They further analyzed the data and found that the difficulty of the passage was not an accurate indicator of whether or not the question was passage dependent. In fact, one question that appeared on the most difficult 13th level was answered with 96% accuracy in the passageless presentation method. The authors

went on to claim that the GORT-IV was not actually measuring reading comprehension abilities inasmuch as it is measuring prior knowledge the best predictor of performance on this test was actually how easy the question could be answered as opposed to how accurately the passage was actually read. Furthermore, Coleman et al. (2010) found similar results when investigating the Nelson-Denny Reading Test (NDRT) (Brown, Fishco, & Hanna, 1993). These two tests represent two of the more prominently utilized reading comprehension assessment tools that the reading field has to offer. Passage independence has been found to be a problem in numerous tests other than these as well, such as the *Minnesota Scholastic Aptitude Test* (Fowler & Kroll, 1978), *Stanford Achievement Test* (Lifson, Scruggs, & Bennion, 1984), *Scholastic Achievement Test* (SAT) (Daneman & Hannon, 2001; Katz, Lautenschlager, Blackburn, & Harris, 1990), and the *Test of English as a Foreign Language* (Tian, 2006).

Another aspect that must be considered is the format in which the questions are presented in a reading comprehension assessment. Different formats include cloze (sentence completion), multiple choice, true/false, open-ended, and online procedures (e.g. eye tracking). It has been indicated that cloze and multiple choice formats essentially measure word recognition skills (Francis, Fletcher, Catts, & Tomblin, 2005; Keenan, Betjemann, & Olson, 2008; Nation & Snowling, 1997). Keenan et al. (2008) completed a study that investigated the validity of the assumption that all reading comprehension measures are essentially assessing the same skill. The authors gave 510 children a battery consisting of: four reading comprehension measures, three listening comprehension measures, two decoding measures (one timed and one untimed), and one nonword decoding measure. The oral comprehension measures that

were used were the *Gray Oral Reading Test–3* (GORT; Wiederholt & Bryant, 1992), the

Qualitative Reading Inventory–3 (QRI; Leslie & Caldwell, 2001), the Woodcock–

Johnson Passage Comprehension subtest (WJPC) from the *Woodcock–Johnson Tests*

of Achievement–III (Woodcock, McGrew, & Mather, 2001), and the Reading

Comprehension subtest from the *Peabody Individual Achievement Test* (PIAT; Dunn &

Markwardt, 1970). The authors found that the variance in scores on the *WJPC* (cloze)

and the *PIAT* (multiple choice) could be accounted for most by decoding skill.

Keenan et al. suggested that their results were not only due to the question

format, but also to another variable of interest: passage length. The PIAT utilizes single

sentences as the stimuli whereas the WJPC typically utilizes two sentences as the

stimuli with one item consisting of three sentences. Keenan et al. hypothesized that the

assessment of comprehension in a short passage is likely to be based upon the

successful decoding of a single word that is found within that passage. They also

indicated that it is likely that a decoding error is more "catastrophic" in a short passage

(p. 297) than it would be in a long passage. In a single sentence, there are few other

words that might help a child determine the correct pronunciation of a difficult word

whereas in longer passages, there is much more context and more of a story arc that

might offer a reader clues as to not only the correct decoding of a word, but also the

meaning of that word. This hypothesis was supported by their findings on the QRI

measure which has relatively longer passages.

In addition to passage dependence, question format, and passage length, an

investigator also must be concerned with the genre of text that is being utilized in a

reading comprehension measure. Previous research has shown that the genre in which

a text is presented can influence the comprehension measures that are obtained (Alvermann, Hynd, & Qian, 1995; Hartley, 1986; McDaniel & Einstein, 1989; Wolfe, 2005; Wolfe & Mienko, 2007). Most of the research has suggested that narrative processing tends to be focused more on the comprehension of the organization of events in a story, whereas expository processing has been shown to be more focused on the activation and integration of relevant prior knowledge into the discourse representation (Wolfe & Woodwyk, 2010). Due to the heavy reliance on prior knowledge in expository processing, some individuals may be placed either at an advantage or a disadvantage when reading certain texts. Specifically, if a comprehension measure uses a text on the history of a certain invention, it is possible that in a cohort of research participants you might assess one or more participants who are highly familiar with that topic. The opposite of that is that you also may encounter one or more participants who have no familiarity at all with the invention. Those who have prior knowledge of the topic are placed at a distinct advantage over the individuals who do not possess this prior knowledge. Any claims that are actually made regarding the *reading comprehension* of these individuals may be misleading. It is certainly possible, that in all actuality, the researcher has only obtained a measure of someone's ability to store and retrieve verbal information regarding their prior experiences.

A final variable of interest that should be considered in the assessment tool selection stage is the type of questions that are asked. Most questions that are typically used in reading comprehension measures fall under one of two categories: literal, meaning they require the reader to recall or revisit explicitly stated information in the passage or inferential, meaning they require the reader to infer the author's thoughts,

integrate multiple lines of text or generate arguments that are implied from the passage (Williams, Ari, & Santamaria, 2011). It has been shown that children are best at answering literal questions (Guszak, 1972; Hansen, 1981). However, this type of question is mostly a measure of rote memory and not an indicator of how well one truly understands the material beneath the surface layer of who, what, when, and where. Questions that are more of the inferential type tend to lead to more elaborate mental processing while stimulating thought, reason, and logic (Singer, 1978). It is for this reason that inferential questioning can result in "active comprehension" which Singer claims is when readers "learn to ask their own questions and guide their own thinking so that they can become independent in the process of reading and learning from text (p. 904). Singer describes this process as reliant upon the reader constantly generating, evaluating, and accepting or rejecting numerous hypotheses throughout the course of a text. However, it should be noted that this level of comprehension is reliant upon a solid foundation of the literal understanding of a text as well (Hansen, 1981). Therefore, one should consider administering an assessment tool that is designed to not only assess literal understanding of the text, but also inferential understanding of the text.

In summary, there are numerous factors that can have an effect on the results of a reading comprehension measure. Although researchers would tend to agree that reading comprehension is in fact a highly complex skill that is made up of several complex components, reading comprehension measures do not reflect this complexity. Instead, as Keenan et al. (2008) stated, "different reading comprehension tests measure different skills…sometimes even the same test measures different things depending on age and ability" (p. 298). When determining an appropriate assessment

tool, it is important to factor in the variables of passage dependence, passage length, the component skills which the format is reliant upon, the text genre, and the question type. Thus, it is prudent to utilize as many measures as time allows in order to obtain a reliable and accurate diagnosis so that the treatment plan will be focused on the most necessary aspects of the disorder.

Diagnosis.

Only after the administration of a thorough battery of decoding, phonological awareness, and comprehension tasks can a reliable diagnosis be made. There are different criteria used to diagnose RD. One method involves comparing the individuals standardized scores that were obtained on the assessment tasks to the normative data which is provided by the assessment tool (typically based on either age or grade level). The normative data provided by the assessment tool defines the level of performance that should be expected by an individual at specific ages and grade levels. A discrepancy between at what level a person should be performing (normative data) and the level at which the individual is actually performing (standardized score) is one way in order to diagnose RD. For example, a standard score, or quotient, has an average range of 85-115, μ=100, SD±15. Therefore, if the test scores are within the 85-115 range, then the person's performance on that task is considered average. If the individual's test scores fall below the average range, they are considered for a diagnosis of RD.

Another, often controversial, method that is used for the diagnosis of RD involves using intelligence versus performance discrepancies. This method involves examining the overall IQ score from tests such as the Wechsler Intelligence Scale for Children-4th

Edition (WISC-IV) (Wechsler, 2003) or the Wechsler Adult Intelligence Scale-4th edition

(WAIS-IV) (Wechsler, 2008) and comparing them with reading tests (performance

tests). As opposed to diagnosing RD based on whether the performance score falls

one standard deviation below the normative average range, this method diagnoses if

the performance score falls outside of the "expected" average range of the IQ score.

For example, if a child receives an IQ score of 90 on the WISC-IV and receives a

standard score of 77 (less than one standard deviation below the IQ score) on a reading

test, then the child is considered to be functioning in their potential range and would not

be diagnosed with RD even though the standard score of 77 is clearly outside of the

average range of their peers. As mentioned previously, this diagnostic criterion is

controversial.

Stanovich et al. (1997) have indicated that the phenotypic indicators of poor

reading (phonological processing deficits) do not correlate with the degree of

discrepancy between intelligence and achievement in poor readers. They state that

reading disabled children with high and low IQs seem to differ greatly in other

information processing systems that support word recognition. Therefore "if there is a

special group of reading disabled children who are behaviorally, cognitively, genetically,

and/or neurologically "different", it is becoming increasingly unlikely that they can be

easily identified by examining achievement/IQ discrepancies" (p. 116). Siegel (1989)

also found inadequacies in using this discrepancy method. Among Siegel's arguments

is the claim that portions of IQ tests are linguistically loaded and measure reading

abilities not actual intelligence. The author notes that the verbal scale of the WISC-R

(Wechsler, 1974) contains a subtest called Vocabulary which requires the child to define

specific words. Siegel states that it is reasonable to expect a child with a reading

disorder to engage in reading far less frequently than their normally developing peers,

and should not be expected to possess a similar vocabulary. Furthermore, Siegel

states that the majority of these tasks measure expressive language because the

response to most questions requires the use of expressive language.

Another issue relative to diagnosis is whether a subtyping method should be

employed. As previously mentioned, individuals with RD are a heterogenic population

who possess reading abilities that can vary tremendously. To treat each individual with

a reading disorder diagnosis in a similar manner would be to ignore the uniqueness

between each of these individuals. However, some researchers/clinicians are opposed

to the subtyping of individuals with reading disorders. Regardless of whether one

chooses to employ a specific method of subtyping into their clinical practice, each

diagnosis should be as explanatory as possible regarding the component processes of

reading. If one chooses to employ a subtyping system, there are a number of

classification methods. These methods should not be considered interchangeable,

even though there are similarities between most of the systems.

One classification method classifies RD into two categories: developmental

phonological dyslexia and developmental surface dyslexia (Castles & Coltheart, 1993).

Developmental phonological dyslexia is characterized by poor nonword reading while

developmental surface dyslexia shows deficits in non-phonetic word reading (Castles,

Datta, Gayan, & Olson 1999). Castles et al. claim that these classifications are not

based on the presence of difficulty in one area and not the other, but rather the

existence of an imbalance between the two skills. However, this classification method

was shown to have its weaknesses when compared to normal readers, for which this classification method was not originally applied. Stanovich, et al. (1997) reanalyzed the data from Castles and Coltheart (1993) while including a normal reading control group in the analysis. They found that the slope of the function relating pseudoword performance to reading age (in months) was steeper for the reading-disabled population than for the chronological age controls (.260 versus .128). However when the reading range was restricted to the lower range (< 117 months) where there was an overlap between the calculated age controls and the reading disabled sample, there was no difference in slopes (.305 versus .378). The authors warned that there are age limits to which this diagnostic classification system might apply.

A similar diagnostic classification system is the Boder classification system which groups RD into five subtypes: normal readers, poor readers with a nonspecific reading disability, dyseidetic readers, dysphonetic readers, and mixed dysphonetic-dyseidetic readers (Boder, 1973). The dyseidetic subtype is similar to the developmental surface dyslexia and the dysphonetic subtype is similar to the developmental phonological dyslexia. The third classification subtype, mixed dysphonetic-dyseidetic, is a combination of the two subtypes.

Another classification system that has been previously mentioned, is the classification method used by Wolf and Bowers' (1999) double-deficit hypothesis. This system subtypes individuals as either phonologically impaired, naming speed impaired, or both.

Intervention.

Intervention is tightly interwoven and with every aspect of the assessment process. The plan for reading intervention should be revealed from and guided by the assessment results. Reciprocally, the assessment battery should lean heavily on the available intervention options and the unique limitations that exist in every situation (e.g. time, space, and materials). Furthermore, the theoretical biases of individuals are often highly apparent in the selection and design of their courses of reading intervention. For example, proponents of the phonological core deficit hypothesis tend to implement treatment protocols that are heavily weighted in phonologically based treatment methods.

The following discussion will address more general philosophies on reading remediation as opposed to specific programs of reading remediation, although specific programs will be mentioned when necessary. Review of specific reading programs is beyond the scope of this study. The Fast ForWord programs (FFW) are a family of three separate programs that have been studied rigorously by the academic community. However, as of this review, no single study exists which studies the individual effectiveness of two of the three programs (Fast ForWord Reading Series and Fast ForWord Literacy Series). Only the original program (Fast ForWord Language series) has yielded any published reports on its methods and results. Regardless, researchers still continue to study the effects of the original FFW Language series on reading abilities, when there is a separate program that is specifically designed and devoted to reading. In using a more general framework to address reading interventions, it is possible to use a categorical approach. Although each program does represent a unique approach with its own nuanced methodologies and terminologies, they still can,

for the most part, be placed into one of a few common rubrics. The National Reading

Panel was established in 1997 and charged with the investigation of the most effective

practices for teaching children to read (NRP, 2000). The panel focused its review on

five important elements of reading: alphabetics, fluency, comprehension, teacher

education, and computer/technology delivery systems. The current review will semi-

adopt this categorical division. Specifically, a review will be provided regarding the

treatment of phonological abilities (alphabetics), fluency, and comprehension as they

are the most relevant to the current study. These three areas are typically deficient in

individuals with reading disorders and as such can be considered as cognitive level

symptoms of reading disorders (Reynolds, Nicolson, & Hambly, 2003). Following a

discussion on the treatment of cognitive level symptoms, a summary of treatment

protocols that bypass the cognitive level and address the neural level will be presented.

Cognitive level treatments.

Phonological abilities.

Alphabetics as defined by the NRP (2000) consists of two elements: phonemic

awareness and phonics. Both of these components also fit neatly into the phonological

abilities category. Phonological abilities have received the most focus in research

devoted to reading development and intervention. As previously mentioned it is

believed that a child who is learning to read must first develop an understanding of the

segmental nature of speech and understand that spoken words are composed of the

smallest of these segments - the phoneme (Pugh et al., 2001). The internal

phonological structure within each word must be recognized as based upon the spoken

word. It is the understanding that the constituents of a printed word bear a relationship

to phonemes that enables a reader to connect printed words to the corresponding

representations in their lexicon. Also as previously mentioned, phonological abilities

can typically be revealed by tasks such as rhyming words, matching initial word sounds,

or counting the number of phonemes (sounds) included in single words. Being able to

identify separate words in a spoken sentence, separating the two words in a compound

word, or hearing and separating syllables in words all require phonological awareness.

Phonemic awareness, which is a distinct component of phonological abilities, is typically

assessed by tasks involving the blending, deleting, substituting, or moving of individual

phonemes within or between words. If the chosen assessment tool reveals deficits in

these types of tasks, then typically these types of tasks become the cornerstone by

which the intervention plan is built upon. There are numerous intervention programs

which focus the majority of their emphasis on the remediation of these phonological

abilities. Some of the more well-known examples of phonological methodologies

include the Lindamood-Bell Learning Processes approach (LiPS) (Lindamood &

Lindamood, 1998), the Orton-Gillingham approach (Gillingham & Stillman, 1997), and

the Phono-Graphix method (McGuinness, McGuiness, & McGuinness, 1998).

Research has revealed that phonological abilities can be improved with

remediation (NRP, 2000). Torgesen et al. (2001) completed an intervention study in

which 60 children who were receiving special education services were randomly

assigned to two separate intervention conditions. Both conditions provided explicit

instruction in phonemic awareness and phonemic-based decoding strategies, but they

differed in terms of the amount of time that was allotted to three separate activities.

One group devoted 85% of their time focusing on phonemic awareness and phonemic

decoding (based upon LiPS program), 10% of their time on fluently recognizing high-frequency words, and 5% of their time reading meaningful text. The second condition consisted of the children spending 20% of the time on phonemic awareness and phonemic decoding, 30% of the time learning high-frequency words, and 50% of their time reading meaningful text. The authors found no significant difference between the two treatment groups. However, both groups exhibited significant gains in standardized measures of word attack, text reading accuracy, and text comprehension. There was no significant improvement in reading fluency.

Research also has shown mixed results in regards to the effectiveness of treatments designed to improve phonological abilities. Lovett, Bordon, Lacerenza, and Brackstone (1994) examined the relative effectiveness of three different treatment protocols. One treatment focused on blending and phonological analysis. A second treatment group focused on word identification strategies. Thirdly, a treatment group consisted of instruction in classroom survival skills (not a reading treatment) and general math skills. This group was utilized as the control group. All of the participants in Lovett et al.'s study could be classified as severely delayed according to four out of five standardized measures of word reading ability that were administered pre-experimentally. The researchers found that after thirty five hours of reading instruction with one teacher and two students that the children would still be classified as severely delayed. The mean scores on word reading improved from 64 to 69.5 and the mean scores in reading comprehension went from 66.4 to 70.8. Findings like these have led some researchers to claim that typical interventions for children with reading disabilities

can most accurately be described as stabilizing the degree of impairment as opposed to normalizing them (Kavale, 1988; Schumaker, Deshler, & Ellis, 1986).

Another variable that needs to be considered relative to explaining the different results found in these two studies is the amount of instructional time spent with each participant. In Torgesen et al. (2001), the participants were provided with 67.5 hours of one-to-one instruction that was delivered in two 50 minute sessions per day for eight weeks whereas the Lovett et al. (1994) study consisted of 35 one hour sessions that were completed four times a week. The intensity level between these two studies is drastically different. Although both studies lasted approximately 8 weeks, the Torgesen et al. (2001) study involved completion of 37.5 more hours of remediation per participant than the Lovett et al. (1994) study. Lovett et al. (2000) conducted a second study in which the duration was increased. In this study, the participants received 70 one hour sessions. The findings of this study resemble of Torgesen et al (2001).

Two conclusions can be drawn by considering the above findings. The first conclusion is that phonological abilities can be improved in children. This finding is supported by a large amount of research (see NRP, 2001 for a review). The second conclusion is that it is probable that the benefits of phonological training are highly reliant upon the amount of individual instruction provided. If these treatment protocols were implemented into a school setting, they would require that the child spend a large amount of time being pulled out of the normal classroom. Furthermore, this would limit the potential size of the caseload for the reading instructor since they would be required to spend over 100 minutes a day with each student (in the case of the Torgesen et al., 2001 study). In fact, Torgesen was the second author on a paper that stated that

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"gains through training are likely to be hard won rather than easily obtained. … highly intensive and sustained phonological awareness training by itself provides, at best, limited improvement in subsequent reading" (Wagner, Torgesen, Laughon, Simmons, & Rashotte, 1993, p. 100). Although reading is a skill that should be devoted as much time as possible, it is possible that there is not enough time possible for some struggling readers to meet the demands proposed by these studies. In addition, Lovett et al. (2000) stated that "phonologically based approaches alone are not sufficient for achieving optimal remedial outcomes with reading disabled children" (p. 281). The authors indicate that a multi-dimensional approach would be necessary in order to achieve the generalization of phonemic skills into other realms of literacy. In this case, "multi-dimensional" refers to the addition of fluency and reading comprehension strategies to the phonologically based strategies.

Another study providing similar results was completed by Hatcher, Hulme, and Ellis (1994). In this study, the authors examined three separate structured methods of reading intervention with 125 children who exhibited below average reading abilities according to a word reading test. The three treatment groups consisted of: one group which received phonological training alone (rhyming, discrimination, synthesizing, segmenting, omitting, substituting, and transposing); one group which received reading activities only (reading and re-reading stories, answering comprehension questions, segmenting portions of stories, pre-reading stories, and writing stories); and one group which received a combination of the first two treatment groups. A control group was used for comparison. This group received regular classroom instruction with no special or additional form of instruction provided by those who were collecting data. The

authors found that all three experimental groups exhibited significant improvement compared to the control group on measures of reading such as word identification, word attack, textual decoding accuracy, comprehension, and spelling. As the authors predicted, the phonological only group outperformed the reading only group. The authors also found that the integrated group exhibited significantly greater gains than any of the other three groups in all reading measures. Thus, the combination group which actually spent less time explicitly addressing textual reading showed greater improvement than the group that focused all its efforts into textual reading. This finding may be somewhat counter-intuitive; however, if one accepts the definition of reading that has been proposed relative to the complex and interactive nature of the top-down and bottom-up processes that define reading, it should not be surprising to expect such results. The authors concluded that the joint approach that integrates phonological training and the teaching of reading is an effective method to improve reading skills. The authors stated that, "concentrating on either component in isolation is not as effective" as combining the two skills into one treatment protocol (p. 52).

In conclusion, phonologically and phonetic based reading instruction has been found to represent a highly important aspect of learning to read relative to the treatment of reading disorders. However, for phonologically based treatments to be beneficial there needs to be an infrastructure that can support a highly intensive regiment that includes long hours, high frequencies, and low student to teacher ratios. Torgesen (2001) indicated that these treatments are extremely time consuming with an average of five hours of intensive one-to-one instruction yielding a 1 point increase in reading standard scores. Even the most intensive phonologically based treatments might not

generalize to other aspects of reading outside of the phonological realm. This is especially the case when considering fluency. Although there are few, if any, proponents of the abolishment of phonological level treatments, it is becoming increasingly apparent that these treatments are not sufficient enough to treat the multiple presentations of reading disorders.

Fluency.

The second focal point of reading intervention as recommended by the NRP (2000) is fluency. Whereas there are numerous phonologically based treatment protocols, the same cannot be said for fluency based protocols. Furthermore, many of the marketed phonologically based treatment protocols are highly organized and follow a hierarchical progression through different levels of complexity. The treatment of fluency has typically been implemented in a less standardized fashion. However, one fluency intervention program has recently been developed (Wolf, Miller, & Donnelly, 2000). The RAVE-O (Retrieval, Automaticity, Vocabulary, Elaboration, and Orthography) program was conceived in order to assist in the development of reading fluency and automaticity. This program is directly related to the cumulative research that led to the proposition of the double-deficit hypothesis (Wolf & Bowers, 1999). The RAVE-O implements many of the practices that are typically associated with other more or less standardized fluency programs and therefore can be used as an exemplar to guide this discussion on fluency intervention. The definition of reading fluency that shaped the treatment plan of the RAVE-O was "smooth rates of processing speed in

reading outcomes (e.g., word identification, word attack, and comprehension" (Wolf, Miller, & Donnelly, 2000, p.377). Wolf et al. conceptualize the RAVE-O as one half of a well balanced treatment package. The authors state, "At no point is RAVE-O envisioned as an independent treatment; that is, it is explicitly designed to follow and expand a systematic phonological analysis and blending program, which serves as its foundation" (p. 376).

The first goal that this program addresses is the improvement of fluency. Tasks that address this goal include practicing, wide reading, and repeated readings. These tasks typically are implemented at the level of connected text and have been found to effectively improve oral reading rates and comprehension (Martinez & Roser, 1985; Samuels, 1985; Samuels, Schermer, & Reinking, 1992; Stahl, Heuback, & Cramond, 1997; Taylor, Wade, & Yekovich, 1985; Wolf, Miller & Donnelly, 2000). Stahl et al. (1997) redesigned a reading program for second grade children around wide reading, partner reading, and repeated readings. The authors considered repeated readings to be the key aspect of their reading program. The children in this program read each story numerous times, with readings at home, by themselves in the classroom, with partners in the classroom, and also in an echoic fashion with the teacher. Partnered reading was used as an alternative to the round-robin methods which can highly reduce the amount of oral reading time that each child completes. It was also implemented with hopes to increase motivation while simultaneously offering a supportive environment in which the child could read.

The children who participated in this study followed this curriculum over the course of two years. A typical lesson plan for this reading program began with the

teacher reading the material aloud to the entire classroom. The teacher would discuss

the story by utilizing a story map, discussions, traditional questions, student generated

questions, and other graphic organizers. After introducing the story, the children who

needed extra help were pulled aside for echo reading. The next component typically

consisted of partner readings. The students also were required to read the stories at

home and write about them in a journal. These journals were discussed and reviewed

with the whole class. The final aspect of this program required the child to read a story

of their own choosing. Fifteen to twenty minutes a day was spent with this exercise.

The researchers found that all but two of the children (out of 120) who entered second

grade reading at a primer level or higher were reading at grade level or higher by the

end of the year according to the *Qualitative Reading Inventory* (Leslie & Caldwell, 1988)

which is a test that focuses on both oral reading accuracy and comprehension. In

addition, half of the children who were not reading at a primer level at the outset of the

study were reading at grade level by the end of the study. In regards to fluency, the

researchers found that the students made significant progress in terms of decoding

accuracy and rate. This effect was most pronounced when considering the children

who were reading below grade level when the study began.

