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Interactive Effects of Working Memory Self-Regulatory Ability and Relevance Instructions on Text Processing

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INTERACTIVE EFFECTS OF WORKING MEMORY SELF-REGULATORY ABILITY AND RELEVANCE

INSTRUCTIONS ON TEXT PROCESSING

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ABSTRACT

Interactive Effects of Working Memory Self-Regulatory Ability and Relevance Instructions

by

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Reading is a process that requires the enactment of many cognitive processes. Each of these processes uses a certain amount of working memory resources, which are severely constrained by biology. More efficiency in the function of working memory may mediate the biological limits of same. Reading relevancy instructions may be one such method to assist readers in utilizing working memory resources more efficiently.

This study examines the relationship between perspective relevance instructions and participants’ ability to regulate their working memory resources. In a 3 x 2 x 2 design the study extended the literature by utilizing a measure of fluid intelligence in order to gain a more accurate understanding of the working memory central executive mechanism at work when a reader is given perspective relevance instructions. Results showed self-regulation had no effect on relevancy instruction. The treatment group took less time to read relevant information than non relevant and recalled more relevant information than non relevant information. These findings highlight the robustness of the relevancy effect.
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Chapter 1

Introduction

Reading is an activity that involves multiple processes; among them are the decoding of words, comprehending the literal meaning of the words, translating the literal words into the meaning of the text as a whole, and understanding grammatical rules. To accomplish these tasks requires many cognitive processes that are initiated and regulated by the working memory component of the brain. Each of these processes use working memory, or attention, resources that humans have in a very limited supply. Indeed, Miller (1956), the first to put a quantitative measurement on the capacity of the working memory, postulated that human beings have the capacity to hold only 5 – 9 pieces of information in our working memory at one time. One method of compensating for this biological constraint is to assist readers in determining which information within a reading passage is most important for the goal a reader brings to that passage. Methods to assist readers in the selection of specific information have, to date, focused on providing specific questions to answer while reading the text (Lapan & Reynolds, 1994; McCrudden, Schraw, & Kambe, 2005; Reynolds, Standiford, & Anderson, 1979; Reynolds, Trathen, Sawyer, & Shepard, 1993; Rothkopf & Billington, 1979; van den Broek, Tzeng, Risden, Trabasso, & Basche, 2001), assigning the reader a particular perspective (e.g. as a homebuyer or a burglar) (Di Vesta & Di Cintio, 1997; Goetz, Schallert, Reynolds, & Radin, 1983; Kaakinen, Hyoenae, & Keenan, 2002; Kaakinen, Hyoenae, & Keenan, 2003; McCrudden & Schraw, 2010; Schraw & Dennison, 1994; Schraw, Wade, & Kardash, 1993; Pichert & Anderson, 1977), or assigning the reader a particular purpose for the reading (e.g. to read for pleasure or for studying) (Lehman &
Schraw, 2002; Linderholm, & van den Broek, 2002; van den Broek, Tzeng, Risden, Trabasso, & Basche, 2001). The following section of this chapter will discuss the literature regarding perspective relevancy instructions because the present study examines this topic in relation to how a person regulates their limited supply of working memory resources. The last section of this chapter contains a brief description of the present study.

**Previous Research on Perspective Relevancy**

When a reader reads a passage from a particular perspective (i.e. as if a burglar or a homebuyer), it assists the reader to activate relevant schemas, thus helping to organize and integrate the new knowledge in long term memory. Pichert and Anderson (1977) conducted two seminal studies in which undergraduate participants were instructed to read prose passages. In the first study, which essentially amounted to a pilot study to determine which units of meaning were important to readers, participants read two passages (the first regarding the layout and contents of a house and the second regarding unusual flora and fauna of an island) and were instructed to read each passage from a particular perspective. Results from this study furthered empirical understanding because it showed that what information is important depends on the perspective from which a person reads a passage. In essence, what is important is determined by the purpose a person brings to the passage. It is assumed that a reader, having been given a goal (or perspective) from which to read a passage, is then directing working memory resource (regulatory) processes in such a way as to increase learning segments of information germane to that goal more effectively than segments not germane to that goal.
Goetz, Shallert, Reynolds, and Radin (1983) conducted a similar study as Pichert and Anderson (1977) when they examined the importance of particular segments of text and how they impacted learning. They expanded the relevancy literature by tracking reading time of the passage to determine the attention participants directed toward sentences. The findings of this study replicated Pichert and Anderson (1977) when it found that participants recalled information contained within their assigned perspective more than information outside their assigned perspective. In addition, this study found that participants spent more time reading the sentences that pertained to their perspective and less time reading sentences that pertained to anything else in the passage. It is presumed that when a person spends longer reading certain portions of information, they will learn that information better.