The second goal of the RAVE-O program is to incorporate lexical and sublexical

goals into a fluency program which is different than most other fluency treatment

paradigms that typically operate at the level of connected text. Wolf et al. (2000)

explain that "an emphasis on the interconnectedness of sublexical and lexical

processes is, we believe, important for achieving fluency in the variety of impaired

readers. If there are...widely differing reasons for slow rates of processing in dysfluent

readers, then it is important to attack a range of possible sources in our interventions (p. 377). At the sub-lexical level, the RAVE-O places an emphasis on tasks that are designed to increase processing speed and automaticity. Visual tasks such as left-to-right scanning, letter recognition, orthographic pattern recognition are included in this program. Auditory tasks also are implemented such as phoneme and rime identification with an emphasis on increasing the speed at which these are successfully completed. At the lexical level, the RAVE-O emphasizes fluent/automatic lexical retrieval skills while directly instructing semantic development. This development is accomplished by systematically introducing "core words" which all have multiple meanings. These words coincide with the introduction of phonemes in the phonologically based treatment that has been utilized along with the RAVE-O. For example, a child would be introduced to the vowel sound /*a*/ and the consonant sound /*m*/ in the phonological program. In RAVE-O, the core words would be introduced with the *am* rime (e.g., jam and ram). The multiple meanings of these words would be discussed. Then the words would be taught on rime cards with separable starter (onset) cards that are color coded. The students are required to learn to segment and recompose a set of approximately five core words each week and also to identify other words with the same rime patterns. The purpose of this is to help children begin to recognize the segments (chunks) in words and to become more flexible in their ability to recognize multiple other examples of taught letter patterns. By combining these lexical and sublexical processes, Wolf et al. is attempting to help the child progress past a reliance on the phonological method of decoding. By focusing on the most common sublexical units, a lexicon of chunks may be created which will facilitate the speed of word recognition processes.

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There are other tasks that have been used in the treatment of fluency that the RAVE-O does not include. Begeny and Silber (2006) conducted a study in which repeated readings, listening passage previews, word list training, and phase drill with error correction tasks were employed in various combinations with four children who were reading below their grade levels. During the repeated readings segment, the children were paired and took turns reading a passage to each other while the nonreader followed along and offered assistance if needed. Each student read the passage twice and listened to the passage twice. During the listening passage preview segment, the trainer read the passage at approximately 100 words per minute while each student read along silently on their own copy of the text. The word list training intervention consisted of the writing of approximately 20 words on a chalkboard. The students were required to chorally respond to each presented word. The selection of these words came from the current training passage. The phase-drill method also requires students to read text from a passage repeatedly; however, the students read a particular phrase containing a word previously read incorrectly (Daly, Martens, Dool, & Hintze 1998). The authors found that each intervention in isolation yielded greater improvements in reading fluency when compared to baseline conditions. However, it was found that the full combination of each of the four interventions yielded the greatest gains in fluency.

Although these studies have shown that increases in reading fluency are both attainable and profitable, it should be noted that a one tracked approach to fluency does not yield positive changes. Anderson, Wilkinson, and Mason (1991) conducted a study that compared a treatment group that focused more on meaning and semantics to a

group that focused more on accuracy and rate. The authors found that the treatment that focused on the fluency aspects of rate and accuracy actually had a detrimental effect on comprehension scores although decoding rate and accuracy did improve. This study led the NRP (2000) to recommend that fluency intervention should be used in the context of an overall reading program, not as a stand-alone intervention.

In conclusion, fluency has been shown to be an important component of any reading remediation program. It has been shown that improving fluency at the lexical and sublexical levels can have a significant impact on the reading comprehension of struggling readers (Wolf et al., 2000). It also has been shown that the technique of repeated readings can increase reading fluency. However, there does remain a few unsolved problems with fluency based strategies. They are difficult to implement with an entire class. Pull-out methodologies which require children to be separated from their class are frequently found in the literature on fluency interventions (Begeny & Silber, 2006; Stahl et al., 1997; Wolf et al., 2001). In a classroom-wide fluency intervention, the text difficulty level would either be too difficult for the child with a reading disorder, or unchallenging for the child without a reading disorder. One method of attempting to alleviate this problem has been to utilize small group contexts. However, the child still has to read aloud which can be a daunting task for the unskilled reader. Children may become self-conscious about the way in which they read aloud, and they may refuse to do so. In this hypothetical, a likely Matthew Effect may begin to emerge and the child will continue to detest the act of reading. Matthew Effect is the term coined by Stanovich (1986) which states that the rich get richer and the poor get poorer. In other words, when a child is not proficient at reading, they read less than

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their peers and thus do not develop the reading skills that those who read with more ease. Despite these minor issues, it has become apparent that reading fluency must be a target of remediation when individuals exhibit deficits in this area.

Comprehension.

As previously mentioned, successful comprehension is the end goal of all reading interventions. Comprehension is a highly complex skill which is composed of several distinct subprocesses that must operate in unison. It is for this reason that many programs do not place their emphasis directly at the level of comprehension. Instead, most programs focus on improving the effectiveness of the skills that lead to successful comprehension such as phonological abilities and fluency. The claim (and hope) is that by building up and solidifying these foundational building blocks of reading will lead to the improvement of comprehension abilities. Although most programs do not place their sole emphasis at the level of comprehension, almost all programs do incorporate comprehension based tasks into their recommended regiment. These tasks will be discussed at length in the following section.

The first aspect of a recommended comprehension focused treatment paradigm as recommended by the NRP (2000) is vocabulary or the lexicon. The NRP states that:

as a learner begins to read, reading vocabulary encountered in texts is mapped onto the oral vocabulary the learner brings to the task. That is, the reader is taught to translate the (relatively) unfamiliar words in print into speech, with the expectation that the speech forms will be easier to comprehend. A benefit in

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understanding text by applying letter-sound correspondences to printed material

only comes about if the resultant oral representation is a known word in the

learner's oral vocabulary. If the resultant oral vocabulary item is not in the

learner's vocabulary, it will not be better understood than it was in print. Thus,

vocabulary seems to occupy an important middle ground in learning to read. Oral

vocabulary is a key to learning to make the transition from oral to written forms,

whereas reading vocabulary is crucial to the comprehension processes of a

skilled reader (p. 4-15).

However, there is little research that has explicitly focused on the effects of improving

vocabulary abilities. This is perhaps due to the tight coupling of vocabulary and

comprehension. Vocabulary is generally thought to exist at the word level where

comprehension is thought to exist at the level of text. Both terms refer to a knowledge

or understanding of meaning. It becomes very difficult to separate the knowledge of

textual meaning (comprehension) from the knowledge of the constituent word meanings

(vocabulary). Another issue when studying comprehension is the different types of

vocabulary. There are at least five different types of vocabulary: receptive, expressive,

reading, oral, and sight vocabulary. Although some parallels can, and have been drawn

between the different types of vocabulary, there exists the possibility that these

comparisons are ill-advised.

In regards to vocabulary based intervention strategies, the NRP chose to assign

each reviewed methodology into one of five categories. The first category consisted of

explicit instruction in vocabulary building. In these methodologies, individuals are given

means by which they are to determine the meaning of words. For example, an

individual may be explicitly given the definition of a word(s) or some attributes of a word.

In the context of a classroom, this is typically followed by some type of vocabulary test

in which the instructor expected the individual to spend some time memorizing the word

and its definition. In this type of instruction, the individuals are often given external cues

to connect the words with meaning. A common example of this technique is the pre-

teaching of vocabulary prior to reading a selection, just as was done in many of the

fluency interventions. Instructors also teach the strategies of root and affix examination

(NRP, 2000). Explicit vocabulary training has been found to be successful in increasing

vocabulary levels (Brett, Rothlein, & Hurley, 1996; Carney, Anderson, Blackburn, et al.,

1984; Dole, Sloan, & Trathen, 1995; Rinaldi, Sells, & McLaughlin, 1997; Tomeson &

Aarnoutse, 1998; White, Graves, & Slater, 1990; Wixson, 1986). However, all these

strategies are reliant on lower level knowledge that an individual with a reading disorder

might not possess. For example, if using contextual cues is the strategy to be

employed and the child is not familiar with the context that is being described, it is likely

that this method will not be of benefit. If the struggling reader has never personally

experienced the context of a story, the struggling reader is less likely to gain experiential

knowledge via reading as they read less than their peers (Stanovich, 1986). Thus, it is

questionable relative to how this method will help the child. The same scenario is also

plausible for the root and affix method. This method requires an underlying knowledge

and recognition of chunks of letters that frequently appear in a language. However,

children with reading disorders typically have difficulty recognizing chunks of letters as

single units (Wolf et al., 2000). Therefore, for explicit vocabulary, instruction should be

implemented with awareness of the underlying abilities that are exhibited by those who will be receiving the intervention.

The second type of vocabulary instruction addressed in the NRP (2000) was indirect vocabulary training. These methodologies typically encourage individuals to read and to read often. The instructors are to provide the individual with many opportunities to read, and to encourage the wide reading of many texts. These methodologies are necessary as not all vocabulary can or should be learned by means of vocabulary specific training (Leung, 1992; Nicholson & Whyte, 1992; Robbins & Ehri, 1994; Senechal & Cornell, 1993; Stewart, Gonzalez, & Page, 1997). Furthermore, these methods make the possibility of incidental learning much more likely. However, inherent in this methodology is the assumption that individuals will be capable of generating the meanings of previously unknown words from the surrounding text. This might not apply to the struggling reader. As previously mentioned, the individual may have no contextual knowledge of the situation being described. These individuals might not possess the means of understanding these contexts.

The third type of vocabulary instruction addressed by the NRP (2000) was multimedia methods. These methods incorporate semantic mapping and graphical organizers of word qualities (Levin et al., 1984; Margosein, Pascarella, & Pflaum, 1982). These methods can be time consuming and they interrupt the flow of reading which can be detrimental to comprehension. That is why proponents of these methods typically recommend repeated readings and multiple revisits and revisions to the organizers. Therefore, multimedia methods are not designed to exist in isolation, but rather in a supplemental role with other strategies such as explicit vocabulary instruction. Overall,

the goal of these types of intervention is *active* participation in the reading process

(Margosein et al., 1982). Another positive attribute of multimedia type interventions is

the ease in which computerized technology can be implemented into these practices.

Computer and internet based games that claim to increase vocabulary have become

exceedingly prevalent. They also have been shown to be a potentially powerful method

to increasing vocabulary (Davidson, Elcock, & Noyes, 1996; Heise, Papalewis, &

Tanner, 1991; Heller, Sturner, Funk & Feezor, 1993; Reinking & Rickman, 1990).

Capacity methods represent the fourth type of vocabulary intervention. These

methods attempt to reduce the cognitive capacity devoted to other reading activities by

practicing them to make them more automatic. These methods assume that the

additional capacity freed up can be used for vocabulary learning. This is precisely the

design of the vocabulary portion of the RAVE-O (Wolf et al., 2000). It should be noted

that these methodologies are behavioral in nature and are still focused on treating

cognitive level symptoms of reading difficulties. Heller, et al. (1993) also examined the

issue of cognitive demands, although in the technological realm. They studied the

effects of different input devices (touch screen vs. keyboard) on vocabulary growth.

They concluded that the use of the keyboard resulted in the greatest demands on

cognitive capacity. Therefore, they concluded that the use of a keyboard in computer

based vocabulary instruction might result in less beneficial vocabulary growth than

when a touch screen can be implemented.

The final category of vocabulary training that is represented in the literature is

association methods. In this technique, learners are expected to associate what they

do know with the novel information that is present in the text. These associations can

be semantic or based upon imagery (NRP, 2000). It is proposed that by forming these mental links that a word's meaning and representation will be accurately and sufficiently stored where it can be efficiently accessed.

The second aspect of comprehension intervention addressed by the NRP (2000) is text comprehension instruction. Cognitive based reading comprehension programs tend to make a distinction between skills and strategies (Dole, Duffy, Roehler, & Pearson, 1991). Skills represent automatic routines that operate at a rigid, somewhat unconscious level whereas strategies are by definition more flexible, sophisticated, and deliberate. Strategies also imply metacognitive awareness, meaning that good readers have an awareness of what they are doing and how well they are doing it while they are reading.   Cognitive views assume active readers who are constructing meaning through the integration of existing and new knowledge while utilizing flexible strategies when appropriate in order to monitor and regulate the end goal of reading: comprehension. Typically, those who struggle with reading comprehension have difficulties utilizing these strategies. Therefore, the underpinnings of an intervention program based on this philosophy are grounded in the improvement of the utilization of the *strategies* that are used to monitor and regulate the reading process.

Five specific strategies have been shown in the literature to increase text comprehension abilities. The first strategy is determining importance or main idea strategy (Baumann, 1986; Cunningham & Moore, 1986; Williams, 1986b). These terms are used interchangeably along with several other variations such as: gist, topic, topic sentence, macrostructure, superstructure, key word, thesis, theme, and interpretation (Williams, 1986; Winograd & Bridge, 1986). It has been proposed that good readers

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accomplish the task of identifying the main idea in three ways: using general and domain specific knowledge, using knowledge of author biases, and using knowledge of text structure (Afflerbach, 1986). However, individuals with reading disorders may have trouble with all three of these techniques (Afflerbach, 1986; Englert & Hiebert, 1984; Johnston & Afflerbach, 1985; Winograd, 1984). It also has been found that readers who are more accurate at identifying and using top-level structure of texts are capable of recalling more than readers who cannot (Meyer, 1975; Meyer & Rice, 1984; Voss, Tyler, & Bisanz, 1982). More importantly, it also has been shown that improving this strategy is capable via different intervention models. Specifically, Stevens, Slavin, and Farnish (1991) were able to significantly improve the accuracy by which third and fourth grade students could identify the main idea in a brief passage compared to the control group. In this study, 486 children were randomly assigned to one of two treatment groups or to a control group which received the same basal reading plan that had already been implemented. Both treatment groups received direct treatments that focused on identifying the main ideas of paragraphs. The only difference was that one group completed follow-up activities with their peers whereas the other group completed the activities individually. The group follow up treatment cohort outperformed all other groups. The authors stated that "as a whole, these results support a direct instruction and cooperative learning" (p. 15). However, it should be noted that there was little or no transfer of training on main idea strategies to improve student performance in inferential comprehension in this study. As previously mentioned, questions that are inferential tend to lead to more elaborate mental processing while stimulating thought, reason, and logic (Singer, 1978). Inferential questions tend to reveal more active comprehension as

opposed to rote memorization of facts. Therefore, careful monitoring must be

undertaken in order to ensure that this type of treatment does not result in passive

memorization as opposed to active cooperation between the reader and the text.

The second category of text comprehension instruction is summarizing

information. Summarizing is a more broad activity than is determining the main idea.

The ability to summarize information requires the reader to differentiate important from

unimportant ideas while sifting through larger amounts of text (Dole et al., 1991). The

reader also must synthesize these important ideas and create new coherent

representations that stand for the original text. Working memory plays a vital role in this

integrating, deleting, and updating of new information (Baddeley, 1974). Once again, it

has been shown that summarization can be improved via direct intervention (Hare &

Borchardt, 1984; Palincsar & Brown, 1984; Taylor, 1982; Taylor & Beach, 1984; Taylor

& Berkowitz, 1980).

The third category of strategies that has been shown to have positive effects on

textual reading comprehension is drawing inferences. As previously mentioned,

inferencing requires active participation in the reading process. As readers conduct

their own models of meaning for any given text, they are constantly using inferencing in

order to fill in details that are omitted in the text. Individuals also use inference to

elaborate on what has been read (Anderson, 1977; Anderson, Spiro, & Anderson, 1978;

Bransford, Barclay, & Franks, 1972; Brown, Smiley, Day, Townsend, & Lawton, 1977;

Kail, Chi, Ingram, & Danner, 1977). Studies have shown that children as young as

second grade can be trained to improve inferencing abilities. Hansen (1981) conducted

a study that attempted to improve inferencing abilities in groups of both poor and good

reading fourth graders. These groups were defined based upon reading comprehension abilities. Four groups of ten were created. There was one treatment group for both the poor and good reader group and one control group for the poor and good reader groups. The treatment group received a three-pronged intervention methodology. The first stage consisted of making students aware of the importance of drawing inferences between new information and existing knowledge structures. The second stage consisted of getting students to discuss, prior to reading, something they had done that was similar to the events in the text and to hypothesize what would happen in the text. Finally, the students were provided with many inferential questions to discuss after reading the selection. The authors found that the poor readers benefited significantly from the instruction.

The fourth category of text comprehension intervention is generating questions. These tasks refer to both teacher and student generated questions. Although teacher generated questions are far more frequently utilized, it has been found that instruction to promote student generated questions also can lead to improved text comprehension (Brown & Palincsar, 1985; Brown, Palincsar, & Armbruster, 1984; Singer & Donlan, 1982). Singer and Donlan (1982) taught high school students to generate story-specific questions from a set of general questions developed from story grammars (e.g., Who are the main characters in the story? What does the leading character initiate?) in order to create their own more specific questions about the particular story they were reading. Students who generated their own questions improved their comprehension of stories more than students who simply answered questions constructed by their teachers. The

authors concluded that the student-generated questions led to an active comprehension of stories which, in turn, led to an improved understanding of the text.

The final text comprehension strategy is termed monitoring comprehension (Dole et al., 1991). Comprehension monitoring is a two part process – being aware of the quality and degree of understanding and knowing what changes need to be made when comprehension failures arise. The research focusing on this error has typically utilized the error detection task. This task requires a participant to read a text that contains errors and identify those errors. Data is typically collected on both the accuracy and speed at which these errors are detected. It has been found that individuals with reading disorders are less efficient at monitoring when errors are present (Baker & Brown, 1984; Garner, 1987; Wagoner, 1983). However, these tasks share little resemblance with everyday reading tasks and have not been implemented in a treatment paradigm. However, more ecologically valid methods also have been utilized in order to investigate monitoring of comprehension. Dewitz, Carr, and Patberg (1987) developed three instructional treatments that can be used with everyday texts. Explicit instruction was given in the study that was designed to assist children in filling in missing words in brief passages. This methodology proved beneficial in regards to overall reading comprehension measures.

Fix-it strategies also are often employed in the sake of monitoring. Studies have shown that good readers are more likely than poor readers to refer back to the text in order to resolve problems (Garner, Macready, & Wagoner, 1984; Garner & Reis, 1981; Garner, Wagoner, & Smith, 1983; Owings, Peterson, Bransford, Morris, & Stein, 1980). Furthermore, Alessi, Anderson, and Goetz (1979) found that knowledge deficits due to

lacking or losing information could be almost completely restored with an induced look-back strategy on the part of college students.

A review of the research focusing on the intervention of text comprehension has revealed that many aspects of text comprehension can be improved if the proper remedial methods are employed. However, the research also has shown that remediating a complex skill such as comprehension by focusing on only one cognitive symptom of reading dysfunction will result in less than desirable outcomes. If taking a cognitive approach to intervention, one must be prepared to address all of the separate subprocesses that lead to successful comprehension.

Neural level treatments.

There are an increasing number of treatment paradigms, both experimental and commercially available, whose efforts attempt to make more global changes in the neural processes of reading. Admittedly, the distinction between cognitive level and neural level theories is a difficult one to make, as no theory can be wholly placed into one group or the other. However, an examination of the philosophical foundations upon which each treatment paradigm was built reveals that distinct differences exist between the neural and cognitive groups in regards to the most effective manner of treating reading disorders.

Fast ForWord.

The first example of a neutrally based treatment paradigm is the Fast ForWord family of programs. This program is a unique approach to ameliorating reading difficulties. One complicating matter in reviewing this technique is that only the original version of this family of products has any published data regarding its effectiveness.

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Regardless, a discussion regarding the basic tenets of this treatment philosophy is relevant due to the preponderance of this method as a treatment technique.

Fast ForWord is based upon a body of work that has mostly been completed by Tallal and her colleagues (see Tallal et al., 1997 for a review). This work culminated in the rapid auditory processing deficit hypothesis which proposes that the phonological deficits that characterize reading disordered individuals reading profiles can be explained by an inability to process sounds that occur briefly or rapidly in time. Therefore, this deficit yields fuzzy representations of speech sounds within the brain and these unstable representations interfere with the brain's ability to utilize the alphabetic principle (McArthur, Ellis, Atkinson, & Coltheart, 2008). More specifically, it has been found that children with reading impairments had significantly more difficulty than normal readers on temporal order judgment and discrimination tasks involving nonverbal auditory stimuli (Tallal, 1980).

Research has shown that auditory processing abilities can be improved (Hayes, Warrier, Nicol, Zecker, & Kraus, 2003; Tallal et al., 1996; Temple et al., 2000). Furthermore, research has shown that there can be concurrent improvements in auditory processing and measures of reading abilities. The controversy surrounding this program arises in the causal explanations that are offered regarding these results. In a brain imaging study, Temple et al. (2000) showed improvements in auditory processing abilities and auditory language comprehension, as well as differences in brain activation in pre- and post-treatment fMRI scans. Three participants underwent on average 33 treatment sessions that each lasted 100 minutes a day five days out of the week. More specifically, seven tasks were completed as part of the Fast ForWord

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protocol. The seven tasks were as followed: identifying the order of non-speech tones

with an increasingly shorter ISI (80 ms to 20 ms) across the speech spectrum (500 Hz

to 2000 Hz), distinguishing phonemic changes in acoustically modified speech,

discriminating between minimal pairs (e.g. /ba/ versus /pa/), discriminating and

remembering simple word structures that have either the same rime or onset,

recognizing words that differ in only one phoneme, comprehension of commands with

increasingly complicated syntax, and comprehending sentences containing increasingly

more complex morphology and syntax. All activities that used speech stimuli would

begin with acoustically modified speech with consonant transitions that were lengthened

from 40 to 80 ms and intensified by 20 db then progress to normal speech while

maintaining 80% accuracy levels. These tasks resulted in improvement for two out of

three participants in this study. McArthur et al. (2001) indicated that results from studies

such as these that include higher level linguistic tasks cannot make statements

regarding the effectiveness of auditory processing treatments. In other words, when the

tasks that are employed in a treatment phase include phonologically as well as

comprehension based tasks that are embedded into auditory processing tasks, then

one cannot isolate auditory processing as being the causal agent.

Studies have shown that the benefits of Fast ForWord are quite comparable to

those of phonologically based treatment protocols. Hook, Macaruso, and Jones (2001)

compared a Fast ForWord treatment group, with an Orton-Gillingham (Gillingham &

Stillman, 1997) treatment group (phonemic based multi-sensory approach), and a

longitudinal control group. The authors found that Fast ForWord improved phonemic

awareness immediately after the treatment concluded but at no greater level than the

Orton-Gillingham group. Furthermore, the authors found that the Orton-Gillingham group exhibited improvements in the area of word attack and word identification, whereas the Fast ForWord group did not show significant improvements in these areas. Finally, after two years, the Fast ForWord group exhibited no significant differences from the control group in all areas. The authors stated that "the intensive amount of time needed to complete the Fast ForWord activities and the expense involved did not seem warranted" (p. 92). These sentiments were echoed by McArthur et al. (2008) who actually assessed the effects of a treatment program that only focused on auditory processing deficits. Although the authors found that auditory processing skills could be improved, these improvements did not lead to increases in reading, spelling, or spoken language skills. These authors stated that "Finding that successfully treating impaired rapid auditory processing…did not improve reading, spoken language, or spelling impairments in children challenges the idea that these deficits affect the acquisition of reading and spoken language skills" (p. 970) and have "no apparent impact on learning new reading, spelling, or spoken language skills" (p. 974).

Exercise-Based Treatments.

Exercise based treatments represent a highly unique group of approaches to the treatment of reading disorders. These treatments are deeply rooted in the cerebellar deficit theory. Recall that the cerebellar deficit theory as proposed by Nicolson and Fawcett (1990) states that dyslexic children have a pervasive difficulty in making skills automatic so that these skills can operate fluently and subconsciously. They claimed that these automatisation deficits were the result of cerebellar dysfunction as the cerebellum plays a large role in skill automatisation and language-based skills (Allen,

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Buxton, Wong, & Courchesne, 1997; Leiner, Leiner, & Dow, 1989; Thach, 1996) including reading (Fulbright et al., 1999). Dore and Rutherford (2001) introduced this line of thinking into the clinical realm when they created a program designed to assess and improve cerebellar function. This type of intervention was originally completed at centers that were called dyslexia, dyspraxia, and attention-deficit treatment centers (DDAT) but they have since been renamed Dore Achievement Centres (DAC) (Reynolds, Nicolson, & Hambly, 2003). The DAC centers operate on three main premises. The first premise is that the cerebellar deficit theory is true and dyslexic individuals do indeed exhibit cerebellar dysfunction. The second premise states that the cerebellum has elastic properties and it can be retrained, at least in childhood (Dore & Rutherford, 2001). The third premise is that training on one sort of cerebellar task should generalize to other unrelated tasks, such as reading. Therefore, DAC type interventions do not specifically target reading exercises, but instead target exercises they believe will retrain functions of the cerebellum. Reynolds et al. (2003) stated that the treatment tasks consist of using a balance board; throwing and catching bean bags (including throwing from hand to hand with careful tracking by eye); practicing dual tasking; and other stretching and coordination tasks. The overall goal of this treatment as stated by Dore and Rutherford (2001) is to stimulate simultaneously the central nervous system mechanisms found to be immature in learning disabled children on electro-neurophysiological assessment exercises. This program has been found to yield beneficial results in a reading disordered population (Reynolds et al., 2003) as well as in a follow up study completed 18 months later (Reynolds & Nicolson, 2007).

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In the original study, Reynolds and Nicolson investigated the effects of DAC treatment in 35 school children (average age: 9.4 years) who were considered at risk for dyslexia based upon a screening test. The participants were divided into two groups with one group receiving DAC treatments while the other group received no additional treatment other than was already being provided at school. The DAC treatment occurred after school hours in the child's home daily. After six months of this treatment, the dyslexia screening test and a battery of cerebellar tasks was re-administered to the participants. The authors found that the participants improved on both the cerebellar and reading tasks after the treatment phase. Specifically the cerebellar improvements were seen in posturography, eye tracking, and bead threading. In regards to reading, it was found that the participants showed improvements in semantic fluency, nonsense word reading, phonological skill, and working memory. There were no significant improvements in spelling or writing. The follow up testing (Reynolds & Nicolson, 2007) revealed similar results with the participants continuing to exhibit improvements in motor skills, phonology, speech/language fluency, and working memory.

Although these results seem promising, they have been mired in controversy since they were first published in 2003. For example, Rack, Snowling, Hulme, and Gibbs (2007) published a critique of the exercise based findings. This critique raised several legitimate questions regarding the validity of the findings in the DAC treatment evaluations. The main criticisms from Rack et al. were the lack of any treatment for the control group, the lack of random assignment to groups, the lack of ability/skill matching between groups which was also not handled appropriately in the statistical analyses, the use of participants with widely varying degrees of difficulty including some with

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diagnosed learning difficulties and others with attainments above the average for their age, using screening tests instead of standardized tests, and inappropriate statistical treatment of deciles (which range from 1 – 10 and are a compilation of several subtest scores) and age scores, treating them as if they were interval data. The authors stated that the most serious problems of the study were failure of random allocation and not treating the control group. They stated that these flaws yield the data uninterpretable due to possible Hawthorne effects.

Rack et al. concluded that any linguistic gains that were found in the experiment were merely "a result of repeated testing on the same activities" (p. 102). This claim also has some scientific evidence behind it. McArthur (2007) conducted a meta-analysis of previous exercise and auditory based treatment studies that have utilized an untreated control group. The author found that test-retest effects explain gains on around 50% of real word reading tests, 33% of phonological recoding tests, 33% of phonological awareness tests, 17–25% of spoken language tests, and 15% of spelling tests. Furthermore, it was found that longer periods of time between the pre and post-tests are associated with test–retest effects on measures of reading but not spoken language. By applying these findings to Reynolds and Nicolson's findings (2007), McArthur (2007) stated that the improvements in phonological awareness and working memory could be explained in terms of test-retest effects and that the other two linguistic gains were measures of spoken language and not reading. McArthur also stated that the evidence simply does not support the ameliorative benefits of DAC treatments on the reading abilities of individuals with reading disorders.

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In conclusion, although exercise based treatment protocols such as DAC type programs might lead to improvements in reading abilities, the level at which these tasks are capable of ameliorating reading difficulties remains to be established. Further outside supportive research would help substantiate the claims made by the DAC centers.

Secondary Auditory Signals.

Another unique avenue of reading remediation that has been investigated is the employment of secondary auditory signals. It has been found that introducing these signals can have a beneficial impact on the reading comprehension abilities of reading disordered individuals. Breznitz (1997b) conducted a study that investigated the reading abilities of 52 children with dyslexia and 52 reading-level matched readers without dyslexia. In this study, both forced reading acceleration and auditory masking were utilized. Breznitz employed auditory masking in the form of a well-known children's melody. This melody was played binaurally during oral reading tasks while measures of decoding and comprehension accuracy were obtained. This is a non-congruent type of secondary auditory signal as it does not follow the output of the individual who is reading. The results of this study indicated that reading acceleration improved oral decoding accuracy and reading comprehension in both groups, but auditory masking was only beneficial to the children with dyslexia. Masking was in fact, detrimental to the control group. She also added that a combined condition of both acceleration and masking was the most effective in enhancing dyslexic children's oral reading comprehension. Breznitz explained that the presence of exogenous, auditory speech-competition possibly influences the distribution of cognitive processing

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resources which allows for either reallocation or differential access to phonological, orthographic, or semantic processing mechanisms.

Whereas Breznitz found that a non-congruent verbal signal had a positive effect on the oral reading comprehension of those with RD when used with reading acceleration (1997b), it also has been found that a congruent verbal speech signal can improve oral reading comprehension in the absence of reading acceleration (Carter et al., 2009; Rastatter et al., 2007). More specifically, Rastatter et al. (2007) and Carter et al. (2009) both employed frequency altered feedback (FAF) during oral reading tasks. FAF provides a congruent and linguistic verbal signal which shifts the frequency of an individual's voice. In both studies, the frequency of the voice was shifted one half octave up and rerouted to the participant binaurally. Rastatter et al. (2007) found that RD children were able to raise their comprehension level by two grade levels according to grade equivalencies for agent and action type comprehension questions. They claimed that this was due to the fact that the FAF signal reduced the effects of impoverished phonological processing systems in the RD children, enabled more effective utilization of orthographic codes, and enhanced top-down contextual effects for the reading disordered children. Carter et al. (2009) found that college age adults with reading disorders were able to significantly improve their reading comprehension levels from the 6th to the 9th grade level, based on their performance on the *Spadafore Diagnostic Reading Test* (Spadafore, 1983). However, Carter et al. did not find any accompanying improvements in decoding ability. The authors explained that it is possible that "the FAF signal assists in reallocating attentional resources for the process of comprehension" (p. 72). The premise was that if increases in reading comprehension

were not a result of increases in decoding ability then increased attention was a logical explanation for the observed increases in reading comprehension. The authors stated that "It is possible that secondary signals place the decoding aspect of reading on a second tier of importance in adults, while simultaneously focusing the majority of the available resources on comprehension when reading aloud" (p. 72).

Although these studies hint at the promise of a potentially beneficial application, it is premature to make any great claims about the ameliorative power of second auditory signals. Currently, more research is needed from outside sources that focus on the actual neurocognitive processes that these secondary auditory signals may be affecting.

Reading Acceleration.

Reading acceleration has frequently been employed in conjunction with research that is guided by the previously mentioned asynchrony theory. Reading acceleration has been found to increase both decoding accuracy and comprehension in normal and disordered readers (Breznitz, 1987; 1997a; 1997b; Breznitz & Norman, 1998; Breznitz & Share, 1992; Norman & Breznitz, 1992). This finding, deemed the "acceleration phenomenon" (Breznitz 1997a, 2001, 2002), has been found in both children (Breznitz, 1987; 1997a; 1997b; 1997c) and adults (Breznitz & Leikin, 2000; Karni et al., 2005; Leikin & Breznitz, 2001). The most frequently observed result in these acceleration studies is that readers of various levels and abilities are able to decrease decoding errors and increase reading comprehension when reading at a faster pace. The basic research protocol used in these studies consists of a script presentation method that automatically erases words off of a computer screen one by one at a predetermined rate as the reader reads the script aloud (see Breznitz 1987 for an example). This

method will be referred to as forced acceleration. Another manner in which this phenomenon has been investigated is by the investigator asking the participant to read faster. This method will be referred to as encouraged acceleration.

An example of the forced acceleration protocol was described in Breznitz (1997b). In this study, Breznitz investigated the oral reading abilities of 23 children with dyslexia (average age: 9.3 years) at three different reading rates. The text for each of the three rates was adapted from a standardized reading comprehension assessment tool. The items consisted of three to four declarative sentences. The child was asked to read each passage aloud and then asked to answer both open-ended and multiple choice comprehension questions. All of the text was presented on a computer screen during all conditions. In the first condition, the children read items at their own natural reading pace (self-paced). In the second condition (fast-paced), the children were prompted to read at a faster rate. In order to control for a possible warm-up effect, a third condition of self-paced reading was administered. The fast paced condition was calculated for each child according to the highest per letter reading rate exhibited in the six self-paced reading tasks. In other words, the material was presented at the highest rate of demonstrated capability for each child. From a technical standpoint, initially the entire text appeared on a screen. As the child began reading, the material was erased letter by letter at the maximum per letter rate as described above (Breznitz, 1997c). Breznitz found that during fast-paced reading, inferential comprehension increased significantly by 26% and factual content recall increased by 6%.

Regardless of whether the investigators have utilized forced or encouraged reading acceleration, these effects have been most pronounced in "poor readers" (see

Breznitz & Berman, 2003 for a review). The increases in reading abilities associated

with this phenomenon have been attributed to several neurocognitive processes. It has

been shown that reading acceleration extends attention span and reduces distractibility

(Breznitz, 1988, 1997b). It also has been shown that reading acceleration helps

overcome some of the capacity limitations of short-term memory while enhancing

working memory processes (Breznitz, 1997a; Breznitz & Share, 1992). In addition, the

research has shown that reading acceleration increases word retrieval from the mental

lexicon (Breznitz, 1987). Breznitz has collapsed all of these cognitive factors into a

more simple and succinct model explained by speed of processing characteristics. As

previously mentioned, speed of processing is essentially the time that elapses from

stimulus presentation until the behavioral response. Dyslexic individuals have been

shown to have deficits in speed of processing in higher level linguistic auditory-

phonological tasks (see Farmer & Klein, 1993 for a review) and in higher level visual

orthographic linguistic tasks (see Willows, Kruk, & Corcos, 1993 for a review). No

differences between normal and disordered readers have been found in lower level

tasks that assess these areas. Breznitz and Misra (2003) concluded that a strong

speed based factor underlies processing among dyslexic individuals as compared to

normal readers. They further claim that slowed and asynchronized speed of information

processing is a general characteristic of dyslexia that can be overcome (or at least

compensated for) while utilizing reading acceleration.

Although numerous studies have been conducted in order to ascertain the

neurocognitive processes that are affected in reading acceleration tasks, no studies

exist which have addressed the limitations of this ameliorative technique in a clinical

sample (Breznitz, 1987; 1997a; 1997b; 1997c; Breznitz & Share, 1992; Norman & Breznitz, 1992; Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001). The degree of reading acceleration requires more systematic investigation. The previously mentioned authors have typically chosen to use the fastest reading rate that had been exhibited by the readers in the baseline tasks. It has been found that this rate averages to a 10 to 12% increase with adults and a 20% increase for children above their average reading rate. However, utilizing this method of selecting acceleration rates excludes rates that were not present in the baseline tasks. A reading rate ceiling must exist where the benefits of reading acceleration will no longer be present and performance will decrease even below baseline. However, to date, this ceiling has not been identified in the research. Optimal reading rate also has not been identified. As Breznitz (1997a) noted of her own research, "the rate of acceleration was adapted to each individual according to his or her normal fastest rate. Thus, reading acceleration rate remained within the limits of each student's demonstrated reading ability…It remains to be seen whether there is a general optimal rate for reading performance" (p. 438).

Another concern is that there is no evidence that supports that reading rate increases can be maintained as text increases in length. Descriptions of the stimuli have been vague, thus yielding uncertainty regarding the specific nature of each text. Describing the material as consisting of three sentences (as was done in Breznitz, 1997a and 1997b) may not be an adequate description because they do not yield stimuli that can be used to replicate the Breznitz studies. Thus, little is known about the actual nature and reading level of the text. Although accurate descriptions are not

available, reviewing the literature on the acceleration phenomenon leads one to believe that shorter text lengths have generally been used as the stimuli in these studies. Breznitz (1987) used stimuli consisting of one to two declarative statements. Breznitz (1997a) used stimuli consisting of two to four declarative sentences. Breznitz (1997b) used stimuli consisting of one to three declarative sentences. Breznitz (1997c) used stimuli consisting of one to ten word sentences. In both of the studies conducted on adults (Breznitz & Leikin, 2001; Leikin & Breznitz, 2001) single sentences of varying length were used. It also should be noted that none of these studies systematically varied the text length, nor was this variable included in statistical analyses of the data. It remains to be seen whether normal or disordered readers can maintain improved reading abilities during accelerated reading conditions as text length increases beyond the ten sentence level.

Summary

Research has shown that the efficiency of numerous cognitive processes and skills can have an effect on reading comprehension. Decoding accuracy, decoding rate, vocabulary knowledge, and working memory capabilities have all been shown to have significant impacts on reading comprehension efficacy (see Breznitz & Misra, 2003 for a review). The Asynchrony Theory (Breznitz & Misra, 2003) offers a parsimonious description that can account for deficits in decoding, vocabulary, and working memory that may potentially lead to deficits in reading comprehension. In their model, both the auditory based phonological system and the visually based lexical system must operate at an appropriate pace as measured by SOP. The authors of this theory state that accurate reading is reliant not only upon adequate SOP capabilities but also upon the

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integration between the visual and auditory modalities at both high and low levels of

processing. During this integration, a speed of processing synchronization must occur.

The authors claim that dyslexia presents when individuals exhibit both speed of

processing deficits and asynchronies in the ability to synchronize the incoming

information from the two modalities. Breznitz has shown in numerous experimental

studies that these SOP deficits and perhaps the asynchrony can be overcome by either

forcing or encouraging readers to accelerate their reading rates (Breznitz, 1987; 1997a;

1997b; Breznitz, 2002; Breznitz & Leikin, 2001; Breznitz & Meyler, 2003; Breznitz &

Misra, 2003; Breznitz & Norman, 1998; Breznitz & Share, 1992; Horowitz-Kraus &

Breznitz, 2010, 2011; Karni et al., 2005; Leikin & Breznitz, 2001; Meyler & Breznitz,

2003, 2005; Norman & Breznitz, 1992). Reading acceleration is a promising avenue of

reading intervention that has been shown to improve both decoding accuracy and

reading comprehension.

Rationale.

Reading acceleration has been shown to be a valuable tool in improving reading

capabilities; however, other variables related to its utilization as a therapeutic tool still

need to be evaluated. For example, many of the studies which have utilized reading

acceleration (Breznitz, 1987; 1997a; 1997b; 1997c; Breznitz & Share, 1992; Norman &

Breznitz, 1992; Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001) have

established the reading rate in the accelerated reading condition as the fastest rate

demonstrated by the individual in pre-experimental testing. This procedure is only

requiring the individual to maintain a previously produced reading rate. This method

excludes all reading rates not produced during pre-experimental testing and thus, does

not allow for the full examination of potential reading benefits that may occur if reading rates exceed those rates that the individual has already demonstrated. It is possible that an optimal reading rate exists for each and every person. As Breznitz and Share (2002) state regarding their own study, "although the fast paced manipulation presented material at the maximum rate of demonstrated capability for an individual subject, this may not be the optimal rate. Exactly what the optimum fast-paced reading rate is for a particular individual remains to be investigated" (p. 197). In order to procedurally identify the range in which an optimal rate exists, the experimental selection of the reading rates must not be limited merely to those reading rates that have already been demonstrated by the individual. This study examined the effects of proportionately increasing oral reading rates above previously described levels.

In addition, the effects of text length need to be investigated while using this remedial method. It remains to be seen whether the beneficial effects of reading acceleration continue as text length increases. It has been shown that increases in text length can lead to increases on the demands of the working memory system (Andreassen & Bråten, 2009; Baddeley, 1975; Baddeley, 2000; Neith & Nairne, 1995). It has also been hypothesized that reading acceleration increases the efficiency of working memory (Breznitz, 1997a; Breznitz & Share, 1992). Furthermore, longer texts may represent a more authentic form of reading to high school students than shorter texts (Ramsay, Sperling, & Dornisch, 2010) and therefore should be considered during reading acceleration tasks. In other words, a high school student's reading load typically consists of passages that are longer than one to three sentences. Therefore, longer texts may be a more accurate portrayal of the text demands that are placed on

an individual student.   However, much of the stimuli used in Breznitz studies only consist of brief one to three sentence passages. This study examined the effects of increased text length on the comprehension and decoding accuracy of both proficient and deficient readers in an accelerated reading task.

Plan of study and experimental questions.

Reading acceleration has been shown to have positive effects on the decoding accuracy and reading comprehension of both reading disordered individuals and individuals with normal reading abilities but its potential as a remedial application relies heavily on its effects as a function of acceleration proportion and text length. As a precursor to implementing this as a treatment methodology, these parameters must be investigated. For example, the baseline reading rates that are exhibited by an individual in a reading task should be considered when determining proportional reading rate increases. This study used these baseline reading rates and established the experimental reading rates based solely upon these rates. Secondly, the maximum speed at which individuals can complete these tasks accurately must be examined. This study investigated the effects of requiring an individual to read at rates that exceeded the previously established proportional increases in reading rate. And finally, one must consider the maximum length of text that is being utilized. This study systematically increased the text length beyond levels that had previously been investigated. Two experiments were conducted in order to add to the current understanding of the benefits of this reading treatment. Experiments I and II were conducted during the same session. In Experiment I, the reader was required to read aloud four different passages at their own individual proficiency level at four different

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reading rates. The rates will consist of proportional increases (0, 10, 20, and 30%) of

their average pre-experimental oral reading rate. By systematically increasing the

reading rates beyond those exhibited in pre-experimental conditions, this study sought

to reveal if optimal reading rates (as determined by the experimental reading rate

condition which yields the highest comprehension percent accuracy) tended to exist

within the acceleration range that has previously been described (Breznitz, 1987;

1997a; 1997b; 1997c; 2001; 2002; Breznitz & Leikin, 2001; Breznitz & Norman, 1998;

Breznitz & Share, 1992; Karni et al., 2005; Leikin & Breznitz, 2001; Norman & Breznitz,

1992). The following questions were addressed in Experiment I:

    1. Are there statistically significant differences in decoding accuracy proportions

as a function of group (control or RD) and acceleration proportion (0%, 10%, 20%, 30%)

following the oral reading of a series of narrative texts?

    2. Are there statistically significant differences in reading comprehension

accuracy proportions as a function of group (control or RD) and acceleration proportion

(0%, 10%, 20%, 30%) following the oral reading of a series of narrative texts?

    In Experiment II, the effects of passage length on oral decoding and oral reading

comprehension accuracy was investigated in an oral reading task. The reader was

required to read aloud four texts of differing lengths. A relatively short and long text

were read with the optimal reading acceleration proportion exhibited in Experiment I and

a relatively short and long text were read aloud at the readers' average reading rate

(baseline rate) exhibited in the pre-experimental administration of the GORT-IV

(Wiederholt & Bryant, 2001). By increasing the passage length beyond the two to three

sentence level, this study sought to investigate if reading acceleration continues to be a

viable treatment method in reading settings which require the individual to read longer

texts. The following research questions were addressed in Experiment II:

3. Are there statistically significant differences in decoding accuracy proportions

as a function of group (control or RD, text length (short or long), optimal acceleration

proportion (10%, 20%, or 30%), and acceleration condition (accelerated or

unaccelerated) following the oral reading of a series of narrative texts?

4. Are there statistically significant differences in reading comprehension

accuracy proportions as a function of group (control or RD, text length (short or long),

optimal acceleration proportion (10%, 20%, or 30%), and acceleration condition

(accelerated or unaccelerated) following the oral reading of a series of narrative texts?

CHAPTER III

METHOD

Two separate experiments were conducted in this study. Eighteen high school students (mean Age = 15.90) with normal reading abilities and sixteen high school students (mean age = 15.65) with reading disorders (RD) participated in the experiments as the control and experimental groups, respectively. Diagnosis of reading disorders was based upon results of either the Test of Word Reading Efficiency (TOWRE) (Torgesen, Wagner, & Rashotte, 1999) or the Woodcock Reading Mastery Tests – Revised (Woodcock, 1987). A standard score of 90 or above on all subtests was required for an individual to qualify for the control group. A standard score (average 85-115) below 80 on any subtest of the TOWRE or the WRMT-R was required for an individual to be placed into the RD group. These criteria allow for an individual in the RD group to present with difficulties in phonological decoding, lexical decoding, or in both. Demographic data and pre-experimental testing is summarized in Table 1.

Participants

Twenty high school students (mean Age = 15.90) with normal reading abilities and sixteen high school students (mean age = 15.65) with reading disorders (RD) participated in both experiments. Participants were required to be younger than 19 years of age. Participants were required to speak English as their primary language. Participants were recruited via various print media including flyers, newspaper ads, and university listservs. Each participant received two $20 gift cards at the conclusion of their participation. Any participant with a self-reported history of brain injury was not

Table 1

Means and Standard Deviations (SD) for Demographic and Pre-Experimental Testing.

Group	Measure	M (SD)
Control		
	Age[#]	15.90 (.275)
	Test Of Word Reading Efficiency Sight Word Efficiency[*]	101.67 (1.98)
	Test Of Word Reading Efficiency Phonemic Decoding Efficiency [*]	99.78 (1.68)
	Woodcock Reading Mastery Tests – Revised Word Identification[*]	100.67 (1.98)
	Woodcock Reading Mastery Tests – Revised Word Attack[*]	104.17 (2.10)
	Peabody Picture Vocabulary Test – 4th Edition[*]	108.33 (2.50)
	Test of Information Processing Working Memory 1[+]	10 (0.352)
	Test of Information Processing Working Memory 2[+]	10.06 (0.44)
	Rapid Automatized Naming – Letters[*]	116.06 (1.51)
	Grey Oral Reading Tests – 4th Edition Comprehension[+]	7.56 (.336)
RD		
	Age	15.90 (.275)
	Test Of Word Reading Efficiency Sight Word Efficiency[*]	82.63 (2.39)
	Test Of Word Reading Efficiency Phonemic Decoding Efficiency [*]	79.94 (3.56)
	Woodcock Reading Mastery Tests – Revised Word	87.25 (3.03)

Identification[*]

Woodcock Reading Mastery Tests – Revised Word Attack[*]	85.19 (3.41)
Peabody Picture Vocabulary Test – 4th Edition[*]	99.81 (3.01)
Rapid Automatized Naming – Letters[*]	109.13 (1.93)
Test of Information Processing Working Memory 1[+]	8.06 (0.48)
Test of Information Processing Working Memory 2[+]	8.31 (0.41)
Grey Oral Reading Tests – 4th Edition Comprehension[+]	7.19 (0.29)

\# indicates years

* indicates standard scores (mean = 100, SD ± 15.

\+ indicates scaled scores (mean = 10, SD ± 3.

elligible to participate in the study. Individuals with ADHD who were currently under

medication for this disorder were permitted to participate in this study.

Participation occurred at East Carolina University. Participation lasted

approximately 1.5 to 2.5 hours. This study was approved by the East Carolina

University Institutional Review Board (see Appendix A). The study was explained to the

participant by reviewing the consent forms with the participant and their parent if the

participant was a minor. In addition, each task was discussed prior to the beginning of

the task. Each task also included two practice trials.

Pre-Experimental Testing

Inclusionary/Exclusionary criteria.

Group membership was defined based upon the results of either the *Test of*

Word Reading Efficiency (TOWRE) (Torgesen, Wagner, & Rashotte, 1999) or the *Word*

Identification or *Word Attack subtests* of the *Woodcock Reading Mastery Tests –*

Revised (WRMT-R) (Woodcock, 1987). The TOWRE was administered in order to

provide a brief assessment of overall word reading accuracy and fluency and to aid in

the determination of a reading disorder. The TOWRE is a nationally standardized

assessment tool which has two subtests. The Sight Word Efficiency subtest assesses

an individual's ability to rapidly decode real words and the Phonemic Decoding

Efficiency subtest assesses an individual's ability to rapidly decode nonsense words

(which assesses phonetic decoding abilities). The TOWRE provides standard scores

(average 85-115) according to age based norms. The *Word Identification* subtest of the

WRMT-R is designed to assess sight word decoding abilities whereas the *Word Attack*

subtest is designed to assess phonological decoding abilities. The WRMT-R provides

standard scores according to age based norms. A standard score of 90 or above on all subtests of the TOWRE and WRMT-R were required for an individual to qualify for the control group. A standard score below 80 on either subtest of the TOWRE or the WRMT-R was required for placement into the RD group.