Schraw, Wade, and Kardash (1993) examined the effects of perspective (termed task-based importance) and how perspective interacted with parts of a text made important because of their relation to other portions of a text (e.g. topic sentences or logical relation), termed text-based importance in a series of three experiments. The results from this experiment replicated Pichert and Anderson (1977) and Goetz et al., (1983) in that participants recalled more information contained within their perspective than outside their perspective. Analysis results in this study showed that each condition remembered more information regarding their assigned perspective (task-based importance). It was also found that participants receiving their perspective at the beginning of reading (encoding) remembered more information than those receiving their perspective at the end of reading (retrieval), although it is important to note that neither of these was statistically significant.
Overall, the results from this experiment show that task-based important segments (homebuyer or burglar) help a reader lessen their dependence on internal text characteristics (e.g. how one sentence relates to the one before it and the one after it). However, when given information was not overtly signified as important, readers relied on text-based importance. In other words, relevant information helped readers learn more relevant information, but didn’t decrease the learning of information that the control group learned. It is assumed that a reader, having been given a goal (or perspective) from which to read a passage, is then directing working memory resource (regulatory) processes in such a way as to increase learning segments of information germane to that goal more effectively than segments not germane to that goal.

Schraw and Dennison (1994) conducted a series of three experiments to examine how, to what extent, and at what point in the reading process a given perspective influences ratings of interest by the reader. Findings from three experiments showed essentially the same results in that when participants were given an assigned perspective they remembered that information better than information that was not in the assigned perspective. This result was found in the participants that received their perspective before they read the passage as well as those that received their perspective after they read the passage but before the outcome measure. To this date in the research discussed here, there have been no studies that have taken into account a person’s individual differences when examining relevancy instructions. The remaining four articles discussed have explored individual differences readers bring to relevancy instructions.

Kaakinen, Hyönä, and Keenan (2002) were the first researchers to examine how differences within a person (in this case, differences in the span of working memory)
interact with perspective instructions. Findings from this study showed that participants recalled statistically significantly more relevant information than non-relevant information. It also showed that participants spent more time looking at relevant information than non-relevant information. Thirdly, eye-tracking data showed that readers with high working memory span were able to determine relevant data when reading it for the first time while low working memory span readers were only able to do so when looking back at the information- having already read and passed this information without longer eye fixations on relevant text the first time.

A second study examining the influence of individual differences on perspective relevancy was conducted by Kaakinen et al. (2003) in which researchers sought to examine how a person’s level of prior knowledge and working memory span would impact/interact with perspective instructions. Findings from this study showed that all participants in the treatment group showed increased recall of perspective relevant information. Readers with high working memory span read the high prior knowledge information without needing more time to do so like the low working memory span group did. This finding is attributed to Daneman and Carpenter’s (1980) supposition that high span readers use their working memory attention resources more efficiently. It was also found that both low and high span readers benefited from perspective relevance instructions when reading an unfamiliar text, in which they could not use prior knowledge. It was discovered that high span readers allocate extra attention resources during their initial reading of the text, whereas the low span readers allocate extra attention resources when they look back at relevant information after the initial read. The authors attribute this to the supposition that higher working memory span readers allocate
attention resources more efficiently than lower span readers. The authors were trying to attribute efficiency to capacity, something suggested by Daneman and Carpenter (1980). However, it may be that a person’s self-regulatory ability of working memory resources (instead of the capacity of those resources) may provide a more accurate understanding of why perspective relevance instructions show the efficacious results they consistently do.

A third study examining high or low levels of working memory span was conducted by Di Vesta and Di Cintio (1997). In this study researchers were exploring how span differences interact with two different perspectives- one given prior to reading (thus the participant learned the information with one perspective in mind) and one given at a second recall (thus the participant learned the information with one perspective in mind, but was told that thinking about the other perspective might assist them in remembering information about their original encoding perspective). Results from this study were interesting in that low working memory span treatment participants did not remember any additional ideas after the switch in perspective. In contrast, high working memory span participants did not have this challenge. Authors attributed this finding to the reader’s ability to “bypass available capacity constraints and, thereby, avoid overloading” (p. 227). Thus they are positing the difficulty of retrieval to be caused by too much cognitive load demand due to having to keep both perspectives in working memory at the same time. They posit that both perspectives overload the biological constraints of attentional resources. However, these results may be just as likely to be caused by lower levels of self-regulatory ability in switching back and forth between the two perspectives, thus the recall of information suffers. The current study on self-
regulatory abilities may provide additional data with which to inform this Di Vesta and Di Cintio study.

The last study to date examining individual differences is that of McCrudden and Schraw (2010). The previous studies regarding individual differences have focused on using working memory span (constraints) to explain how relevance instructions assist readers. McCrudden and Schraw examined how verbal ability, a measure of crystallized intelligence (Brody, 1992) might explain the efficacious effects of perspective relevancy instructions. The results of this study showed that readers with higher verbal ability recalled more information and read the information faster than participants with lower verbal ability. The same results were found for those participants who were given a perspective with which to read the passage. It was also found that the perspective and verbal ability were having these effects separately from each other. In other words, verbal ability was not responsible for explaining the effect perspective relevance has on recall and time. This finding is not surprising since the goal of exploring individual differences is trying to determine biological differences, but this study was examining crystallized intelligence (or learned facts). The current study used a measure of fluid intelligence (Brody, 1992) known as the Stroop interference task in an effort to come closer to understanding readers’ biological processing differences when explaining the effects of perspective relevance.

**Purpose of the Present Study**

The purpose of this study was to examine the relationship between a reader’s regulation of working memory resources and relevance instructions. For purposes of this study, regulation of working memory resources is viewed as an aspect of internal self-
regulation, while relevance instructions is viewed as an aspect of external regulation.

There are two main research questions. The first question is whether relevance instructions, self-regulatory ability, or an interaction of the two have an impact on recall of relevant information. Previous research has shown that giving participants specific information to read for increases recall for that information (Di Vesta & Di Cintio, 1997; Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010; Schraw & Dennison, 1994; Schraw et al., 1993). Some of these studies have examined individual differences in this process (Di Vesta & Di Cintio, 1997; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010) while others have not (Goetz et al., 1983; Schraw & Dennison, 1994; Schraw et al., 1993). The current study will investigate how an individual’s regulation of their working memory resources affects recall of relevant information as opposed to the span of working memory resources as some have done (e.g. Daneman & Carpenter, 1980; Di Vesta & Di Cintio, 1997; Kaakinen et al., 2002, 2003) or the measuring of a learned vocabulary ability (e.g. McCrudden & Schraw, 2010). That is, the present study focuses on the regulation of attentional capacity, rather than the amount of regulatory capacity, available to the learner.

The second question is whether relevance instructions, self-regulatory ability, or an interaction of the two have an impact on reading time of information. Previous results have shown that readers spend more time reading information that has been deemed relevant to the perspective they’ve been assigned (Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010). The current study will investigate how individual differences in a person’s ability to regulate their attention will affect the segments of text the person spends more time reading.
These questions are important for theoretical and practical reasons. The first is that while most studies have not made distinctions regarding the role an individual’s biological constraints play in the process of reading comprehension, those previous works regarding individual differences in reading comprehension and relevancy instructions that have been conducted (Di Vesta & Di Cintio, 1997; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010) have done so by using either verbal ability measures or span tests, neither of which are sufficient to gain an understanding of the underlying mechanisms at work when a person reads a text. Miyake (2001) postulated readers with higher verbal ability have either more working memory resources available or they use their working memory resources more effectively. McCrudden and Schraw (2010) used a standard vocabulary instrument of 36 items to assess the verbal ability of their participants. Although verbal ability has been correlated with working memory span (Miyake, 2001) utilizing such an instrument does not provide an actual measure of how working memory is regulated by readers. Verbal ability assessments are thought to be measures of Cattell’s crystallized intelligence, pieces of information that can be learned by schooling (Brody, 1992). As such they are not as sophisticated a measure as the Stroop Task (Stroop, 1935). The Stroop Task provides a measure of how well a person can block competing stimuli, a measure of how the working memory actually processes information rather than how much information can be held there (the span). Daneman and Carpenter (1980) examined the effect of working memory span (or capacity) on reading comprehension. Although other measures of working memory span existed, they did not tax the processing aspect of working memory enough to gain an accurate reflection of the underlying mechanisms at work during the effortful process of reading. The researchers
developed a new span task that was shown to give a more accurate reflection of the relationship between working memory span and reading comprehension. Their 1980 studies, however, were correlational and as such did not imply causation. For the field to advance its understanding of how text relevance functions, there must be increased understanding of mechanisms involved when relevance instructions interact with the biological constraints of working memory attention resources.