Reading comprehension baseline grade level was established based upon the *Gray Oral Reading Tests-Fourth Edition* (GORT-4) (Wiederholt & Bryant, 2001). Reading comprehension scores and reading rate baseline measures were be obtained by utilizing Form A of the GORT-4. The GORT-4 is a normed-referenced test of oral reading rate, decoding accuracy, fluency, and comprehension. It consists of passages that increase in complexity as the test progresses. Accompanying each individual passage is a series of five multiple choice comprehension questions. Administration of the GORT-4 served two main purposes. The first purpose was to identify the reading comprehension grade level equivalent for each participant. The GORT-4 provides the investigator with grade level reading equivalents, which are designed to be accurate measures of what grade level an individual is currently reading. Each individual who participated in this study obtained a reading comprehension grade equivalent between 4th and 10th grade on the GORT-4. These criteria were established in order to align the reading levels provided by the GORT-4 with the readability index provided by the Fry Readability Index (Fry, 1977). The Fry Readability Index assigns an approximate grade reading level to a passage of text. The formula depends on the vocabulary and sentence structure of the text, not the organization or content. The grade reading level is found by plotting the average number of sentences and syllables on the Fry Readability Graph which assigns a text reading level from first grade to college years. It

was found that few narrative texts are written above the 10th grade level. In an attempt

to match the reading level of the material with the reading level exhibited on the GORT-

4, it was determined that individuals reading above the 10th grade level were not

included into the study. Oral reading comprehension standard scores (mean = 100,

average range = 85-115) pertaining to were obtained from the GORT-4 and entered into

subsequent correlational analyses along with all other pre-experimental testing standard

scores.

The second purpose of administering the GORT-4 was to establish baseline

reading rate levels upon which the proportional reading rate increases in the two

experiments were based. The baseline reading rate measure was calculated by

averaging the oral reading rate (words read correctly per second) of the two passages

that occurred prior to the ceiling level. The GORT-IV establishes the ceiling level when

the individual misses three out of the five comprehension questions that follow each

text.

In addition, the *Peabody Picture Vocabulary Test-IV* (PPVT-IV) (Dunn & Dunn,

2007) was administered in order to obtain a standardized measure of receptive

vocabulary abilities. All participants were required to obtain a standard score of 90 or

above. These scores were not used for group membership purposes.

Additional pre-experimental assessment.

In order to obtain a measure of rapid naming abilities, the RAN-letters subtest of

the Rapid Automatized Naming and Rapid Alternating Stimulus Tests was administered.

This subtest has been shown to have the highest correlation with decoding abilities

(Wile & Borowsky, 2004). No inclusion/exclusion criteria were applied relative to the

use of this measure. These scores were entered into subsequent correlational analyses along with all other pre-experimental testing standard scores, but were not used for group membership purposes.

In order to obtain a working memory measure, the Test of Information Processing Skills (TIPS) (Webster, 2009) was administered. The subtest scaled scores of Working Memory 1 and Working Memory 2 were obtained. Working Memory 1 involves a 15-20 seconds delay and is designed to access the impact of a rote, automatic verbal interference task on retention and retrieval of letter strings. This procedure requires the person to actively organize and manipulate the stimuli in some meaningful way for later access and retrieval. Working Memory 2 involves a 30 – 35 second delay and is designed to assess working memory at a more complicated level. No inclusion/exclusion criteria were applied to this measure. These scores were entered into subsequent correlational analyses along with all other pre-experimental testing standard scores, but were not used for group membership purposes.

To obtain a measure of decoding ability, Form G of the Word Attack and Word Identification subtests of the *Woodcock Reading Mastery Tests-Revised* (WRMT-R) (Woodcock, 1987) were administered to participants. The WRMT-R is designed to provide a measure of sight word and phonological decoding abilities. No inclusion/exclusion criteria were applied relative to the use of this measure. These scores were entered into subsequent correlational analyses along with all other pre-experimental testing standard scores, but were not be used for group membership purposes.

All participants passed a hearing screening administered at 20dB HL at the following frequencies: 1000, 2000, and 4000 Hz (ASHA, 1997). In addition, a visual screening test was passed by all participants (http://www.sterlingoptical.com/eye_screening/2). This online screening test is designed to address visual acuity and reading magnification level. All participants passed this visual screening tool.

Experiment I: Effects of Increased Oral Reading Rate

Experiment I was conducted on the same day as the pre-experimental testing. Experiment I addressed the effects of increased oral reading rate on the reading comprehension and oral decoding accuracy of reading disordered individuals.

Experiment I procedure.

Each participant was required to read aloud a series of four experimental passages. The four passages in Experiment I were read using Adobe Premier 6.0 (Adobe Systems Incorporated, 2000). Adobe Premier was used to control for the speed of text presentation. Adobe Premier enables the presentation of horizontally scrolling text across the computer screen at a pre-determined rate (words per second). Each participant was required to read aloud four passages. The text presentation rate for each passage was calculated to be proportional increases in reading rate (words per second) above the baseline reading rate that was obtained from the pre-experimental utilization of the GORT-4 (Wiederholt & Bryant, 2001). The proportional accelerated reading rates were established for each of the participants as 0%, 10%, 20%, and 30% faster than their baseline reading rate. For example, if an individual exhibited an average reading rate of 2 words per second reading rate on the pre-experimental

administration of the GORT-4, then their reading acceleration percentages would have been 2.0 words per second (0% increase), 2.2 words second (10 % increase), 2.4 words per second (20% increase), and 2.6 words per second (30% increase). All passages were read aloud so that a proportion of correctly decoded words out of total words were obtained within each task. Open-ended comprehension questions were immediately presented on a hard copy following the presentation of each of the texts. The participant was required to orally read each question and answer aloud. The participant was not allowed to refer to the text during the answering of the questions. Open-ended questions were utilized because, as has been previously indicated, multiple choice formats tend to measure word recognition skills as opposed to comprehension (Francis, Fletcher, Catts, & Tomblin, 2005; Keenan, Betjemann, & Olson, 2008; Nation & Snowling, 1997). Four factual questions and two inferential questions accompanied each text (see Appendix A). The assignment of individual passages to reading rate (words per second) was counterbalanced among the four texts within each grade level. The presentation order of the passages also was counter-balanced in order to control for any possible order effects. Decoding accuracy proportions and comprehension accuracy proportions were obtained for each passage.

Independent variables for Experiment I consisted of group (control or reading disordered) and acceleration proportion (0%, 10%, 20%, and 30%). Dependent variables for Experiment I consisted of the percentage of words correctly decoded per passage and reading comprehension accuracy percentage.

Experiment I stimuli.

The stimuli used in Experiment I consisted of twelve 90 to 110 word narrative texts (see Appendix A) that were written about various topics and were assigned a reading level based upon the Fry Readability Index (Fry, 1977). The Fry Readability Formula assigns an approximate grade reading level to a passage of text. The formula depends on the vocabulary and sentence structure of the text, not the organization or content. The grade reading level is found by plotting the average number of sentences and syllables on the Fry Readability Graph, which assigns a text reading level from first grade to college level. Narrative texts were utilized for this study since it has been claimed that narrative processing tends to be focused more on the comprehension of the organization of events in a story, whereas expository processing has been shown to focus more on the activation and integration of relevant prior knowledge into discourse representation (Wolfe & Woodwyk, 2010). The narrative texts consisted of excerpts from short stories. The short stories were selected from text books that were required reading in introductory level English classes at East Carolina University during the Fall 2011 semester based upon available online class syllabi. By utilizing the *Fry Readability Index* (Fry, 1977) four texts were selected that were written at the 6th grade level, four texts were considered to be written at the 8th grade level, and four texts were considered to be written at the 10th grade level. The grade level that was used for each participant was dependent upon the pre-experimental reading level exhibited by the participant, as measured by grade equivalents on the GORT-4 (Wiederholt & Bryant, 2001). Thus the administration of the GORT-4 provides the investigator with a grade equivalent that includes a grade total and a month total based upon normative data.

For example, a possible grade equivalent can be 6th grade, 4 months. For the purposes of this study, if an individual read at a 4th through 6th grade level in pre-experimental testing, then the 6th grade passages were selected. If a participant read at a 7th or 8th grade level according to pre-experimental testing, then the 8th grade passages were selected. If an individual read at a 9th or 10th grade reading level, then the 10th grade passages were selected. Reading age equivalents that included an additional 6 or more months were rounded up to the next year. In other words, if an individual obtained a 6 years 8 months reading age, that individual was considered to be reading at a 7th grade level.

Experiment I instrumentation.

The stimuli for Experiment I were presented on a Hewlett Packard 18.5 inch LED backlit monitor. Adobe Premiere 6.0 (Adobe, Systems, Incorporated, 2000) was used to save .mov files of the scrolling text at the desired rate. The .mov files were played for each participant using Windows Media Player.

Experiment I statistical analyses.

Both decoding and comprehension accuracy percentages were transformed using the following formula: $2*\arcsin[\sqrt{(\text{accuracy} \% / 100)}]$. This transformation was completed since accuracy proportions essentially represent binomial data, meaning something is either correct or incorrect. Therefore, the mean and variance are often highly related. This transformation is undertaken in order to account for the differences between the variances while adding a degree of normality to the data. The transformed data was then entered into statistical software (SPSS) where two separate two-way

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repeated measures ANOVAs were conducted with a between subjects factor of group and a within subjects factor of acceleration proportion.

In addition, a series of Pearson product-moment correlations were completed on the standard scores obtained on all of the pre-experimental tests and the decoding and comprehension accuracy data obtained in Experiment I. These were conducted in order to investigate the existence of any relationships between the skills assessed by these tools and the statistical effects on decoding and comprehension that were investigated in the experimental conditions.

Experiment II: The Effects of Increasing Text Length

Experiment II was conducted immediately following Experiment I. Experiment II addressed the effect of text length on oral reading comprehension in reading disordered individuals in an accelerated reading task. As this experiment is concerned with text length, an operational definition of *length* was first established. As previously stated, describing text length solely by measuring the number of words or sentences is limited. Therefore, this study adopted the recommendation made by Carver (1990) that text length should be determined by considering a single word as six characters including spaces.

Experiment II procedure.

Each participant engaged in a series of four oral reading tasks that were presented using Adobe Premier 6.0 (Adobe Systems Incorporated, 2000) on a computer screen. The text in this experiment scrolled horizontally across the computer screen at pre-determined rates based upon the optimal acceleration proportion exhibited in Experiment I. The optimal acceleration proportion was defined as the rate

at which the participant exhibited the highest comprehension accuracy proportion. If two or more percentage increases yielded identical comprehension accuracies, then the higher rate was utilized as the optimal reading rate. The participant was required to read aloud one short passage with no acceleration, one short passage presented at their optimal accelerated reading rate, one long passage with no acceleration, and one long passage presented at their optimal accelerated reading rate. The participant was required to read each passage aloud so that decoding accuracy proportions could be obtained. A hard copy containing open-ended comprehension questions was immediately presented to each participant following the presentation of each of the texts. The participant was required to orally read each question and answer aloud. Regardless of text length, four factual questions and two inferential questions accompanied each text (see Appendix B). The participant was not allowed to refer back to the print during the answering of questions. Counterbalancing was utilized between texts and between acceleration rates to control for any order effects for each participant. Each individual completed all reading tasks in Experiment II at their previously established reading level as measured by the grade equivalents that were obtained in the pre-experimental administration of the GORT-4 (Wiederholt & Bryant, 2001).

Independent variables for Experiment II consisted of group (control and reading disordered), text length (short and long), acceleration condition (no acceleration or optimal acceleration condition based upon Experiment I results), and Experiment I optimal acceleration percentage (10%, 20%, or 30% proportional increase in reading rate). Dependent variables for Experiment II consisted of decoding accuracy percentage and reading comprehension accuracy percentage.

Experiment II stimuli.

The stimuli for Experiment II consisted of twelve narrative texts that were not used in Experiment I (see Appendix B). As in Experiment I, the *Fry Readability* Index (Fry, 1977) was used to determine grade level of the material to be used in this study. The texts also were selected based upon word count. The short texts were 300-350 words long whereas the long texts were 600-650 words long. Ranges of length were utilized in the selection of texts in this experiment in order to avoid the abrupt ending of any possible story arcs or storylines. In summary, each individual read two texts (one long and one short) at their pre-established baseline reading rate and two passages (one long and one short) at their pre-determined optimal accelerated reading rate as determined by Experiment I data.

Experiment II instrumentation.

The stimuli for Experiment I were presented on a Hewlett Packard 18.5 inch LED backlit monitor. Adobe Premiere 6.0 (Adobe, Systems, Incorporated, 2000) was used to save .mov files of the scrolling text at the desired rate. The .mov files were played for each participant using Windows Media Player.

Experiment II statistical analyses.

Both decoding and comprehension accuracy percentages were transformed using the following formula: 2*arcsine [√(accuracy % / 100)]. This transformation was completed since accuracy proportions essentially represent binomial data, meaning something is either correct or incorrect. Therefore, the mean and variance are often highly related. This transformation is undertaken in order to account for the differences between the variances while adding a degree of normality to the data. The transformed

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data was then entered into statistical software (SPSS) where two separate three-way repeated measures ANOVAs were conducted with two between subjects factors of group and Experiment I optimal acceleration proportion and two within subjects factors of acceleration condition and text length.

In addition, two separate two-way ANOVAs were conducted on the comprehension accuracy data with a between subjects factor of optimal acceleration percentage and two within subjects factors of acceleration proportion and text length.

In addition, a series of Pearson product-moment correlations were completed on the standard scores obtained on all of the pre-experimental tests and the decoding and comprehension accuracy data obtained in Experiment II. These were conducted in order to investigate the existence of any relationships between the skills assessed by these tools and the statistical effects on decoding and comprehension that were investigated in the experimental conditions.

CHAPTER IV

RESULTS

It has been shown that forcing an individual to read at an increased rate can have positive effects on the decoding and comprehension abilities of readers at all proficiency levels. However, it has not yet been shown whether these positive effects continue as acceleration increases beyond previously established levels and as text length increases beyond short passages. This study was designed to extend understanding of the effects of reading acceleration on reading comprehension and decoding accuracy. Oral reading rates were extended beyond the participants' previously exhibited rates in a systematic manner while also examining the effect of text length on reading comprehension and decoding accuracy.

In order to address whether there were differences between the two groups in terms of pre-experimental testing which included measures of single word decoding accuracy, single word decoding fluency, working memory, naming speed, and receptive vocabulary, a One-Way ANOVA was conducted on all pre-experimental testing results with a between subjects factor of group. Significant differences were found between all testing protocols (see Table 2 for p-values). These protocols were designed to measure the following skills: sight word decoding accuracy and fluency, phonological decoding accuracy and fluency, receptive vocabulary, visual working memory, rapid automatized naming, and textual comprehension. In addition, the non-standardized measure of reading rate was also found to be significantly different between the two groups with the control group exhibiting a faster reading rate (2.61 words/second) than did the RD group (2.15 words/second), $F (1, 32)7.199$, $p < .01$.

Table 2

P-Values for Group Differences Between Pre-Experimental Assessment Tools.

Measure	*p-value*
Test Of Word Reading Efficiency Sight Word Efficiency	0.000
Test Of Word Reading Efficiency Phonemic Decoding Efficiency	0.000
Woodcock Reading Mastery Tests – Revised Word Identification	0.000
Woodcock Reading Mastery Tests – Revised Word Attack	0.001
Peabody Picture Vocabulary Test – 4th Edition	0.036
Rapid Automatized Naming – Letters	0.007
Test of Information Processing Working Memory 1	0.002
Test of Information Processing Working Memory 2	0.007
Gray Oral Reading Tests – 4th Edition Comprehension	0.013

\# indicates years

* indicates standard scores (mean = 100, SD ± 15.

\+ indicates scaled scores (mean = 10, SD ± 3.

Experiment I: Effects of Increased Oral Reading Rate

  Decoding accuracy results.

  In order to address the experimental question which asked if there are statistically significant differences in decoding accuracy as a function of group and acceleration proportion, a two-way repeated measures ANOVA was conducted on the arcsine transformed decoding accuracy proportions with a between subjects factor of group and within subjects factor of acceleration proportion (see Table 3). A significant main effect was found for acceleration proportion, F (3, 30)12.650, p < .01. On average, the participants exhibited a higher decoding accuracy proportion (97.152%) when reading 10% faster than their baseline reading rate. The second highest mean proportion (92.73%) was demonstrated during the baseline reading rate while the third highest accuracy proportion (91.19%) was demonstrated when reading 20% faster. Mean decoding accuracy proportions were found to be the lowest (88.31%) when reading with a 30% increase in reading rate. No significant main effect of group was found and all interactions were not found to be significant.

  Post-hoc testing consisted of a series of six paired t-tests. This analysis revealed significant differences in decoding accuracy between the following proportional reading rate increases: 0% and 10%, 0% and 30%, 10% and 20%, 10% and 30%, 20% and 30%.

  Comprehension accuracy results.

  In order to address the experimental question asking if there are statistically significant differences in reading comprehension accuracy as a function of group and acceleration proportion, a two-way repeated measures ANOVA was conducted on the

Table 3

Means and Standard Deviations (SD) of Experiment I Decoding Accuracy Proportions
as a Function of Group and Acceleration Proportion.

	Comprehension Acceleration Proportion			
Group	0%	10%	20%	30%
Control	91.28 (16.28)	98.33 (2.00)	92.17 (7.57)	90.17 (7.59)
Reading Disordered	94.19 (6.07)	95.97 (4.00)	90.21 (8.78)	86.46 (11.38)

arcsine transformed comprehension accuracy proportions with a between subjects factor of group and a within subjects factor of acceleration proportion (see Table 4).

A significant main effect was found for acceleration proportion, F (3, 30)13.538, p < .01. On average, the participants answered more comprehension questions correctly (58.83%) when reading 10% faster than their baseline rate. The second highest mean proportion (51.09%) was while reading with a 20% increase in reading rate while the third highest accuracy proportion (48.53%) was while reading with a 0% increase in reading rate. Comprehension proportions (37.13%) were lowest while reading with a 30% increase in reading rate. No significant main effect was found for group and no significant two-way interactions were found.

Post-hoc testing consisted of a series of six paired t-tests. This analysis revealed significant differences between the following: 0% and 10%, 0% and 30%, 10% and 30%, 20% and 30% at a significance level of 0.05.

Experiment II: The Effects of Increasing Text Length

Decoding accuracy results.

In order to address the experimental question which asked if there are statistically significant differences in decoding accuracy as a function of group (RD or Control), optimal acceleration proportion (0, 10, 20, 30), text length (short, long), and acceleration condition (unaccelerated or accelerated), a repeated measures ANOVA was conducted on the arcsine transformed decoding accuracy proportions with two between subjects factors of group and optimal acceleration proportion and two within subjects factors of acceleration condition and length (see Table 5). A significant main effect of acceleration condition was found, $F(1,28) = 8.79$, $p = .006$ with the accelerated

Table 4

Means and Standard Deviations (SD) of Experiment I Comprehension Accuracy Proportions as a Function of Group and Acceleration Proportion.

	Comprehension Accuracy Proportion			
Group	0%	10%	20%	30%
Control	47.06 (5.58)	59.28 (4.85)	49.00 (5.42)	38.89 (7.32)
Reading Disordered	50.00 (5.92)	58.38 (5.15)	53.19 (5.75)	35.36 (7.77)

Table 5

Means and Standard Deviations (SD) of Experiment II Decoding Accuracy Proportions as a Function of Group, Optimal Reading Rate, Text Length, and Acceleration.

		Optimal Reading Rate		
Group	Condition	10%	20%	30%
Control				
	Short/Accelerated	76.45 (34.64)	73.50 (20.73)	90.33 (3.51)
	Short/Unaccelerated	82.73 (25.92)	84.25 (23.64)	96.67 (2.08)
	Long/Accelerated	92.12 (5.58)	90.50 (9.95)	95.00 (4.58)
	Long/Unaccelerated	89.63 (7.86)	96.50 (4.51)	92.33 (8.08)
RD				
	Short/Accelerated	87.43 (5.71)	91.93 (5.57)	75.09 (28.95)
	Short/Unaccelerated	92.14 (2.97)	96.30 (3.55)	96.67 (2.08)
	Long/Accelerated	90.57 (5.38)	92.13 (8.88)	89.52 (6.48)
	Long/Unaccelerated	90.42 (3.21)	92.29 (7.72)	91.13 (8.23)

condition yielding poorer decoding accuracy proportions (72.58%) than did the

unaccelerated condition (90.40%). However, the variable of acceleration condition also

was involved in the significant interaction that was found between length and

acceleration condition, $F(1,28) = 9.78$, $p = .004$. This interaction revealed that the

difference between decoding accuracy when reading short passages (82.46%) and

when reading long passages (88.75%) in the unaccelerated condition differed from the

accelerated condition which higher decoding accuracies when reading longer passages

(92.05%) than when reading shorter passages (62.70%) (see Figure 2). No significant

main effects were found for the variables of group, optimal acceleration proportion, or

text length were found and all other interactions were not found to be significant.

In order to address the experimental question which asked if there are

statistically significant differences in reading comprehension accuracy as a function of

group (RD or Control), optimal acceleration proportion (0, 10, 20, 30), length (short,

long), and acceleration condition (unaccelerated, accelerated), a repeated measures

ANOVA was conducted on the arcsine transformed comprehension accuracy

proportions with two between subjects factors of group and optimal acceleration

proportion and two within subjects factors of acceleration condition and length (see

Table 6). A significant three way interaction was found between group, length, and

optimal acceleration proportion, $F (2, 28) = 3.22$, $p = .06$. The reading disordered group

exhibited a significant two-way interaction between acceleration proportion and length,

$F (1, 13) + 6.26$, $p = .026$ whereas the control group did not exhibit this interaction, $F (1, 15) = .048$, $p = .83$. In order to better explain this complex interaction, two separate

analyses were conducted on the two separate groups (RD and Control).
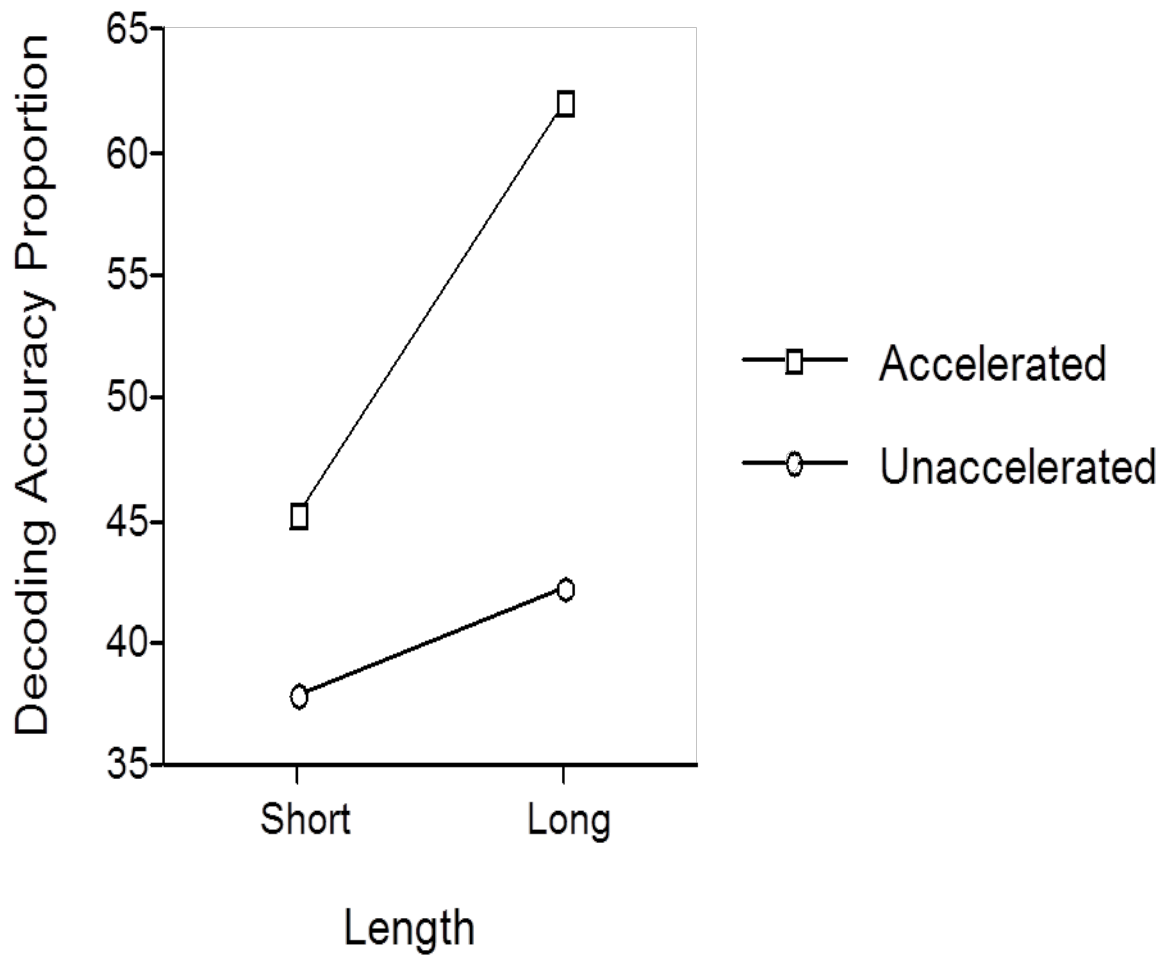
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Figure 2. Experiment II comprehension accuracy proportions as a function of text length and acceleration condition.