Secondly, this study has practical implication for reading teachers, in particular, and all teachers, generally. An increased understanding of the interaction between biology and relevancy may allow for more specialized instruction being administered by reading teachers. This may have more generalized educational benefits for all educational pursuits for a student in addition to reading.

The current study administered a task of working memory interference (the Stroop Task) as an individual difference measure reflecting how efficiently a person was using their working memory resources (i.e., attentional regulation). The 125 participants were then divided into a low, medium, or high self-regulatory group based on their Stroop score and given a passage to read about four esoteric countries. The self-regulatory group (e.g. treatment group) were then given a particular perspective (e.g. pay attention to the country Pitcairn information) while the control group was told to remember all they could from the passage. After reading the passage, all participants completed a measure asking them to recall all they could about the passage. The recalls were scored to see if there were differences in the amount of relevant (Pitcairn) information recalled versus the non-relevant (anything other than Pitcairn) for the high, medium, and low self-regulatory groups. Reading time by sentence was also collected to
determine which sentences participants were directing their working memory resources to and if the self-regulatory ability of the participants had an impact on the placement of resources.
Chapter 2

Review of Literature

This chapter situates self-regulation within the human mind, discusses how it is measured, and discusses strengths and weaknesses of different measures of self-regulation. It also discusses reading relevance and provides a review of relevance literature as it pertains to perspective instructions. The goal of this review is to better understand self-regulation, relevance, and the relationship between them. The beginning of this chapter will situate self-regulation within a component of the human memory store, working memory, and discuss the functions and processes within it. The next section critically discusses seven methods of measuring self-regulation. The last section of this chapter discusses text relevancy in general and reviews eight germane empirical research pieces on perspective text relevance specifically. The discussion begins with the nature of the process when human beings attempt to monitor, shift, engage, and/or disengage their short-term attention resources. In short, what happens when humans engage in self-regulation.

The Nature of Memory

With the rise of the cognitive paradigm of the 1950’s- 1970’s, there arose many attempts to map a model of the human mind. While there were several researchers that proposed different models, most of them had some common characteristics. The common characteristics were due to the shared assumption that there were different, and independent, memory stores because memory had different types of analysis and storage functions to perform. These types of models were called modal models (Hulme & Mackenzie, 1992) and sought to explain how humans process incoming perceptual
stimuli and meaningful units of auditory and visual information. In short, these models sought to explain how human beings deal with information that comes in through our five senses.

One of the most influential models was proposed by Atkinson and Shiffrin (1968). It postulated that memory was comprised of three storage systems, each with its own constraints. The three storage systems are: a) sensory memory, b) short-term memory (now called working memory), and c) long-term memory. Stimuli come into each of these stores for action of some variety. Thousands of stimuli come into the sensory memory but unless it is attended to in some way most of those stimuli will decay very rapidly without the person even being aware they entered the storage system initially. Since this model was introduced, the thought paradigm of human memory has shifted and current thinking is that what was called the sensory memory is now part of what we call perception. Once information has been retained in the sensory memory, or given attention resources, it moves to the working memory and from there moves into long term memory. Next is a discussion on the long-term memory store before moving into the discussion on working memory so the reader has a more complete conceptual understanding of the information storage process as a lens with which to view the limitations of working memory.