Table 6

Means and Standard Deviations (SD) of Experiment II Comprehension Accuracy Proportions as a Function of Group, Optimal Oral Reading Rate, Text Length, and Acceleration.

		Optimal Reading Rate		
Group	Condition	10%	20%	30%
Control				
	Short/Accelerated	37.82(18.44)	50.00 (30.31)	61.33 (9.82)
	Short/Unaccelerated	33.27 (16.60)	37.50 (15.84)	39.00 (19.05)
	Long/Accelerated	66.09 (18.96)	72.50 (29.64)	61.33 (9.82)
	Long/Unaccelerated	43.27 (28.95)	69.75 (35.98)	44.33 (34.50)
RD				
	Short/Accelerated	54.86 (12.85)	43.40 (19.03)	25.00 (21.43)
	Short/Unaccelerated	40.43 (21.31)	53.20 (18.21)	21.00 (8.00)
	Long/Accelerated	66.57 (25.21)	53.20 (18.21)	56.50 (29.14)
	Long/Unaccelerated	21.29 (15.67)	43.40 (28.06)	36.75 (29.80)

Repeated measures ANOVAs were conducted on the mean comprehension proportion data as a function of text length, acceleration condition, and optimal oral acceleration proportion.

For the RD group, a significant interaction was found between acceleration condition and optimal acceleration level, $F (2, 13) = 4.72$, $p = .029$. For those RD participants whose optimal proportion increase was 10% it was found that reading in the accelerated condition yielded significantly greater mean comprehension proportions (60.74%) than when reading at baseline reading rates (30.86%). For those RD participants whose optimal proportion increase was 20%, no significant differences in comprehension were found between the accelerated reading condition (48.30) and the unaccelerated reading condition (48.30). For those RD participants whose optimal percentage increase was 30% it was found that reading in the accelerated condition yielded significantly greater comprehension proportions (40.75) than when reading in the unaccelerated condition (28.88) (see Figure 3).

In addition, within the RD group, a significant interaction was found between passage length and acceleration condition, $F (1, 13) = 6.26$, $p = .026$. If the passage was short, then there were no significant differences between the comprehension proportions when the presentations of the passages were accelerated (41.09%) and when the presentations were not accelerated (38.21%); however, if the passages were longer, then significantly greater comprehension proportions were obtained in the accelerated condition (58.76%) than were obtained in the unaccelerated condition (33.81%) (see Figure 4).
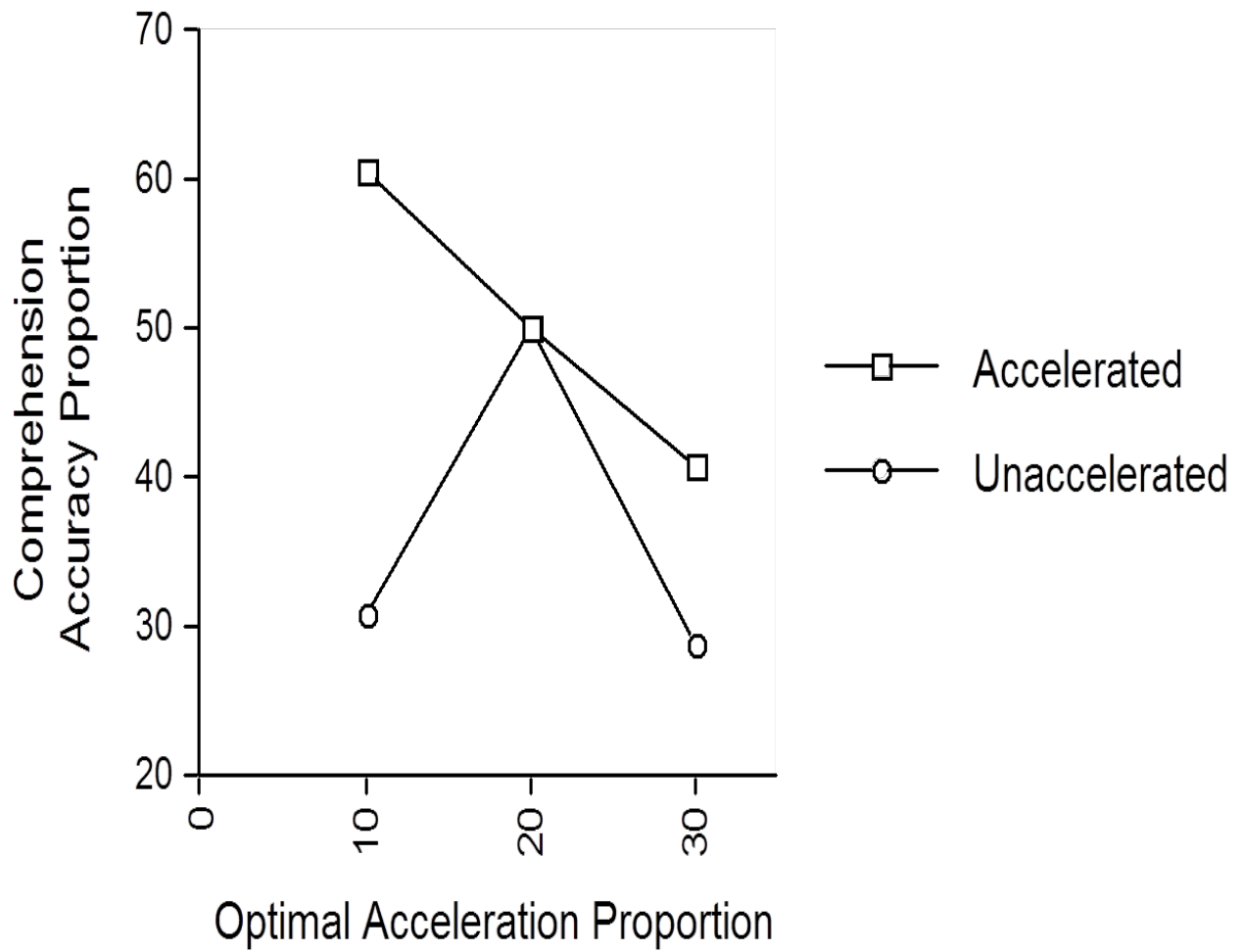
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Figure 3. Experiment II RD group comprehension accuracy proportions as a function of

acceleration condition and optimal acceleration proportion for the RD group.
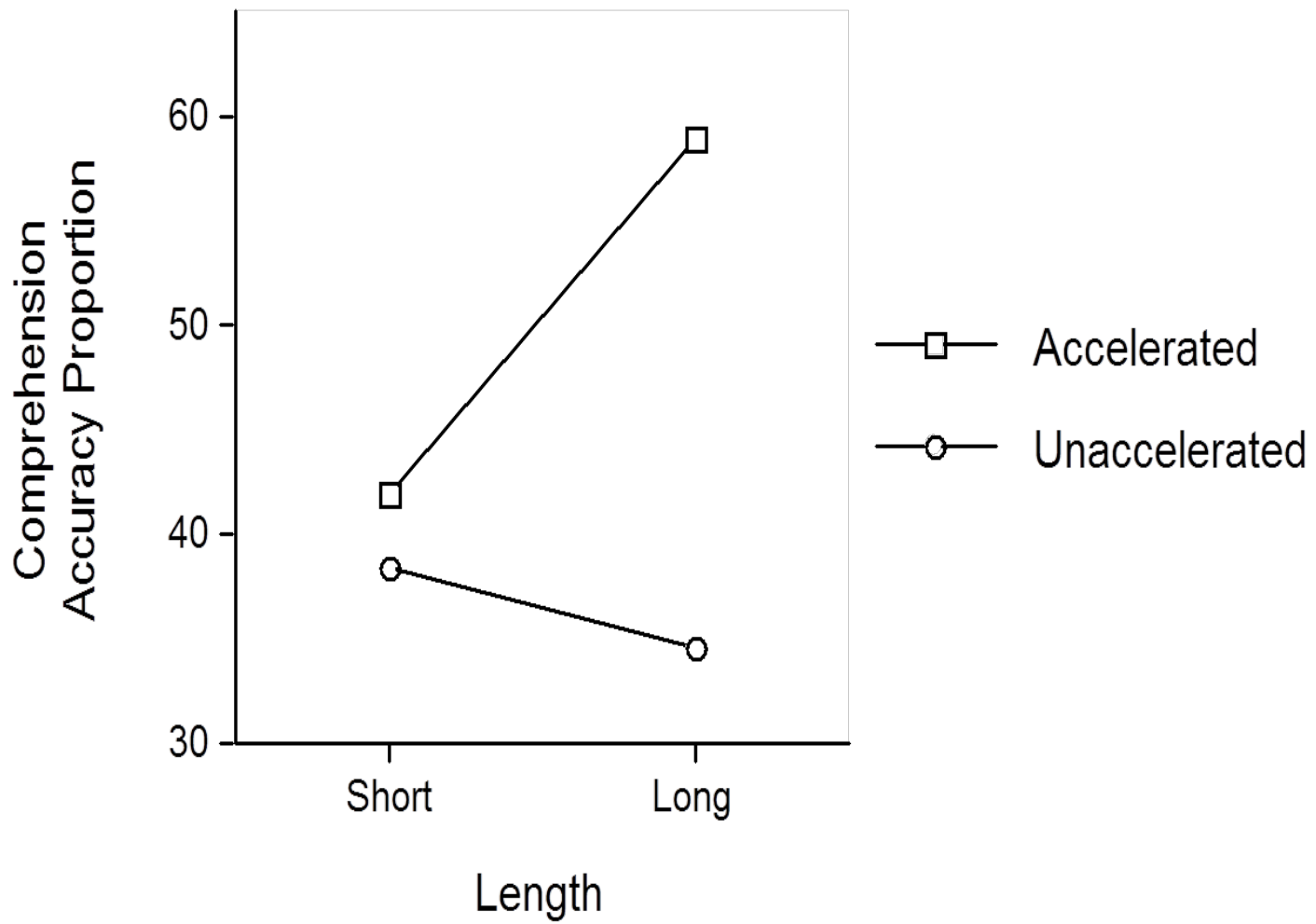
Figure 4. Experiment II RD group comprehension accuracy proportions as a function of

length and acceleration condition.

Finally, within the RD group, a significant interaction was found between length and optimal acceleration rate, $F(2, 13) = 5.58$, $p = .018$. For those RD participants whose optimal proportional increase was 10% it was found that reading shorter texts yielded higher comprehension proportions (47.64%) than did reading longer texts (43.93%). For those RD participants whose optimal proportional reading rate increase was determined to be 20% no significant differences in comprehension proportions were found when reading longer texts (48.30%) as compared to reading shorter texts (48.30%). For those RD participants whose optimal proportional increase was determined to be 30% it was found that reading longer texts yielded significantly greater comprehension proportions (46.63%) than did reading shorter texts (23.00%) (see Figure 4).

Within the control group, a significant main effect of length was found, $F(1, 15) = 5.20$, $p = .038$. On average, the control group answered more comprehension questions correctly when reading longer passages (59.55%) than when reading shorter passages (43.15%).

Additionally within the control group, a significant main effect of acceleration condition was found, $F(1, 15) = 8.25$, $p = .012$. On average, the control group answered more comprehension questions correctly when reading in the accelerated condition (58.18%) than when reading in the unaccelerated condition (44.52%).
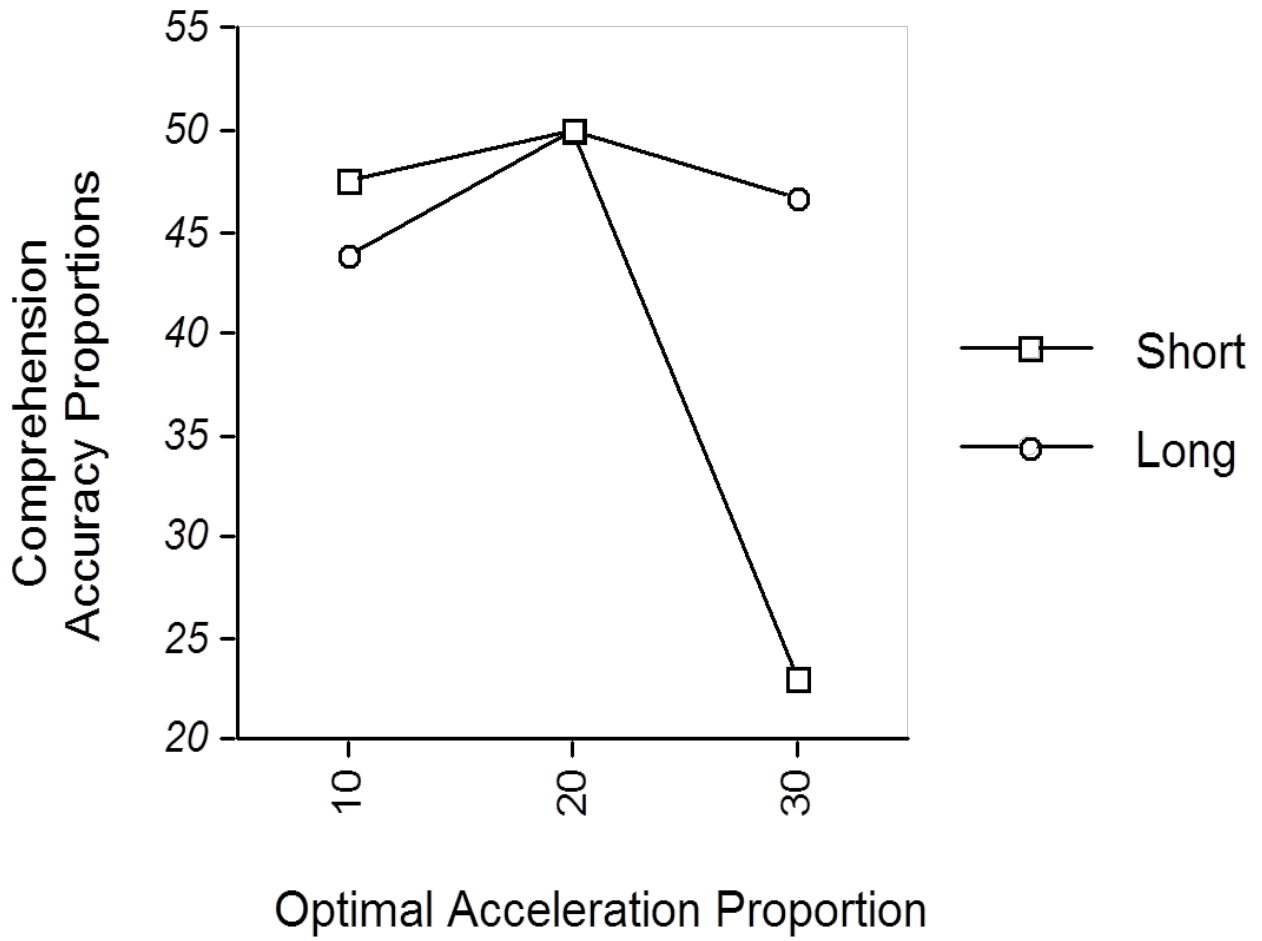
Figure 5. Experiment II RD group comprehension accuracy proportions as a function of

length and optimal acceleration proportion.

CHAPTER V

DISCUSSION

The purpose of this study was to examine the beneficial effects of oral reading acceleration on comprehension and decoding accuracy at rates faster than previously reported while using longer texts than have previously reported upon. It has been hypothesized that reading difficulties can be attributed to an asynchrony between the speed of processing (SOP) characteristics of the auditory based phonological system and the visually based lexical system (Breznitz & Misra, 2003). As a result, reading acceleration has been utilized in an attempt to overcome this asynchrony. Reading acceleration has been shown to improve both decoding and comprehension accuracy in individuals with both proficient and deficient reading abilities (Breznitz, 1987; 1997a; 1997b; Breznitz & Norman, 1998; Breznitz & Share, 1992; Norman & Breznitz, 1992). This "acceleration phenomenon" (Breznitz 1997a, 2001, 2002), has been exhibited in both children (Breznitz, 1987; 1997a; 1997b; 1997c) and adults (Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001). The typical finding in each of the aforementioned studies is that adults tend to decrease decoding errors and increase comprehension accuracy if required to read at a rate about 10 - 12% faster than their normal rate whereas children tend to do the same when reading approximately 20% faster than their normal rate. These results have been attributed to an extended attention span (Breznitz, 1998; 1997b), reduced distractibility (Breznitz, 1998; 1997b), and more efficient working memory processing and storage (Breznitz 1997a, Breznitz & Share, 1992).

Although the neurocognitive processes that underlie the acceleration phenomenon have been studied at great length, the clinical manipulations of this technique have not received the same amount of focus. For example, prior to this study, no study had addressed the effects of systematically increasing oral reading rates above previously exhibited reading rates. Previous studies have utilized an individual's fastest reading rate as measured in pre-experimental testing as the accelerated reading rate for each individual (Breznitz, 1987; 1997a; 1997b; 1997c; 2001; 2002; Breznitz & Leikin, 2001; Breznitz & Norman, 1998; Breznitz & Share, 1992; Karni et al., 2005; Leikin & Breznitz, 2001; Norman & Breznitz, 1992). Although this technique has been shown to improve reading abilities, it is possible that reading abilities may show more improvement if the proportional increases in acceleration rates are increased beyond the previously utilized proportional increases. This study investigated decoding accuracy and comprehension accuracy while proportionally increasing oral reading rates at higher levels than has previously been reported.

In addition, no study has addressed the effects of text length on reading comprehension and decoding accuracy as an effect of text length in accelerated oral reading conditions. Most studies have either utilized relatively short passages in order to investigate the "acceleration phenomenon" or the researchers did not provide a description of the length of the text that could yield any valuable information regarding this factor (Breznitz, 1987; 1997a; 1997b; 1997c; Breznitz & Share, 1992; Norman & Breznitz, 1992; Breznitz & Leikin, 2001; Karni et al., 2005; Leikin & Breznitz, 2001). Although reading acceleration had shown much promise in improving reading abilities it had not previously been shown to be effective beyond the short passage level

regardless of the fact that much reading for comprehension occurs with longer texts. For example, students' study materials, devotional materials, newspapers, and online blogs typically include passages that contain more than three sentences. This study investigated decoding accuracy and comprehension accuracy while systematically increasing text length beyond previously reported levels in order to examine if reading acceleration continues to benefit readers as text length increases.

Pre-Experimental Data

All pre-experimental test scores were entered into a One-way ANOVA with a between subjects factor of group. Pre-experimental testing provided measures of single word decoding ability, receptive vocabulary, working memory, naming speed, and reading comprehension. These skills have all been shown to influence reading ability. Significant differences existed between groups on all pre-experimental measures. This finding represents the multi-componential nature of reading. In this study, the groups were defined solely upon decoding skills, however, the groups exhibited differences in all of the other skills that were assessed in this study. It should be noted that not all component skills were determined to be deficient in the RD group. For example, the RD group obtained mean scores within the average range on working memory, receptive vocabulary, textual decoding accuracy, textual comprehension accuracy, and rapid automatized naming.

Furthermore, significant differences were found between the two groups in regards to reading rate. Each individual's average reading rate was determined by averaging the oral reading rate (words read correctly per second) of the two passages that were completed prior to their ceiling level on the GORT-IV (Wiederholt & Bryant,

2001). The GORT-IV establishes the ceiling level when the individual misses three out

of the five comprehension questions that follow each text. According to Hasbrouck and

Tindal (2006) the average oral reading rate for a high school student should be 2.52

words per second with a standard deviation of 0.68 words per second. This places the

RD group's mean oral reading rate (2.15 words/second) within the low average range.

So although the RD group obtained many scores that were significantly lower than the

control group, their decoding skills seem to be the only variable that accurately identifies

them as having below average reading abilities.

Experiment I: Effects of Increased Oral Reading Rate

Experiment I was designed in order to investigate the effects on decoding and

comprehension accuracy when reading rates were proportionally increased beyond

previously established levels. The first experimental question addressed if there were

differences in decoding accuracy as a function of group and acceleration proportion.

The analysis of the decoding accuracy data revealed a significant main effect of

acceleration proportion. Participants exhibited the highest mean decoding accuracy

proportion at a 10% increase from their baseline reading rate. This finding is similar to

Breznitz who exhibited that decoding accuracy could significantly improve with

approximately a 10 - 12% increase in reading rate (Breznitz et al., 1994). The current

data indicate that the optimal reading rate for decoding accuracy exists between a 0%

and a 20% increase above baseline reading rates, which would include the range that

Breznitz proposed. The difference between Breznitz's studies and the current study is

that the current study sought to investigate when oral decoding abilities would decrease.

It was found that when reading rates were proportionally increased by more than 20%,

decoding accuracy began to suffer. It is possible that proportionally increasing reading

rates beyond 20% begins to exceed the resources necessary for the cognitive,

linguistic, and motoric processes that must occur during oral reading comprehension

tasks.

The second experimental question addressed whether or not significant

differences existed in comprehension accuracy proportions as a function of group and

acceleration proportion. Once again, analysis of the comprehension data revealed a

significant main effect of acceleration proportion. It was found that a 10% increase in

reading rate yielded significantly higher comprehension proportions for both groups

compared to all other acceleration conditions. Both groups exhibited similar trends in

reading comprehension as a function of acceleration proportion. The data also revealed

that orally reading 30% faster than baseline does not significantly improve reading

ability. These data suggests that any optimal reading rate most likely exists between

the individuals' normal reading rates and a 30% increase in normal reading rates. This

finding is mostly congruent with many of Breznitz's former findings. She has stated that

if individuals can be made to read approximately 12% faster than they normally do, then

comprehension increases. However, this study is the first to attempt to isolate the

range in which reading acceleration continues to be beneficial to the reader.

Considering that the participants exhibited the highest comprehension proportions when

reading with a ten percent increase and reading comprehension proportions did not

improve with a thirty percent increase, then these data suggest that individuals read

most effectively when reading between 10% and >30% faster than they normally read.

The 30% increase condition is the only condition in which individuals did not exhibit

greater comprehension than they did with no increase in baseline reading rate. This data provide further support regarding the potential benefits of reading acceleration as a short term ameliorative reading technique.

It is important to consider the cumulative results of the decoding and comprehension analyses since doing so can have a critical impact on the recommended delivery methods of reading acceleration as a clinical tool. These results show that individuals can continue to exhibit marked improvement in decoding and comprehension even when reading at rates that are 20% faster than their average reading rate. Previous research had tended to focus around the 10 - 12% increase in reading rate (Breznitz et al., 1994). However, the current results point toward the variability that exists around that previously established range. This beneficial acceleration range had not previously been explored in a systematic manner. If a program only uses 10 to 12% increases in reading rate for all clients, then it is possible that they are not fully utilizing reading acceleration to its full potential. These data suggest that investigating a large range of acceleration proportions might prove to be beneficial if attempting to individualize this technique for each reader

It should be noted that there were 7 (4 RD, 3 Control) individuals who exhibited the 30% condition as their optimal acceleration proportion, which equaled 21% of the study participants. The existence of this large proportion compounds the necessity to consider individual variability when designing a reading acceleration program. Therefore, even though it seems likely that the beneficial acceleration range exists below a 30% increase, individual variability should always be taken into account.

Future studies should continue to attempt to more accurately define the proportional acceleration range in which acceleration continues to benefit the reader.

In addition, this is the first study that attempted to investigate the limits of oral reading acceleration in terms of the amount of acceleration utilized. No previous research had established at what point this strategy might no longer prove beneficial to the reader. Intuitively, some proportional increase in reading rate must result in a situation in which decoding and comprehension both cease to improve and in fact begin to suffer. The capabilities of presentation software are far greater than the motoric and cognitive capabilities of the human reader. These results provide insight as to where this point is likely to exist. These results showed that a 30% reading rate increase (also the maximum increase) was the only rate at which individuals did not, on average, comprehend the material more accurately. Both 10% and 20% increases yielded comprehension improvements over the baseline measure (0% increase). Therefore, these data indicate that the point at which improvements cease most likely exists between a 30% and 20% increase. On average, a 30% increase proved to be too rapid of a presentation pace for individuals to exhibit any gains in comprehension or in decoding accuracy which coincided with a significant decrease in decoding accuracy as well.

Experiment II: The Effects of Increasing Text Length

Experiment II was conducted in order to investigate the effects of increasing text length on the decoding and comprehension accuracy in an accelerated oral reading task. The first experimental question addressed whether or not differences existed in decoding accuracy as a function of text length, acceleration condition, optimal

acceleration proportion, and group. Analysis of the decoding data revealed a significant interaction between text length and acceleration condition. It was found that decoding accuracy did not differ between short and long passages during the unaccelerated condition whereas there were significant differences in decoding accuracy between short and long texts during the accelerated reading tasks. In the accelerated reading tasks, it was found that both groups obtained a higher mean decoding accuracy proportion when reading longer texts than when they were reading shorter texts. These results indicate the value of contextual cues and textual redundancy in comprehension tasks. The participants in the RD group only decoded 81% of the words accurately in the short accelerated condition. This is a very low proportion. If the participants began exhibiting decoding errors, they often had difficulties catching up with the rapidly moving text. In contrast, the participants read 91% of the words correctly in the long accelerated condition. A ten percent increase in accuracy represents a clinically significant increase in decoding accuracy. The individuals were able to rejoin the text possibly due to relying on the context of the entire passage when the length increased. This can be explained in terms of accelerated reading providing an increase in contextual information becoming available in working memory (Breznitz, 1987; Breznitz & Share, 2002). Working memory is a term used to describe the ability to simultaneously maintain and process goal relevant information. More specifically, it is the ability to mentally store information in an active and readily accessible state, while concurrently and selectively processing new information, making possible skills such as planning, reasoning, problem solving, reading, and abstraction (Conway, Jarrold, Kane, Miyake, & Towse, 2008). These defining characteristics pose serious limitations for

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information-processing tasks, such as reading, which require that the words and phrases being decoded be retained temporarily in memory to be arranged and encoded into meaningful sentences or propositions (Perfetti & Lesgold, 1977). Breznitz and Share (2002) conducted a series of experiments designed to investigate the effects of reading acceleration on short-term memory storage and access. One of the experiments in their study required individuals to read three passages (self-paced, fast-paced, and a second self-paced condition). Following the presentation of the passage, two test passages were simultaneously presented. One of the two test passages was the original passage and the other test passage contained either a semantic change or a wording change. The participants were required to identify the correct (original) version. It was found that the fast paced condition yielded superior detection of wording as opposed to semantic changes. This means that participants were more often "fooled by a substitute word that preserved meaning than by meaning-altering changes (p. 197). The authors claimed these results were evidence that accelerated reading operates upon the working memory system. Improvements in working memory, which would allow for more contextual information to be stored, may be the cause for the improvements in decoding accuracy as length increased.

The second experimental question addressed whether there were significant differences in comprehension abilities as a function of text length, acceleration condition, optimal acceleration proportion, and group. Analysis of the comprehension data revealed a three-way interaction between group, length, and optimal acceleration proportion. The reading disordered group exhibited a significant two-way interaction between acceleration condition and length whereas the control group did not exhibit this

interaction. In order to more clearly investigate this complex interaction, two separate analyses were conducted on the two separate groups' (RD and Control) comprehension proportions as a function of text length, acceleration condition, and optimal acceleration proportion.

Within the RD group, a significant interaction was found between text length and optimal acceleration level. Those participants who obtained a 10% optimal rate tended to score higher on the shorter texts whereas those who obtained 20% or 30% exhibited higher scores on the longer texts. This effect was especially pronounced for those who obtained 30% as their optimal rate. These results are in line with Keenan et al. (2008) who hypothesized that the comprehension of short passages is likely to be based upon the successful decoding of a single word that is found within that passage. The authors believed that a decoding error is more "catastrophic" in short passages (p. 297) than in longer passages. In a passage that only consists of a single sentence, there are few other words that might help an individual determine the correct pronunciation of a difficult word whereas in longer passages, there is much more context and more of a story arc that might offer a reader clues as to not only the correct decoding of a word, but also the meaning of that word. Keenan et al. went on to state that these story arcs provide an increased level of redundancy as text length increases. Thus, the shorter passages seem to have been presented too rapidly for this group to decode and comprehend what was read. It is possible that as the length increased, these individuals were capable of utilizing contextual cues and textual redundancy without the over-reliance on their impoverished decoding systems (Rastatter et al., 2007).

Within the RD group, a significant interaction was found between passage length and acceleration condition. If passages were short, then the comprehension proportions were similar regardless of acceleration. However, when the passages were longer, there was an obvious benefit in regards to comprehension when the passages were accelerated. These results also are in line with Breznitz's (1988) reasoning that reading acceleration improves focused attention. Breznitz stated that a slow reading rate gives more opportunities for distracting stimuli to manifest during the relatively longer periods of "empty time" between syllables, words, phrases, and sentences. Secondly, a fast-paced reading rate may increase attentional capacity by increasing the nonspecific arousal due to a higher ratio of stimuli per unit time (Posner & Rothbart, 1980). In other words, more stimuli in less time decreases distractibility and improves focused attention. In normal reading situations, longer passages provide more opportunities for distracting features to manifest themselves if for no other reason than they take longer to read. Reducing the potential for these distracting elements is one potential explanation for why the RD group exhibited this interaction between passage length and acceleration condition.

The results are also in line with O'Connor, Swanson, and Geraghty (2010) who attempted to improve reading fluency in a group of reading disordered children by having them practice reading aloud three times a week for 15 minutes over a twenty week span. The researchers compared pre- and post-treatment reading assessment results and found that fluency growth moderated changes in reading comprehension. The authors stated that growth in fluency appeared to be especially important as passages increased in length. The evidence they cited for this assertion was found in

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the differing amount of variance attributed to fluency improvement across different types of comprehension demands. At the sentence level, fluency improvement accounted for 60% of the explainable variance in comprehension. When passages were longer (e.g., 100–300), fluency growth exerted a stronger influence, accounting for 83% of comprehension growth.

In contrast, the analysis of the control group's comprehension data did not reveal this interaction. Instead, the control group data revealed two separate significant main effects of length and acceleration condition, with longer passages and accelerated passages yielding higher comprehension proportions. The fact that both groups performed more accurately with longer passages provides further evidence of the existence of redundancy in texts of longer lengths and the beneficial nature of that redundancy. Once again, longer texts seem to provide more contextual cues for the reader, while simultaneously lessening the load placed on decoding abilities. The fact that the control group obtained higher comprehension proportions when reading accelerated material adds to the growing body of support for the beneficial aspects of reading acceleration (Breznitz, 1987; 1994; 1997a; 1997b; 1997c; 2001; Breznitz & Berman, 2003; Breznitz & Leikin, 2001; Breznitz & Misra, 2001; Breznitz & Norman, 1998; Breznitz & Share, 1992; Karni & Breznitz, 2005; Meyler & Breznitz, 2003; Norman & Breznitz, 1992). However, this is the first study to demonstrate that reading acceleration as a remedial tool can be beneficial when used in more naturalistic reading situations when the text length is extended.

Within the RD group, an interaction was found between acceleration condition and optimal acceleration proportion. Mean scores indicate that the participants tended

to obtain higher comprehension proportions at all rates regardless of their optimal acceleration proportion, although there were no significant differences in comprehension proportions for those whose optimal acceleration proportion was determined to be 20%. However, there was an extremely large difference in mean comprehension proportions for those whose optimal acceleration proportion was determined to be 10% and a significant difference for those whose acceleration proportion was determined to be 30%. Further analysis of the pre-experimental data while utilizing optimal acceleration proportion as a grouping variable reveals some of the details of this finding. The group who obtained a 10% optimal acceleration proportion obtained the lowest scores of the three groups on: all four pre-experimental single word decoding tasks, receptive vocabulary, reading fluency, reading rate, and overall reading comprehension. This group obtained a 30% increase in reading comprehension accuracy proportions when reading in the accelerated condition. The 20% group obtained the highest scores of the three groups on all the previously mentioned pre-experimental tasks and they obtained a 0% improvement when reading in the accelerated condition. Finally, the 30% group's mean scores on all pre-experimental tests were in the middle of the other two groups and they exhibited an 11.88% increase in comprehension proportions when reading rate was accelerated. These data strongly suggest that the 10% group represents those who exhibit a more severely deficient reading profile with the 30% group exhibiting less severe deficits and the 20% group most closely resembling the control group. It has previously been shown that those who exhibit more severe deficiencies tend to benefit the most from reading acceleration. Breznitz (1997a) stated that deficient (poor) readers tend to derive the most benefit in

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regards to decoding and comprehension from utilizing reading acceleration. Obviously,

readers with deficient reading skills have more room to improve than do readers with

average to above average reading abilities. As a result, reading performance in these

individuals tends to respond well to the influence of reading acceleration. The 10%

group represented the most severe of the RD group and they showed the greatest

improvements in comprehension when reading under accelerated conditions. The more

the RD sub-group resembled the control group based upon pre-experimental testing,

the less the amount of improvement was observed when reading under the accelerated

condition.

This finding is important clinically. Previous studies in reading acceleration have

only attempted to group the experimental population dichotomously as either disordered

or not disordered. No reading acceleration study has attempted to subtype within the

disordered population. Reading disorders present in numerous manners and these

data provide further evidence of the variability that has been described in reading

disorders (see Wolf & Bowers 1999 for a review). These data provide a preliminary

description regarding the reading profile that best identifies positive responders to

reading acceleration as a treatment protocol.

General Discussion

When the comprehension and decoding accuracy data from both experiments is

considered, an interesting finding becomes apparent. The significant increases in

decoding accuracy tend to co-occur with significant increases in comprehension when

readers are performing accelerated reading tasks. This provides evidence for the

importance of decoding in comprehension tasks. However, the comprehension data

derived from Experiment II reveal that short passages are comprehended significantly

better when accelerated as compared to unaccelerated, even though the decoding

proportion drops significantly. More specifically, the comprehension proportion

increased by 11.56% while the decoding accuracy proportion decreases by 8%. These

results do not support narrow views of reading which state that decoding should be the

sole focus of reading intervention (Kamhi, 2009). Decoding accuracy, without doubt,

accounts for a large proportion of reading comprehension abilities. However, it does not

account for all comprehension abilities. Other factors such as attention and working

memory play large roles in determining the proficiency by which one can read

(Baddeley, 1992; Baddeley, 2000; Baddeley, 2010, Baddeley & Hitch, 1974; Breznitz,

2002; Carter et al., 2009; Daneman & Carpenter, 1980; Gathercole, Alloway, Willis, &

Adams, 2006; Just & Carpenter, 1992; Miller, 1956; Palladino, Cornoldi, de Beni, &

Pazzaglia, 2001; Reichle et al., 1998; Simon, 1974; Swanson et al., 2009). In fact, it

has been hypothesized frequently by Breznitz that reading acceleration might act upon

cognitive attention and memory networks (see Breznitz 2005 for a review).

Furthermore, there has been at least one other study that has shown that

comprehension can improve in the absence of improvements in decoding accuracy

(Carter et al., 2009). Carter et al. showed that altering the auditory feedback that an

adult with a reading disorder hears during oral reading tasks can improve

comprehension (approximately 2 grade levels) without the co-occurrence of improved

decoding skills. It is possible that both the altered feedback and the reading

acceleration operate on similar attentional networks, allowing the reader to more

efficiently utilize top down processing of the text. In fact, reading acceleration and

auditory masking have been used in conjunction in an attempt to improve dyslexic children's decoding and comprehension (Breznitz, 1997b). The combination of these two manipulations yielded increased reading comprehension and decoding accuracy in a group of fifty two children who were diagnosed with dyslexia. In addition, Rastatter et al. (2007) found an increase in both decoding accuracy and comprehension accuracy in a group of children while using altered auditory feedback with no manipulations regarding reading rate. The question remains as to why Breznitz (1997b) and Rastatter et al. (2007) found increases in decoding accuracy and why Carter et al. (2009) and the current study did not find increases in decoding accuracy although all three studies found significant increases in reading comprehension. The most obvious distinction between the studies who showed improvements in decoding (Breznitz 1997b, Rastatter, 2007) and those that did not is the age of the experimental group in each study. Both of the studies that utilized children as participants found increases in decoding ability. It is possible that as individuals mature, decoding becomes somewhat less important to comprehension and other factors begin to be of greater importance in successful reading.   Possible skills accounting for those other factors may include memory and attention. These factors should be addressed further in the adult population.

Finally, the lack of a significant main effect of group in either experiment reveals the potential universality of this remedial approach. This approach does not require the presence of disordered reading abilities to yield beneficial results. Breznitz (1997a) stated that her study "emphasizes the finding that even when reading skills are proficient, optimal performance levels are not normally achieved" (p. 438). A beneficial

reading tool that improves reading success in nearly all individuals while decreasing the amount of time needed to read in a rapid paced society is quite a powerful tool indeed.

The results of this study have shown that forced reading acceleration can improve the reading comprehension of individuals regardless of their reading proficiency. Previous studies have shown similar findings. However, no study had attempted to quantify the beneficial acceleration range. Instead, studies have typically utilized the individual's faster reading rate exhibited in pre-experimental testing. This methodology only allows the investigator to examine reading rates at which that the participants have already demonstrated proficiency. The current findings suggest that it is quite possible that many adult readers may benefit at higher proportional increases than have typically been utilized in studies of reading acceleration (12%) (Breznitz & Leikin, 2000; Karni et al., 2005; Leikin & Breznitz, 2001). The variability in optimal reading rates that was shown in the comprehension data obtained in Experiment I should encourage practitioners and researchers to expand beyond cookie cutter approaches and to embrace individual variability when designing reading programs, although these data also indicate that extending beyond a 30% increase might not be beneficial to the individual. In addition, the results of this study indicate that reading acceleration can continue to be a valuable tool as text length increases, possibly due to an increase in focused attention, more efficient memory processes, and improved top down processing. Also, the results suggest that specific subtypes within the RD population may exist which accurately determine which individuals with deficient reading are most likely to benefit from accelerated reading. Finally, this study indicates that successful decoding is associated strongly with reading comprehension, although it is

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not the only critical aspect of reading comprehension. Attention and working memory are two cognitive resources that can be recruited in order to improve reading comprehension.

Limitations

In the current study, as in all research, the constraints of time, energy, and available resources affected not only the results, which were found, but the questions that could be asked. One such restraint on this study was the number of incremental increases that could be utilized in Experiment I. As such, this study does not address the effects of increasing reading rate more than 30% above average reading rates. However, both comprehension and decoding accuracy were lower at 30% than they were with a 20% increase, which indicates the upper limits most likely do not exist above 30%. Furthermore, by utilizing ten percent increases, all smaller increments could not be investigated. Therefore, this study was only able to describe what occurs within ranges of ten percent as opposed to more specific ranges. Future studies should investigate the effects of proportionally increasing reading rates at increments of five or less.

Finally, by increasing the reading rates proportionally, those who were more proficient readers experienced greater increases in reading rate than those who read slower. For example, the average control participant who read at 2.61 words per second increased their rate by 0.26 words per second per ten percent per experimental interval whereas the average RD participant who read at 2.15 words per second increased their rate by .22 words per second. With a 30% increase in reading rate, the control group would be reading at an average rate of 3.39 words per second whereas

the RD group would be reading at an average rate of 2.80 words per second. This represents a 0.78 words per second increase for the control group and a 0.65 words per second increase for the RD group. Thus it is possible that by attempting to individualize each person's acceleration level according to their average reading rate, some individuals did not attempt what may potentially be their optimal reading rate in this study. This limitation may also be addressed in future studies by proportionally increasing reading rates above 30% or by a pre-determination of the amount of increases in rate such as 0.68 words per second increases which is a one standard deviation increase in oral reading rate according to Hasbrouck and Tindal (2006).

Implications for Future Research

The current study established that oral reading acceleration continues to show beneficial effects on reading comprehension and decoding accuracy even as the acceleration proportions and text lengths increased beyond previously established levels. Future research should focus on the limitations that were present in the current study. Specifically, future research can address more proportional increases in an attempt to more specifically define the range of beneficial acceleratory increases. Also, future research should investigate the differences between proportionally increasing reading rates versus statically increasing reading rates by pre-determined levels.

A second avenue of investigation which should be addressed is the effects of reading acceleration in oral reading tasks versus the effects during silent reading tasks. This study was concerned with decoding accuracy as well as comprehension accuracy; therefore an oral reading paradigm was selected. However, considering most adults

utilize silent reading over oral reading, a study which investigated these differences is warranted.

Conclusions

The purpose of the current study was to investigate mean differences in oral decoding and oral reading comprehension accuracy in accelerated reading conditions as reading rate and text length increased. Previous research has demonstrated gains in both decoding and comprehension during accelerated reading conditions. However, these studies have typically used reading rates that have already been demonstrated by the participants as the experimental accelerated rates. Breznitz (date) stated that this rate typically is approximately 10 – 12% faster than the reader's average rate. Utilizing the reading rate at which an individual has already shown proficiency excludes a vast range of rates that might prove to be even more beneficial to the individual reader. This study showed that individuals were capable of improving reading performance (decoding and comprehension) when rates exceeded 12%. In fact, many individuals exhibited the greatest improvements in comprehension when reading 30% faster than their average rates.

In addition, the body of research supporting reading acceleration's effectiveness has only used short passages as stimuli. A typical description of the stimuli is, "the passages consisted of one to two declarative statements" (Breznitz, DATE). Adults, and especially adult students, tend to read more than one to two statements at a time. If reading acceleration is to be utilized as part of a treatment protocol, then it is important that it continue to positively affect oral reading comprehension and decoding in passages that consist of more than two sentences. This study showed that

individuals continue to benefit from accelerated reading beyond the short passage level. More specifically, it was found that reading acceleration improved both decoding and accuracy more so in longer passages than shorter passages. These results indicate that reading acceleration might not only continue to help as text length increases, but its effects might be even more pronounced in longer passages.

Perhaps most importantly, although the results of this study indicate that reading acceleration is an important clinical tool in the amelioration of reading disorders, the presence of deficient reading abilities is not vital for this approach to help. This study revealed no differences in the magnitude of the comprehension and decoding gains as a function of group. There are situations in nearly every person's life when reading comprehension is of vital importance. This technique could benefit individuals in those situations. The existence of an instantaneous beneficial technique that works for almost all people is quite remarkable.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Matthew Carter
CC:
         Michael Rastatter
Date: 1/25/2012
Re: UMCIRB 11-001293
         Reading Acceleration

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 1/25/2012 to 1/24/2013. The research study is eligible for review under expedited category #6, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

The approval includes the following items:

Name	Description
Advertisement.doc | History	Recruitment Documents/Scripts
Assent Template 12 -17 years of age.doc | History	Consent Forms
Dissertation Prospectus | History	Study Protocol or Grant Application
GFW.pdf | History	Standardized/Non-Standardized Instruments/Measures
GORT-4 Form A.pdf | History	Standardized/Non-Standardized Instruments/Measures
Informed Consent Template-No More Than Minimal Risk 5-1-10.doc | History	Consent Forms
Parental Consent for Using Research Data.doc | History	Consent Forms
PPVT-4 Form A.pdf | History	Standardized/Non-Standardized Instruments/Measures
RAN-RAS.pdf | History	Standardized/Non-Standardized Instruments/Measures
Text and Questions.doc | History	Standardized/Non-Standardized Instruments/Measures
TIPS.pdf | History	Standardized/Non-Standardized

TOWRE FORM B.pdf | History

**Instruments/Measures
Standardized/Non-Standardized
Instruments/Measures**

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418 IRB00004973
East Carolina U IRB #4 (Behavioral/SS Summer) IORG0000418

APPENDIX B: INFORMED CONSENT DOCUMENT FOR PARTICIPANTS OLDER

THAN 18

Title of Study: The Limitations of Reading Acceleration

East Carolina University

Informed Consent to Participate in Research
Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: The limitations of reading acceleration
Principal Investigator: Matthew Carter
Institution/Department or Division: East Carolina University, Department of Communication Sciences and Disorders
Address: Health Sciences Building, Greenville, 27834
Telephone #: 336-413-4215

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to see if making people read faster improves how well they understand what they read. The decision to take part in this research is yours to make. By doing this research, the researchers hope to learn how fast people can read and for how long they can read that fast.

Why am I being invited to take part in this research?
You are being invited to take part in this research because you either have average reading abilities or you have some trouble reading. If you volunteer to take part in this research, you will be one of about 60 people to do so.

Are there reasons I should not take part in this research?
You should not take part in this study if you didn't learn English as your first language. You also should not participate if you have been diagnosed with ADHD and are not currently taking medication. Also, you shouldn't participate if you have received brain damage in the past.

What other choices do I have if I do not take part in this research?
You can choose not to participate. If you feel that you need help reading, you may obtain services from your school or from local tutoring centers.

Where is the research going to take place and how long will it last?
The research procedures will be conducted at the Health Sciences Building on East Carolina University's campus. It is located behind the hospital. You will need to come to room number 2310 N one time during the study, with the possibility of a follow up session. The total amount of time you will be asked to volunteer for this study is 3 hours

What will I be asked to do?
You are being asked to complete a series of tests. The *Test of Word Reading Efficiency* will be completed to see how well you read single words. This will take about 3 minutes to complete. The *Grey Oral Reading Tests – 4ᵗʰ Ed.* will be completed to see how well you understand what you read. This will take about 15 minutes. The *Peabody Picture Vocabulary Test – 4ᵗʰ Ed.* will be completed in order to see how well you can identify objects and actions in pictures. This will take about 15 minutes. The *Test of Information Processing* will be administered in order to see how well you remember some things. This will take about 15 minutes. The *Goldman-Fristoe-Woodcock Sound Symbol Tests* will be administered in order to see how well you can understand letter sounds. This will take about 15 minutes. The

Title of Study: The Limitations of Reading Acceleration

Rapid Automatized Naming and Rapid Serial Naming Test will be completed to see how quickly you can name common objects. This will take about 2 minutes.

You will also have your hearing and vision screened.

You will also be asked to complete a series of 8 oral reading tasks. In these tasks, the words will be presented at different speeds and some of the texts will be longer than others. You will be asked to complete a series of comprehension questions after you read each passage.

All of your responses will be audio-recorded so that the investigators can go back and listen to the session. These tapes will be erased after 3 years. You can stop participating at any time during or after the study with no penalty.

What possible harms or discomforts might I experience if I take part in the research?
It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

What are the possible benefits I may experience from taking part in this research?
We do not know if you will get any benefits by taking part in this study. This research might help us learn more about ways to help individuals read better. You also can receive a detailed description of your reading strengths and weaknesses. You also will receive two $20 gift certificates from Target for a total of $40 in gift cards. However, there may be no personal benefit from your participation but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?
We will pay you for the time you volunteer while being in this study. You will receive two gift cards for $20 to Target for a total of 40$ when you complete the entire research participation.

What will it cost me to take part in this research?
It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:
  • The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
Your data will be collected and stored in a locked cabinet. The audiotapes of your session will also be kept in this cabinet and destroyed after 3 years. No identifiers will be kept electronically.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 336-413-4215 (M-F, between 1and 5 P.M.)

UMCIRB Number:_____ *Page 2 of 3*

Consent Version # or Date:_____
UMCIRB Version 2010.05.01   *Participant's Initials*

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Title of Study: The Limitations of Reading Acceleration

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

_____   _____
Participant's Name (PRINT)   **Signature**   **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

_____   _____
Person Obtaining Consent (PRINT)   **Signature**   **Date**

*UMCIRB Number:*_____

*Consent Version # or Date:*_____
UMCIRB Version 2010.05.01

Page 3 of 3

_____
Participant's Initials

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APPENDIX C: MINOR ASSENT DOCUMENT FOR PARTICIPANTS UNDER AGE 18

East Carolina University **Assent Form**
Things You Should Know Before You Agree To Take Part in this Research

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IRB Study #_____

Title of Study: The Limitations of Reading Acceleration

Person in charge of study: Matthew Carter
Where they work: East Carolina University
Other people who work on the study: Michael P. Rastatter, PhD

Study contact phone number: 336-413-4215
Study contact E-mail Address: carterm03@students.ecu.edu

People at ECU study ways to make people's lives better. These studies are called research. This research is trying to find out if making people read faster improves how well they understand what they read. The decision to take part in this research is yours to make. By doing this research, we hope to learn how fast people can read and for how long they can read fast.