Long term memory is a relatively permanent storage facility that is capable of storing huge amounts of information. Indeed, as of 2010, researchers have not determined the upper limits of the amount of data that can be stored there, but it is known to be quite sizable because every memory in a person’s life and semantic fact a person knows is thought to be stored there. Information in long term memory consists of two types,
declarative and procedural knowledge. Declarative knowledge is information that has been learned and generally is considered to be “facts”. If a person knows the capital of the state they live in, or that he/she received a pony for their 10th birthday, they are accessing declarative knowledge stored in their long term memory. Declarative knowledge is further divided into semantic knowledge (a collection of general knowledge) and episodic knowledge (information that has happened to the person). The second type of knowledge in long term memory is procedural. Information of this type is any information requiring a set of steps to perform. When a person knows the process of baking a cake or going through their typical morning routine, that person is accessing procedural knowledge. The long term memory store and the previously discussed sensory memory store are thought to be almost unlimited in their capacity, a shared characteristic quite different from the characteristics of the working memory store.

Working memory may be defined as “the brief, immediate memory for material that you are currently processing; a portion of working memory also actively coordinates your ongoing mental activities. In other words, working memory lets you keep information active and accessible, so that you can use it in a wide variety of cognitive tasks” (Matlin, 2009, pp. 95). Since George Miller’s article, “The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information” was published in 1956, the prevailing thought in cognitive psychology was that working memory is severely biologically constrained when compared to the storage of the sensory memory (holding, albeit briefly, almost unlimited stimuli) and the long-term memory (holding almost unlimited information). Miller discussed that working memory is only able to hold between five and nine pieces of information at a time. When thousands of
pieces of information are coming into the sensory memory store and thousands of pieces of information are capable of being stored in long-term memory, having a 5 – 9 pieces of information store in the middle of the two, bottle-necking the information flow process, creates a pretty strong blockage of information from the outside world into the long term storage in the human mind. Due to the size constraints of working memory, there have been extensive amounts of research conducted on its structure and function, how to work within or around the size constraint, and how to maximize its processing efficiency. The severe size limitation of working memory is the primary reason for the current research being discussed in this document.

This discussion regarding long term memory, working memory, and sensory register memory has shown that while the stores of Atkinson and Shiffrin’s (1968) modal model are presented as, and indeed were originally thought to be, completely separate but somewhat interactive components, current research shows the components of memory are much more interactive than originally believed. For instance, sensory memory was originally thought to be simply a gathering point for external sensory stimuli, but the current paradigm is that sensory stimuli is filtered through a person’s perceptions, thus shaping the way we interact with information that is given attention very early on in the information processing process. Current research also suggests that working and long term memory are highly interactive with each other through the central executive component of working memory (as discussed in the next section). Indeed, some researchers have advocated that working memory and long term memory are essentially the same store facility, not separate as originally espoused (Bruning, Schraw, Norby, & Ronning, 2004). While there have been conceptual and empirical changes regarding the
exact structure and function of memory, one concept briefly illuminated in the sensory memory discussion is the necessity of attending to information in order to move stimuli into working memory. The next section of this paper will examine a prototypical model of working memory.

**A model of working memory.** While there have been numerous models of working memory postulated, one of the most influential models of working memory was created in 1974 by Baddeley and Hitch. Baddeley and Hitch’s (1974) model of working memory postulated three components of working memory wherein each component was responsible for specific types of stimuli and decisions. The three components are: a) visuospatial sketchpad, b) phonological loop, and c) central executive. The visuospatial sketchpad and the phonological loop are considered slave systems, meaning they act via the volition of the central executive. The phonological loop is responsible for processing sounds a person hears. The visuospatial sketchpad, in contrast, processes visual and spatial information for a short time. The sketchpad allows a person to gather the size and shape of an object as well as allowing knowledge regarding where that object is in a particular scene (e.g. a vase of flowers on a table). Due to both of these being constrained by Miller’s (1956) theory of working memory, they can store only a small amount of information for a small amount of time (Matlin, 2009). In contrast to the slave systems, the central executive controls the processes of planning, initiating, and monitoring present and future actions. Toward the service of these goals, the central executive makes decisions, guides processes, and integrates information coming into, and going out of, the working memory system. In terms of everyday utility, if a reader has a goal of reading a passage, the central executive guides decisions such as where to begin to read the passage.
(e.g. the first sentence of the first paragraph versus the third sentence of the second paragraph), how much attention resources to give sentence one versus sentence six, and how to integrate the new knowledge in the passage into prior knowledge schemata already in long term memory. Baddeley and other scholars have continued conducting research and, as a consequence, the latest revision of the model includes the aforementioned components and adds an episodic buffer where information from the visuospatial sketchpad and the phonological loop are combined with information from long term memory in a temporary storage facility. This was done because in the original model, working memory was seen as a rigid store with fixed capacity. The current paradigm within cognitive psychology is that working memory is a flexible and strategic memory component responsible for many complex processes that transform, and transfer, stimuli from sensory memory to long term memory. Given the importance of working memory’s function and its’ capacity constraints, the following section discusses the issue of the size of working memory versus the efficient use of the size of working memory. One of the most influential theories regarding a person’s working memory span and efficiency in light of size constraints was in 1980 by Daneman and Carpenter.