Your parent(s) needs to give permission for you to be in this research. You do not have to be in this research if you don't want to, even if your parent(s) has already given permission.

You may stop being in the study at any time. If you decide to stop, no one will be angry or upset with you.

Why are you doing this research study?
The reason for doing this research is to help others understand ways to help people read.

Why am I being asked to be in this research study?
We are asking you to take part in this research because I either read as well or less well than my peers.

How many people will take part in this study?
If you decide to be in this research, you will be one of about 60 people taking part in it.

What will happen during this study?
You will spend about 3 hours completing this testing. Most of these tests will involve reading and answering questions. If you finish in one day, you will not have to come back. You have been told that the testing will be tape recorded. You have also been told that these tapes will be kept in a locked cabinet and destroyed after 3 years.
> Check the line that best matches your choice:
> _____ OK to record me during the study
> _____ Not OK to record me during the study

1

This study will take place at the Health Sciences building at ECU and will last 3 hours.

Who will be told the things we learn about you in this study?
The researchers at East Carolina University (Matthew Carter and Michael Rastatter) will have access to the results of your study. The people at ECU who make sure the researchers are following the rules will also be able to look at your results.

What are the good things that might happen?
Sometimes good things happen to people who take part in research. These are called "benefits." The benefits to you of being in this study may be that you learn more about how you read and how you might be able to read better. There is a chance you will benefit from being in this research.

What are the bad things that might happen?
Sometimes things we may not like happen to people in research studies. These things may even make them feel bad. These are called "risks." There are no known risks in this study. You may or may not have these things happen to you. Things may also happen that the researchers do not know about right now. You should report any problems to your parents and to the researcher

Will you get any money or gifts for being in this research study?
You will receive two $20 gift certificates for being in this study for a total of $40 in gift certificates.

Who should you ask if you have any questions?
If you have questions about the research, you should ask the people listed on the first page of this form. If you have other questions about your rights while you are in this research study you may call the Institutional Review Board at 252-744-2914.

If you decide to take part in this research, you should sign your name below. It means that you agree to take part in this research study.

_____   _____
Sign your name here if you want to be in the study   Date

_____
Print your name here if you want to be in the study

_____   _____
Signature of Person Obtaining Assent   Date

_____
Printed Name of Person Obtaining Assent

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APPENDIX D: PARENTAL CONSENT FORM

Parental Consent for Using Research Data

Dear Parent/Guardian,

I'm presently working on my Doctorate of Philosophy degree at East Carolina University. As part of my degree requirements, I am planning an educational research project to take place at East Carolina University that will help me to learn more about reading. I am trying to learn more about how fast students can read and for how long they can read fast. The fundamental goal of this research study is to see how well children can read when they are made to read about 10-30% faster than they normally do. Your child will be paid two $20 gift certificates if you and they agree to participate.

As part of this research project, your child will participate in one session over 3 hours that will allow me to study how well they read. As this study is for educational research purposes only, the results of these tests **will not** affect your child's grade. There are no known risks associated with this study.

I am requesting permission from you to use your child's data (i.e. test scores) in my research study. Please understand that your permission is entirely voluntary.

If you have any questions or concerns, please feel free to contact me at school at 336-413-4215 or by emailing me at carterm03@students.ecu.edu. If you have any questions about the rights of your child as a research participant, you may contact *The University and Medical Center Institutional Review Board* at 252-744-2914.

Please detach and return the form below by   . Thank you for your interest in   my educational research study.

Matthew Carter
Researcher/Investigator

As the parent or guardian of _____,
(write your child's name)

☐ **I grant my permission for Mr. Carter to use my child's data in her educational research project regarding reading instruction. I voluntarily consent to Mr. Carter using any of the data gathered about my student in her study. I fully understand that the data will not affect my child's grade, will be kept completely confidential, and will be used only for the purposes of her research study.**

☐ **I do NOT grant my permission for Mr. Carter to use my child's data in her educational research project regarding reading.**

Signature of
Parent/Guardian: _____**Date:** _____

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APPENDIX E: STIMULI FOR EXPERIMENT I

San Souci, R. D. (2006). The caller. In Avi & C. Shute (Eds.), Best Shorts*:
Favorite Short Stories for Sharing* (pp. 17-26). New York: Houghton Mifflin.
Grade Level: 6th grade

It was hot at Aunt Margaret's funeral. Being in church was tiring, but this was worse. Lindsay had to stand in the hot sun, sweating in the ugly, black, too-heavy dress her parents had made her wear, while the minister prayed on. The flowers that were draped across the coffin had wilted. Lindsay almost giggled as she thought of Aunt Margaret in her coffin turning golden brown like a big biscuit in a toaster oven. Several of Aunt Margaret's neighbors at the old folk's home were there. Lindsay knew that her best friends were getting ready for a party later that night. It was a pajama party and all her friends were going to come.

Questions

1) Where was Lindsay in this story?

2) Who had died in this story?

3) Other than family, who was at the funeral?

4) How would you describe Lindsay's relationship like with her Aunt?

5) How old is Lindsay?

6) Why is Lindsay upset?

San Souci, R. D. (2006). The caller. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 17-26). New York: Houghton Mifflin.

Grade Level: 6th grade

But the guests finally left. Lindsay ran to her room to change so that her father could drive her to Missy's party. When she was ready, she opened her red velvet jewel case and took out Aunt Margaret's ring, set with real diamonds in white gold. She had always loved it, and Aunt Margaret had promised it to her just before she died. Her mother had wanted to keep it until Lindsay was older, but Lindsay had thrown one of her best tantrums and said that the old woman had wanted her to wear it always and showing off to Missy and Noelle and Candice and the others was special!

Questions

1) To whom did the ring originally belong?

2) How did Lindsay convince her mother to allow her to wear the ring?

3) What color was the jewelry box?

4) When was the ring promised to Lindsay?

5) Why did Lindsay's mother want her to wait until she was older to wear the ring?

6) How can Lindsay's behavior best be described?

Wynne-Jones, T. (2006). The night of the pomegranate. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 178-184). New York: Houghton Mifflin.

Grade Level: 6th grade

Being outside at this moment reminded Harriet of a time when she was younger. She had been a girl then, and had heard on the radio the famous broadcast of The War of the Worlds. It was a radio drama based on a story about Martians attacking the world, but it was presented in a series of news bulletins and reports, and a lot of people had believed it was true. Harriet listened to Mrs. Pond talk about the depression while she sipped her cocoa and stared at the heavens. Mars was wonderfully clear in the telescope, but even with the naked eye she could imagine canals and raging storms.

Questions

1) Which planet was Harriet looking at?

2) What did Harriet imagine about the planet?

3) What did Mrs. Pond talk about?

4) Where are Harriet and Mrs. Pond?

5) Do you think that Harriet believes in Martians? Why?

6) What was the sky like in this story?

Wynne-Jones, T. (2006). The night of the pomegranate. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 178-184). New York: Houghton Mifflin.

Grade Level: 6th grade

Everything about her project was wrong. The crumpled paper was coming undone. Because she had used the last of the Scotch tape on Saturn's rings, the rest had nothing to keep them scrunched up. Tiny Pluto was already bigger than Jupiter and growing by the minute. She had also run out of glue, so part of her solar system was stuck together with grape chewing gum. Dad was annoyed at Harriet for using part of the business section. Mostly she had stuck to the want ads, but then an advertisement printed in red ink in the business section caught her eye, and she just had to have it.

Questions

1) Why did the rest of the planets keep coming undone?

2) Which planet was growing by the minute?

3) Why was Dad annoyed at Harriet?

4) What caught Harriet's eye in the newspaper?

5) About how old is Harriet?

6) Is Harriet proud of her project? Why or why not?

Stevenson, R. L. (1932). A lodging for the night. In W. Taylor (Ed.), *Varied Narratives* (pp. 36-56). New York: Ray Long & Richard Smith, Inc.

Grade Level: 8th grade

The cemetery of St. John had taken its own share of the snow. All the graves were decently covered; tall white housetops stood around in grave array; worthy neighbors were long ago in bed, nightcapped like their domiciles; there was no light in all the neighborhood but a little peep from a lamp that hung swinging in the church choir, and tossed the shadows to and fro in time to its oscillations. A black-clad monk was using his keys on the door. The clock was hard on ten when the patrol went by with halberds and a lantern, beating their hands; and they saw nothing suspicious about the cemetery at all.

Questions

1) What was the name of the cemetery?

2) Where were the neighbors?

3) Where was the lamp?

4) What time of year was it?

5) Who was carrying halberds and a lantern?

6) What do you think happened next in this story?

Schwartz, D. (1970). In dreams begin responsibilities. In J. Tytell & H. Jaffe (Eds.), *Affinities: A Short Story Anthology* (pp. 365-372). New York: Thomas Y. Crowell Company.

Grade Level: 8th grade

My father walks the street, once in a while coming to an avenue on which a streetcar skates and yaws, progressing slowly. The taxi helps a young lady wearing a hat into the car. He makes change and rings his bell as the passengers mount the car. Everyone is wearing fine clothes and the streetcar's noises emphasize the quiet. (Brooklyn is said to be the city of churches.) The shops are closed and their shades drawn but for one drugstore. My father has chosen to take this long walk because he likes to walk and think. He doesn't notice the trees on each street, now coming to green and the time when they will enclose the whole street in shadow.

Questions

1) Where does this story take place?

2) What is the young lady wearing?

3) What does the taxi driver do after making change?

4) Why has father chosen this street?

5) What day is it?

6) What time of year is it?

Zweig, S. (1942). The invisible collection. In M. E. Speare (Ed.), *World's Great Short Stories* (pp. 224-235). New York: The World Publishing Company.

Grade Level: 8th grade

You know what has been going on in my trade since the value of money began to diffuse into the void like gas. War profiteers have developed a taste for old masters (Madonnas and so on), for incunabula, for ancient tapestries. It is difficult to satisfy their craving; and a man like myself, who prefers to keep the best for his own use and enjoyment, is hard put to it not to have his house stripped bare. If I let them, they would buy the cuff-links from my shirt and the lamp from my writing-table. Harder and harder to find wares to sell. I'm afraid the term "wares" may grate upon you in this connection, but you must excuse me. I have picked it up from customers of the new sort.

Questions

1) What has happened to the value of money?

2) Who developed a taste for old masters?

3) What did the narrator say the people would buy if he would let them?

4) What is the narrators occupation?

5) What time period does this story take place in?

6) Why does the narrator dislike war profiteers?

Steinbeck, J. (1942). The promise. In M. E. Speare (Ed.), *World's Great Short Stories* (pp. 15-31). New York: The World Publishing Company.

Grade Level: 8th grade

At the fork in the road, the rifle evaporated and the tigers and bears melted from the hillsides. Even the moist and uncomfortable creatures in the lunch pail ceased to exist, for the little red metal flag was up on the mailbox, signifying that some postal matter was inside. Jody set his pail on the ground and opened the letter box. There was a Montgomery Ward catalog. He slammed the box, picked up his lunch pail and trotted over the ridge and down into the cup of the ranch. Past the barn he ran, and the bunkhouse and the cypress tree. He banged through the front screen door of the ranch house calling, "Ma'am, ma'am, there's a catalog."

Questions

1) What melted from the hillsides?

2) What was in his lunch pail?

3) What kind of catalog was in the mail?

4) What type of house was he at?

5) When did this story take place?

6) Why did the creatures cease to exist to the boy?

Roth, P. (1980). The professor in Prague. In P. Roth (Ed.), *A Philip Roth Reader* (pp. 111-146). New York: Farrar, Straus and Giroux.

Grade Level: 10th grade

I am invited for a weekend on Cape Cod by a faculty couple I have just gotten to know, and there I am introduced to Claire Ovington, their young neighbor, who is renting a tiny shingled bungalow in a wild-rose patch near the Orleans beach for herself and her golden Labrador. Some ten days after the morning we spent talking together on the beach I take the impulse by the horns and return to Orleans, where I move into the local inn. I am drawn at first by the same look of soft voluptuousness that had done so much to draw me to Helen, and which has touched off, for the first time in over a year, a spontaneous surge of warm feeling.

Questions

1) Who invited him to Cape Cod?

2) What type of dog did Claire have?

3) Where did the narrator and Claire spend time talking together?

4) What did the narrator say he was drawn toward?

5) Who was Helen?

6) What do you think happened next in this story?

Roth, P. (1980). The professor in Prague. In P. Roth (Ed.), *A Philip Roth Reader* (pp. 111-146). New York: Farrar, Straus and Giroux.

Grade Level: 10th grade

Now it is as if a gong has been struck in my stomach when I recall that I had written Claire my flirtatious letter, and then had nearly been content to leave it at that. Had even told Klinger that writing out of the blue to a voluptuous young woman I had spoken with casually on a beach for two hours was a measure of just how hopeless I was. I had almost decided against showing up for breakfast that last morning, so fearful of what my convalescent desire might have in store for me if I came with a suitcase in one hand and my plane ticket in the other, and put it to a last-minute test. However I did manage to make it past my shameful secret.

Questions

1) How does the narrator describe his letter?

2) Who did he tell about the letter?

3) What was he fearful of?

4) What did he almost decide not to show up for?

5) How would you describe how this man feels?

6) What do you think was his secret?

Von Goethe, J. W. (1971). Novella (E. Mayer & L. Bogan, Trans.), In J. W. von

Goethe (Ed.), *The Sorrows of Young Werther and Novella* (pp. 169-201). New York:

Vintage Books.

Grade Level: 10th grade

A thick autumn mist still flooded the spacious inner court of the Prince's castle;

but when the veil gradually lifted, the hustle and bustle of the hunting party, on

horseback and on foot, became more or less visible. Knapsacks of badger skin were

adjusted, while the impatient hounds almost pulled their keepers along by their leashes.

Here and there a horse pranced nervously, pricked by its own fiery temper or by the

spur of its rider who, even in the dim light, could not suppress a certain vanity to show

off. All, however, were waiting for the Prince, whose farewells to his young wife had

already caused too much delay.

Questions

1) Where was the hunting party?

2) What time of year was it?

3) What were the knapsacks made of?

4) Who were they waiting for?

5) Why did the horses prance nervously?

6) Why do you think the Prince was late?

Sturgeon, T. (1959). The [widget], the [wadget], and boff. In A. Boucher (Ed.), *A Treasury of Great Science Fiction: Vol. I* (pp. 308-369). New York: Doubleday & Company, Inc.

Grade Level: 10th grade

Human eyes would never have recognized the device for what it was. Its memory bank was an atomic cloud, each particle of which was sealed away from the others by a self-sustaining envelope of force. Subtle differences in nuclei were the coding and fields of almost infinite variability called up the particles in the desired combinations. These were channeled in a way beyond description in earthly mathematics and translated into an analog of what we understand as language. It yielded results, in this particular setting, which was surprising. These were correlated into a report, the gist of which was this: Prognosis positive, or prognosis negative.

Questions

1) What would never recognize the device?

2) What was an atomic cloud?

3) What was incapable of being described by earthly mathematics?

4) What was it translated into?

5) What do you think the device is?

6) What was the prognosis for the results of this device?

APPENDIX F: STIMULI FOR EXPERIMENT II

Untermeyer, L. (2006). The dog of Pompeii. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 178-184). New York: Houghton Mifflin.

Grade Level: 6th grade

Passage Length: Long

Tito and his dog Bimbo lived (if you could call it living) under the city wall where it joined the inner gate. They really didn't live there; they just slept there. They lived anywhere. Pompeii was one of the grandest of the old Roman towns, but although Tito was never an unhappy boy, he was not exactly a merry one. The streets were always lively with shining chariots and bright red trappings; the open-air theaters rocked with laughing crowds; sham battles and athletic sports were free for the asking in the great stadium. Once a year the emperor visited the pleasure city, and the fireworks and other forms of entertainment lasted for days. But Tito saw none of these things. He was known to everyone in the poorer quarters. But no one could say how old he was; no one remembered his parents; no one could tell where he came from. Bimbo was another mystery. As long as people could remember seeing Tito - several years at least - they had seen Bimbo. The dog never left his side. He was not only a watchdog, but mother and father to Tito. Did I say Bimbo never left his master? (Perhaps I had better say "comrade," for if anyone was the master, it was Bimbo.) I was wrong. Bimbo did trust Tito alone exactly three times a day. It was a custom understood between boy and dog since the beginning of their friendship, and the way it worked was this: Early in the morning, shortly after dawn, while Tito was still dreaming, Bimbo would disappear. When Tito awoke, Bimbo would be sitting quietly at his side, his ears cocked, his stump of a tail tapping the ground, and a fresh-baked loaf of bread - more like a large round

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roll - at his feet. Tito would stretch himself, Bimbo would yawn, and they would eat

breakfast. At noon, no matter where they happened to be, Bimbo would put his paw on

Tito's knee, and the two of them would return to the inner gate. Tito would curl up in the

corner (almost like a dog) and go to sleep, while Bimbo, looking quite important (almost

like a boy), would disappear again. In a half-hour he would be back with their lunch.

Sometimes it would be a piece of fruit or a scrap of meat; often it was nothing but a dry

crust. But sometimes there would be one of those flat, rich cakes, sprinkled with raisins

and sugar that Tito liked so much. At suppertime the same thing happened, although

there was a little less of everything, for things were hard to snatch in the evening with

the streets full of people. But whether there was much or little, hot or cold, fresh or dry,

food was always there. Tito never asked where it came from, and Bimbo never told him.

There was plenty of rainwater in the hollows of soft stones; the old egg woman at the

corner sometimes gave him a cupful of strong goat's milk; in the grape season the fat

winemaker let him have drippings of the mild juice. So there was no danger of going

hungry or thirsty. There was plenty of everything in Pompeii if you knew where to find it -

and if you had a dog like Bimbo. As I said before, Tito was not the merriest boy in

Pompeii. He could not romp with the other youngsters or play hare-and-hounds and I-

spy and follow-your-master and ball-against-the-building and jackstone and kings-and-

robbers with them. But that did not make him sorry for himself. If he could not see the

sights that delighted the lads of Pompeii, he could hear and smell things they never

noticed. When he and Bimbo went out walking, he knew just where they were going and

exactly what was happening. As they passed a handsome villa, he'd sniff and say, "Ah,

Mister Pansa is giving a grand dinner here tonight. They're going to have three kinds of

bread and roast pigling and stuffed goose and a great stew - I think bear stew - and a fig

pie." And Bimbo would note that this would be a good place to visit tomorrow.

Questions

1) What did they eat for breakfast?

2) Where was water to be found in this story?

3) What treat did Tito like so much?

4) What did the grapemaker let him have?

5) Where will Tito and Bimbo visit tomorrow?

6) Why couldn't Tito play games with the other young children?

Fleischman, P. (2006). The binnacle boy. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 208-227). New York: Houghton Mifflin.

Grade Level: 6th grade

Passage Length: Long

When the brig Orion, three weeks out from Havana, appeared off her home port of New Bethany, Maine, Miss Evangeline Frye was just parting her bed curtains, formally banishing night. While those who'd chanced to spy the sails wondered why the ship hadn't fired a salute, Miss Frye was combing her coarse gray hair. While the Orion drifted unexpectedly about, at last presenting her stern to the harbor, Miss Frye was blowing the hearth fire into being. And while the harbor pilot's drowsy son rowed his father out to the ship, to return in a frenzy, eyes wide and hands trembling, Miss Frye was stationed at her parlor window, awaiting the sight of Sarah Peel. She peered down the length of Bartholomew Street. Straight-spined as a mast and so tall that her gaze was aimed out through the top row of windowpanes, Miss Frye eyed the clock on the town hall next door. It was 8:51. The girl was late – and plenty of scrubbing and spinning to be done. She pursed her lips, lowered her eyes, and looked out upon her flower garden. It was nearly Independence Day - tansy was thriving, pinks were in bloom, marigolds were budding on schedule. But the poppy seeds she'd bought from a rogue of a peddler, and gullibly planted with care, still hadn't sent up a single shoot. And probably never would, she reflected. In memory, she heard her mother's voice: "Girls take after their mothers, Evangeline. Men take after the Devil." All of a sudden Miss Frye rushed to the window. She heard someone announce, "All of the crew were found to be dead." Bells were tolled. Trunks were opened and mourning clothes solemnly

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exhumed. The crew of the brig Orion was buried. And yet the matter remained

unfinished. No evidence of attack had been found. There was no-sign of scurvy, no

shortage of food. When the ship was boarded the crew was discovered to be lying

about the decks as if hexed, with no witness to bear the tale to the living. None, that is,

except the binnacle boy. He alone remained standing, the life-sized carving of a sailor

boy holding the iron binnacle, the housing for the ship's compass. Straight backed,

sober lipped, in his jacket and cap, he stood resolutely before the helm, his lacquered

eyes shining chicory blue. And after the ship's sails had been furled and her cargo of

molasses unloaded, the binnacle boy was laid in a wagon and, like the seventeen

sailors before him, slowly borne up the road to the top of the cliff upon which New

Bethany stood. And there, before the town hall, the pinewood statue was mounted, still

bearing the ship's compass, a memorial to the Orion's crew. Upon him the families of

the dead gazed for hours, convinced he'd somehow reveal the nature of the catastrophe

he'd witnessed. Mothers kept watch on his ruddy lips, expecting each moment to see

them move. Fathers stared into his painted eyes, waiting to catch them in the act of

blinking. Children cocked their ears to the wind as it moaned eerily over the boy, and

believed they heard the sound of his voice. Yet the binnacle boy clung to his secret. The

mystery of the Orion remained, and gradually, as the summer progressed, those who

stood and awaited the boy's words were replaced by those who'd come instead to leave

him with secrets of their own, knowing his steadfast lips to be sealed. At first it was

children who took up the practice. After whispering into his chiseled ear, they ran off, or

studied his stouthearted features as if expecting a nod of acknowledgment. Soon their

elders took after them, and before long the binnacle boy became the repository for all

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that couldn't be safely spoken aloud in New Bethany. Lovers opened their hearts to him. Hurrying figures sought him out in the night. Those who felt their lives running out entrusted him with their final confessions.

Questions:

1) Where did this story take place?

2) What plant had not yet grown?

3) Why was the death of the crew a mystery?

4) What was the ship's cargo?

5) Why do you think the binnacle boy wouldn't speak?

6) Why do you think the people of the town told their secrets to the binnacle boy?

Fleischman, P. (2006). The binnacle boy. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 208-227). New York: Houghton Mifflin.

Grade Level: 6th grade

Passage Length: Short

After her three visitors had gone and Tara had finished her chores and left, Miss Frye climbed to the top of the stairs, and then turned right. Tara's revelation still rang in her head as she walked down the hall, came to a halt - and opened the door to Ethan's room. She stood there in the doorway a moment. The room was musty, the light dim. She passed his bed, opened the curtains, and gazed out his window at the indigo sea, musing on all he might have been. Miss Frye turned around. Surveying the cobwebs, she recalled that both her natural sons had occupied the room as well. But they'd grown up wild, and long ago had left, following their father to sea, and like him gaining a fondness for the rum they freighted across the waters. When the schooner on which all three had shipped went down in a gale off the Georgia coast, Miss Frye had been neither surprised nor sorry, and had returned with relief to her maiden name. Her mother, herself abandoned by her husband, regarded the sinking as a fitting judgment. "Men," she'd summed up, "are a stench in God's nostrils." Miss Frye paced slowly about the room. She found herself staring at Ethan's washstand, recalling the chill October day she'd gone mushroom picking, miles from home, and discovered an infant wrapped in a flour sack, left at a crossroads, dead. Or so she'd feared, till she'd gradually warmed him, holding the bundle next to her skin-and felt him slowly begin to squirm. Astonished, she hadn't known what to do, until suddenly something her mother had long ago told her leaped into memory: "If you save a creature's life, Evangeline, you're

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responsible for its every deed afterward." Unwilling to entrust his raising to another,

she'd borne him home, burnt the flour sack, bathed him thoroughly, and named him

Ethan. Miss Frye walked up to his mahogany desk. The lamp by which he'd worked was

dusty. His quill pen and his ink bottle waited. She opened the primer he'd used, and

recalled the pleasures of shaping his youthful mind.

Questions

1) How many natural sons did Miss Frye have?

2) In what month was Ethan found by Miss Frye?

3) What two things sat on Ethan's desk?

4) What was Miss Frye doing when she found Ethan?

5) Why did Miss Frye take Ethan home?

6) How did Miss Frye feel when in this room?

Untermeyer, L. (2006). The dog of Pompeii. In Avi & C. Shute (Eds.), *Best Shorts: Favorite Short Stories for Sharing* (pp. 178-184). New York: Houghton Mifflin.

Grade Level: 6th grade

Passage Length: Short

Tito and Bimbo were hungry so they went to the forum where everybody came at least once during the day. Everything happened there. There were no private houses; all was public-the chief temples, the gold and red bazaars, the silk shops, the town hall, the booths belonging to the weavers and the jewel merchants, the wealthy woolen market. Everything gleamed brightly here; the buildings looked new. The earthquake of twelve years ago had brought down all the old structures; and since the citizens of Pompeii were ambitious to rival Naples and even Rome, they had seized the opportunity to rebuild the whole town. Hence there was scarcely a building that was older than Tito. Tito had heard a great deal about the earthquake, although, since he was only about a year old at the time, he could hardly remember it. This particular quake had been a light one, as earthquakes go. The crude houses had been shaken down, and parts of the outworn wall had been wrecked, but there had been little loss of life. No one knew what caused these earthquakes. Records showed they had happened in the neighborhood since the beginning of time. Sailors said that it was to teach the lazy city folk a lesson and make them appreciate those who risked the dangers of the sea to bring them luxuries and to protect their town from invaders. The tradesmen said that the foreign merchants had corrupted the ground and it was no longer safe to traffic in imported goods that came from strange places and carried a curse upon them. Everyone had a different explanation and everyone's explanation was louder and sillier

than his neighbor's. People were talking about it this afternoon as Tito and Bimbo came

out of the side street into the public square. The forum was crowded. Tito's ears, as well

as his nose, guided them to the place where the talk was loudest.

Questions

1) Which part of the town did everyone visit at least once a day?

2) Why did the sailors claim these earthquakes happened?

3) What was being sold in the market? (at least two things)

4) Why did Tito have difficulty remembering the earthquake?

5) Why do you think Tito was in the forum?

6) What do you think the people were talking about?

Guild, E. S. (1932). The end of the charm. In W. Taylor (Ed.), *Varied Narratives* (pp. 245-259). New York: Ray Long & Richard Smith, Inc.

Grade Level: 8th grade

Passage Length: Short

When she reappeared, a wrap about her shoulders, she seemed to have forgotten her huff, for she chatted gaily about the doings of the village younger set. The two walked down the hard clay path which was called a sidewalk, crossed the railroad tracks, and went on through the town, past the drugstore with its crowd of loafers outside along the covered walk, past the dark bank, and the blacksmith shop, lit redly from its glowing forge. Hattenville boasted no sidewalks outside the business districts, and so the couple now took to the middle of the street, because it was unsafe to cut across lots on account of gullies and stumps. The waxing moon shone softly, illumining the dusty road, and touching with light and shade the low cottages, the gullied streets, the bare hillsides of the straggling sawmill town, trying to transform it into what it could never be - a thing of beauty. May-Louise kept up a steady stream of what she considered sprightly conversation, punctuated by intervals of silent and rapid jaw-movement. She was using spearmint that evening. Allan became vaguely conscious that as a sport gum-chewing was more pleasant to the actual participant than to the bystander. Since May-Louise was one of the principal California Fruit consumers of the community, it was a wonder that he endured her. Indeed, he himself could not have told why he "went with her." She was as good, in her class, as the town afforded; that much must be said. And the two had always gotten along very, very well. Half-listening, he walked by her side, holding her arm, the better to guide her along their perilous path.

His twenty-dollar suit of hand-me-downs, bought of Nathan Cohen, could not conceal

the fact that he was well set up; and even with a neck-shave he was good-looking. His

face would have seemed immobile if it had not been for the intent, searching look in his

dark eyes. But maybe that look was there because he had to pick his way so carefully

through the young canyons of the village street. Roots and tree stumps filled their path.

Questions

1) What was she wearing around her shoulders?

2) Where were the crowds of loafers?

3) Why was it unsafe to cut across the lots?

4) What did the story say that the town could never be?

5) How would you describe his feelings toward May-Louise?

6) What do you think happened next in the story?

Post, M. D. (1932). The new administration. In W. Taylor (Ed.), *Varied Narratives* (pp. 89-105). New York: Ray Long & Richard Smith, Inc.

Grade Level: 8th grade

Passage Length: Short

It seemed to the judge that the best thing for him to do was to pass quickly. He opened the door with a latchkey, entered and closed it behind him. Then he put down his hat and, with his bundle of legal papers under his arm, went slowly up the stairway. At the first landing he stopped, held on to the baluster and looked back. Through the little squares of glass along the side of the door he could see the woman on the porch in that abject position, the tears trickling through her fingers. The court opened with the two Supreme Judges sitting with the District Judge. A gust of rain had cleared out the heat. The air was fresh. Everybody seemed vitalized and restored to the energies of life-except the District Judge. He looked the mere physical wreck of a man. His face was pallid and his jaw sagged as he sat in his black silk robe between his two associates. Perhaps the fine, clean-cut, vital faces of those two associate judges brought his ill appearance more conspicuously to the eye. The courtroom was crowded. Everybody came in to see the visiting members of the Supreme Court. We have a belief that the conduct of great affairs and elevation above the passions and interests of men give, in time, to the human face a power and serenity beyond anything to be observed in our usual life. And the aspect of these two members of the highest tribunal in the world amply justified this theory. Everybody was impressed. The courtroom was silent. The clerk and attendants went about on tiptoe and spoke in whispers. There was an atmosphere of dignity that swept out and ejected every trivial thing. There was here,

now, the awe and the solemnity, the grip of power, that we feel must inevitably attend

the majestic presence of that vast, dominating, imperial thing we call the State.

Everybody felt that, at last-finally-he was before that regal ultimate authority that ruled

the order of his life and the conduct of his affairs, pressing on him on all sides invisibly,

like the air-an authority that he could neither resist nor question.

Questions

1) What did the judge carry under his arm?

2) What had cleared out the heat?

3) Who did the district judge sit with?

4) What did the "atmosphere of dignity" sweep out?

5) How did the district judge feel? Why?

6) Why was the courtroom so quiet?

Guild, E. S. (1932). The end of the charm. In W. Taylor (Ed.), *Varied Narratives* (pp. 245-259). New York: Ray Long & Richard Smith, Inc.

Grade Level: 8th grade

Passage Length: Long

But May-Louise had seen Allan jump when the crash came, and she was in no mood to go on. Giving the keys an irritated bang with the palm of her hand, she jumped up and joined a group at the far end of the room, and the party had to look for other amusement. So they played post-office, and guessing hands, and touch-me-not. But there was no kissing in these pastimes; Mrs. Tate's sense of moral rectitude would not allow that. Instead of the customary osculation the couples would go for a short walk in the front yard. Anyone who has never indulged in these denatured diversions has no idea what highly innocuous things they really are. A kissing game without any kissing has about as much kick to it as a whiskey-and-soda without any whiskey. May-Louise went with Allen several times on a short-course promenade, and although she kept up a high-pressure flow of chatter, it seemed to her that Allan was silent and moody. To tell the truth, Allan was disgusted-with the party, with those present at the party, with himself, with May-Louise, with everything. He was accomplishing a rather unusual thing: although he had never known anything else, he was sensing dimly the vacant barrenness of the surroundings in which he passed his days, and of which the party was the type and climax. But because he had never known anything different, he could not interpret or justify his feeling. All he knew was that an unreasoning wave of loathing was surging up within him. However, this loathing was temporarily lulled by that agent which has quelled many stronger emotions-food; for a halt was called in the hilarity at this

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juncture, and refreshments were served. Mrs. Tate "sure knew how to get things together"; and while consuming cake and sherbet the boys laid aside their goggle-eyed embarrassment, the girls their simpering vacuity, and in the words of the village paper, a good time was had by all. After the refreshments, cards were proposed. Mrs. Tate regarded a deck of cards with Kings and Queens and Jacks as an instrument of the Devil, but she saw nothing wrong with other packs which had no face cards and were divided into colors instead of suits. The difference certainly was not apparent to the casual observer, but it soothed Mrs. Tate's conscientious scruples, and everyone else seemed satisfied. Now an amicable game of cards would naturally be the very thing to adjust the strained relations already apparent between Allan and May-Louise. Unfortunately, it brought the difference between the two to a startling crescendo. As they were proceeding to their table, May-Louise sidled up to Allan and whispered stridently: "I know a way to beat that old Joe Hicks and Maggie Tate. We'll just signal to each other. When I'm strong in Black, I'll put my finger on the tip of my nose. My right eye'll be for Red, and my left for Green, and my chin for Yellow, and when I chew my gum-like this-it means I want to know what you're strong in. See?" Allan made no reply, and May considered the thing settled. The two couples seated themselves at the table, and cards were dealt. Immediately May began to dab furtively at some portion of her countenance. She was signaling Black. Allan gave no sign, and when his turn came, coolly bid in Red. May's brow clouded and her form stiffened. Nor were her outraged feelings calmed when Allan failed to take the necessary tricks and the couple found themselves deep in the hole, with little prospect of getting out. On the second deal May had scarcely taken up her cards when she began chewing her gum with vigor and

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abandon, the while she cast menacing glances at Allan. But Allan seemed blind-and

deaf-at the moment to everything but Maggie Tate, and consequently the only result of

May's masticatory efforts was a remark from Joe Hicks.

Questions

1) What did Allan do when the crash came?

2) What were two games that they played?

3) What did Mrs. Tate regard a deck of cards with face cards as?

4) What was the sign for being strong in black?

5) Why was Allan in a bad mood?

6) What do you think happened next in the story? Why?

Taylor, E. (1970). A red-letter day. In J. Tytell & H. Jaffe (Eds.), *Affinities: A Short Story Anthology* (pp. 327-336). New York: Thomas Y. Crowell Company.

Grade Level: 8th grade

Passage Length: Long

Through the mist, cabs came suddenly face to face with one another, passing and repassing between station and school. Backing into the hedges, twigs, withered berries striking the windows - the drivers leaned out to exchange remarks incomprehensible to their passengers, who felt oddly at their mercy. Town parents, especially, shrank from this malevolent landscape - the wastes of rotting cabbages, flint cottages with rakish privies, rubbish heaps, gray napkins drooping on clotheslines, soil like plum cake. Even turning in at the rather superior school gates, they were dismayed by the mossy stone and the smell of fungus. Then, as the building itself came into view, they could see Matron standing at the top of the steps, fantastically white. She had an air of professional good naturedness, as if she shared in the gaiety of the occasion. But, each term, Visiting Day to her was like Christmas Day to a clergyman, a great climax of work and preparation. Tory was one of the last to get a cab. She stamped her feet, feeling the damp creeping through her shoes. When she left home, she had thought herself suitably dressed. One after another, she had tried on every hat she owned, and had come out, in the end, leaving hats all over the bed, so that it resembled a new grave with its mound of wreathed flowers. But the other mothers had hats of undreamed of austerity, and the most sensible of Tory's shoes could not withstand the insidious damp. One other woman was on her own. Tory eyed her with distaste. Her sons would never feel the lack of a father (as Tory's one boy was bound to), for she was large

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enough to be both father and mother to them. Yes, Tory thought, she would have them out on the lawn and bowl at them by the hour, would coach them in mathematics, and tan their backsides. Tory was working herself up into a hatred of this woman, who seemed to be all that she herself was not. She has probably eaten her husband now that her child-bearing days are over, Tory thought. He would never have dared to ask for a divorce, as mine did. The woman still carried her "mother's bag" -the vast thing that, full of diapers, bibs, bottles of orange juice, accompanies babies out to tea. Tory wondered what was in it now. Sensible things - a Bradshaw, ration books, a bag of biscuits, large, clean handkerchiefs, a tablet of soap, and aspirins? A jolly manner. ("I love young people-I feed on them," Tory thought spitefully.) The furs on the woman's shoulders made her even larger; they clasped paws across her great, authoritative back. Nervous dread made her feel fretful and vicious. In her life, all was frail, precarious - emotions fleeting, relationships fragmentary. Her life with her husband had suddenly loosened and dissolved; her love for her son was painful, shadowed by guilt - the guilt of having nothing solid to offer, of having grown up and forgotten, of adventuring still, away from her child, of not being able to resist those emotional adventures, the tenuous grasping after life. He was threatened by the very look of her, attracting those delicious secret glances, glimpses, and whispers, by the challenge she always felt, and the excitement - not deeply sexual, for she was merely flirtatious. But I am not, she thought, watching Mrs. Hay-Hardy (whose name she was soon to learn but did not yet know) rearranging her furs on her shoulders, I am not a great feather bed of oblivion. Between Edward and me there is no premise of love, none at all-nothing taken for granted, as between most sons and mothers, but all tentative and agonized. We are

indeed amateurs, both of us; no tradition behind us, no gift for the job. We try too piteously to please one another, and if we do, feel frightened by the miracle of it. I do indeed love him above all others.

Questions

1) What did it smell like at the school gates?

2) What was the woman carrying?

3) What made Tory feel fretful and vicious?

4) What was Mrs. Hay-Hardy rearranging?

5) Why did Tory dislike the single woman?

6) How would you describe the relationship between Tory and her son?

Sturgeon, T. (1959). The [widget], the [wadget], and boff. In A. Boucher (Ed.), *A Treasury of Great Science Fiction: Vol. I* (pp. 308-369). New York: Doubleday & Company, Inc.

Grade Level: 10th grade

Passage Length: Short

The town was old enough to have slums, large enough to have no specific "tracks" with a right and a wrong side. Its nature was such that a boarding house could, without being unusual, contain such varied rungs on the social ladder as a young, widowed night-club hostess and her three-year-old son; a very good vocational guidance expert; a young law clerk; the librarian from the high school; and a stage-struck maiden from a very small small town. They said Sam Bittelman, who nominally owned and operated the boarding house, could have been an engineer, and if he had been, a marine architect as well, but instead he had never risen higher than shop foreman. Whether this constituted failure or success is speculative; apply to a chief petty officer or top sergeant who won't accept a commission, and to the president of your local bank, and take your pick of their arguments. It probably never occurred to Sam to examine the matter. He had other things to amuse him. Tolerant, curious, intensely alive, old Sam had apparently never retired from anything but his job at the shipyards back east. He in turn was owned and operated by his wife, whom everyone called "Bitty" and who possessed the harshest countenance and the most acid idiom ever found in a charter member of the Suckers for Sick Kittens and Sob Stories Society. Between them they took care of their roomers in that special way possible only in

boarding houses which feature a big dining table and a place set for everyone. Such places are less than a family, or more if you value your freedom. They are more than a hotel, or less if you like formality. To Mary Haunt, who claimed to be twenty-two and lied, the place was the most forgettable and soon-to-be-forgotten of stepping stones; to Robin it was home and more: it was the world and the universe, an environment as ubiquitous, unnoticed, and unquestioned as the water around a fish; but Robin would, of course, feel differently later. He was only three.

Questions

1) How old was the widowed night-club hostess's son?

2) What was Sam's occupation?

5) How old did Mary Haunt claim to be?

6) How old was Robin?

7) How would you describe Sam?

8) Why do you think Robin would feel differently about the boarding house later?

Sturgeon, T. (1959). The [widget], the [wadget], and boff. In A. Boucher (Ed.), *A Treasury of Great Science Fiction: Vol. I* (pp. 308-369). New York: Doubleday & Company, Inc.

Grade Level: 10th grade

Passage Length: Short

"This is all very entertaining, Mr. Blade. But even if I conceded your background is based on authentic observation, that is hardly enough to satisfy the reader. Your story has to sound plausible. But what have you given us? An incredibly advanced civilization where nearly everything is done by machine. A civilization which travels between continents in spaceships at hundreds of miles an hour. The homes of your civilization are a mass of implausible gadgets run by buttons. Buttons are pushed to bring light, clean rugs, wash clothes, and even to squeeze juice from fruit. Every home has built-in entertainment which picks music, talk and pictures from the air. Heat comes from the walls instead of from stoves, and water, both hot and cold, comes in unlimited amounts from spigots which merely have to have their handles twisted instead of being pumped. And the warfare you describe! Don't you see how implausible it all sounds?" The editor smiled indulgently. "Perhaps life will be as you describe it in one million A.D. But no reader would accept such tremendous scientific advance in a mere fifty years. What you seemed to have overlooked, Mr. Blade, is that the children of today will be the leaders of your fantastic future world. You yourself may quite likely still be alive. The whole world has fresh in its mind Andre's balloon attempt, yet you expect your readers to believe such enormous air progress as you describe will take place during their own lifetimes! And your war weapons! Warfare has advanced tremendously in the past few

decades - the revolver, the automatic rifle, the ironclad warship - but a Napoleonic

marshal could almost instantly master these modern developments." Mr. Grayson's

smile became gentler. "But your worst error in plausibility is related to the first I

mentioned. Your leaders of 1950 are living now. Yet in your story they are adjusted to

their incredibly mechanized life as though it had always existed. They are not even

surprised at civilization's progress. It simply isn't plausible that people would take such a

life for granted."

Questions

1) How does the civilization travel between continents?

2) When did the editor think this story could be true.

3) What does pressing buttons bring in this story?

4) What did the editor think was Mr. Blade's worst error in plausibility?

5) When did this story take place?

6) What is Mr. Blade doing in this story?

Von Goethe, J. W. (1971). Novella (E. Mayer & L. Bogan, Trans.), In J. W. von Goethe (Ed.), *The Sorrows of Young Werther and Novella* (pp. 169-201). New York: Vintage Books.

Grade Level: 10th grade

Passage Length: Long

The Princess, after having waved her handkerchief to her husband in the courtyard below, went to the rooms on the other side of the castle, from which she had a clear view of the mountains - a view all the more beautiful since the rather elevated position of the castle above the river offered a variety of remarkable prospects on either side. She found the excellent telescope still in the position in which it had been left the evening before, when they had talked about the lofty ruins of the old family castle which could be seen over bush, mountain and wooded summit, and which had stood out unusually clear in the evening glow, the great masses of light and shade throwing into sharp relief this mighty monument of times long past. Now, in the early-morning light, the autumn colors of the various kinds of trees which had soared up unchecked and undisturbed through the masonry for so many years were startlingly distinct through the strong lenses which brought everything closer to the eye. The lovely lady, however, lowered the telescope slightly toward a barren stony tract where the hunting party would pass; she waited patiently for that moment and was not disappointed: because of the clarity and magnifying power of the instrument, her bright eyes clearly recognized the Prince and the Grand Master of the Horse. She could not resist waving her handkerchief again when she more imagined than saw that they briefly halted and looked back. At this moment Friedrich, the Prince's uncle, was announced. He entered

the room with his draftsman who carried under his arm a large portfolio. "My niece," said the still-vigorous old gentleman, "we want to show you the drawings of the old castle, which have been made to demonstrate from various angles how remarkably well the powerful structure, built for shelter and defense, has resisted all seasons and all weathers from time immemorial, and how its masonry, nevertheless, has had to give way, here and there collapsing into desolate ruins. We have already taken steps to make this wilderness more accessible, for it is all that is needed to surprise and delight any wanderer or visitor." After having explained to her in detail each single drawing, the old Prince continued: "Here, as we ascend through the hollow path in the outer ring of walls, we come to the castle itself, where a rock rises before us - one of the most massive rocks in the whole mountain range. Upon it a watchtower was built; but nobody would be able to say where nature ends and art and workmanship begin. Walls are annexed on both sides, and outworks slope downward in terraces. But this is not quite accurate, for it is actually a forest which girds this age-old summit. For the last hundred and fifty years no stroke of an ax has rung out here, and everywhere gigantic trees have grown to a great height. When you push your way along the walls, the smooth maple, the sturdy oak and the slender fir tree obstruct your progress with their trunks and roots, and you have to wind your way around them and choose your footing with caution. Look, how admirably has our masterly artist shown, in his drawing, these characteristic features; how clearly you can recognize the various kinds of trunk and root interwoven with the masonry, and the strong branches interlaced through the gaps in the walls. This wilderness has no parallel; it is a unique place, where ancient traces of long-vanished human strength can be seen in a deadly struggle with the everlasting and ever-acting

forces of nature." Taking up another drawing, he went on: "And what do you think of this courtyard, which became inaccessible after the collapse of the old gate tower and has never been entered by any human being for countless years! We tried to force an entrance from one side; we broke through walls, blasted vaults, and in this way made a convenient but secret passage.

Questions

1) What did the Princess wave to her husband?

2) What time of year was it?

3) What was built upon the massive rock?

4) Why must someone choose their footing with caution?

5) Why was the courtyard inaccessible?

6) What was the importance of the old castle?

Roth, P. (1980). The professor in Prague. In P. Roth (Ed.), *A Philip Roth Reader* (pp. 111-146). New York: Farrar, Straus and Giroux.

Grade Level: 10th grade

Passage Length: Long

One night, after dinner at my apartment, while Claire is preparing her next day's lessons at the cleared dining table, I finally get up the nerve, or no longer seem to need "nerve," to reread what there is of my Chekhov book, shelved now for more than two years. In the midst of the laborious and deadly competence of those fragmentary chapters intended to focus upon the subject of romantic disillusionment, I find five pages that are somewhat readable-reflections growing out of Chekhov's comic little story, "Man in a Shell," about the tyrannical rise and celebrated fall - "I confess," says the goodhearted narrator after the tyrant's funeral, "it is a great pleasure to bury people like Belikov"-the rise and fall of a provincial high school official whose love of prohibitions and hatred of all deviations from the rules manages to hold a whole town of "thoughtful, decent people" under his thumb for fifteen years. I go back to reread the story, then to reread "Gooseberries" and "About Love," written in sequence with it and forming a series of anecdotal ruminations upon the varieties of pain engendered by spiritual imprisonment-by petty despotism, by ordinary human complacency, and finally, even by the inhibitions upon feeling necessary to support a Scrupulous man's sense of decency. For the next month, with a notebook on my lap, and some tentative observations in mind, I return to Chekhov's fiction nightly, listening for the anguished cry of the trapped and miserable socialized being, the well-bred wives who during dinner with the guests wonder "Why do I smile and lie?", and the husbands, seemingly settled and secure,

who are "full of conventional truth and conventional deception." Simultaneously I am watching how Chekhov, simply and clearly, though not quite so pitilessly as Flaubert, reveals the humiliations and failures-worst of all, the destructive power-of those who seek a way out of the shell of restrictions and convention, out of the pervasive boredom and the stifling despair, out of the painful marital situations and the endemic social falsity, into what they take to be a vibrant and desirable life. There is the agitated young wife in "Misfortune" who looks for "a bit of excitement" against the grain of her own offended respectability; there is the lovesick landowner in "Ariadne," confessing with helplessness to a romantic misadventure with a vulgar trampy tigress who gradually transforms him into a hopeless misogynist, but whom he nonetheless waits on hand and foot; there is the young actress in "A Boring Story," whose bright hopeful enthusiasm for a life on the stage, and a life with men, turns bitter with her first experiences of the stage and of men, and of her own lack of talent-"I have no talent, you see, I have no talent and ... and lots of vanity." And there is "The Duel." Every night for a week (with Claire only footsteps away) I reread Chekhov's masterpiece about the weaseling, slovenly, intelligent, literary-minded seducer Layevsky, immersed in his lies and his self-pity, and Layevsky's antagonist, the ruthless punitive conscience who all but murders him, the voluble scientist Von Koren. It is this immersion in "The Duel" that finally gets me writing, and within four months the five pages extracted from the old unfinished rehash of my thesis on romantic disillusionment are transformed into some forty thousand words entitled Man in a Shell, an essay on license and restraint in Chekhov's world-longings fulfilled, pleasures denied, and the pain occasioned by both; a study, at bottom, of what makes for Chekhov's pervasive pessimism about the methods-

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scrupulous, odious, noble, dubious - by which the men and women of his time try in vain

to achieve "that sense of personal freedom" to which Chekhov himself is so devoted.

My first book!

Questions

1) Whose books are being read by the narrator?

2) How long was the town held under Belikov's thumb?

3) What does the agitated young wife in "Misfortune" look for?

4) What does the narrator say that men and women try in vain to achieve?

5) What is the narrator's opinion of the author in this story?

6) How do you think the narrator felt at the end of this story?