**Cognitive capacity versus cognitive efficiency.** It is generally accepted that working memory capacity is fixed and most people possess more or less the same amount. How a person regulates that small amount is of primary importance to learning. Daneman and Carpenter (1980) highlight the importance of this regulation in their discussion of working memory capacity in relation to cognitive processes in general, and reading in particular. They espouse the viewpoint that working memory has the ability to both actively process information (efficiency) as well as store information (overall
capacity) in limited amounts and the two interact with each other in a fluid and dynamic fashion. In addition, a compensatory relationship is assumed between the processing and storage functions. When a person regulates their attention resources more efficiently, they free up more of the limited capacity that working memory is constrained by and, thus, are able to process more of the thousands of stimuli coming from the sensory memory than a person who regulates their working memory resources less efficiently. Regulating working memory resources can occur from sources internal or external to the individual.

Using relevance instructions, the purpose of this study, is one such way to assist the reader in regulating their limited capacity of working memory resources. Daneman and Carpenter explain efficiency versus capacity fluidity in this way,

A good reader may require fewer processes than a poor reader to perform exactly the same computation; in good readers, the intermediate steps might be eliminated in some or all of the stages such as decoding, lexical accessing, parsing, inferencing, and integrating. Such efficiency would imply that the good reader would have fewer computational demands on working memory; hence, he would have more capacity for storing the necessary intermediate and final products of the reading process. More efficient processes would also be functionally faster (Daneman & Carpenter, 1980, pp. 451).

The discussion of efficiency versus capacity has important implications for academic and life function. In the case of academic reading, when a person is more regulated so that they don’t need to use as many resources for decoding words and grammar, there are more resources available for comprehending new knowledge, integrating the new knowledge with already existing knowledge in long term memory, as well as forming
Cognitive load considerations. Another concept related to working memory that is of particular importance given the size constraints of working memory capacity versus efficiency is that of cognitive load. Cognitive load theory makes the assertion that all learning environments and tasks impose processing demands on working memory to some greater or lesser degree (Sweller, van Merrienboer, & Paas, 1998). Once a person’s cognitive load threshold has been met cognitive overload commences, and information processing efficiency decreases until cognitive load is dropped below the threshold and a person’s recovery time has been met.

There are three types of cognitive load variables—extraneous, intrinsic, and germane. Intrinsic load factors are those that are innate in the information to be learned and as such are only able to be altered by acquiring additional schemata. The second type of load factor is that of extraneous load. Extraneous load factors are those that arise from learning activities required and/or the method in which the information to be learned has been brought to the awareness of the learner (e.g. directions given to the reader, how well or poorly the ideas in a text are organized, etc). The third type of cognitive load factor is that of germane cognitive load. Germane load refers to the working memory resources available that a person directs to the internal load factors of the material being read (Sweller, 2010). While intrinsic factors cannot be changed, extrinsic factors can, and
should be, managed in order to reduce overall cognitive load demands on the learner. Employing relevance instructions may be one way to assist the learner in reducing extraneous cognitive load, thus reducing germane load. It is when cognitive load demands on a reader exceed the individual’s working memory capacity that the reader loses information contained within the passage. Advanced organizers, summaries of information, automatizing foundational reading/computational skills, and assisting in making information relevant for the learner are all ways of minimizing extraneous cognitive load demands (Bruning et al., 2004). Cognitive load factors play a part in all models of working memory. These strategies serve to assist readers in regulating their attention. While individuals who have higher levels of self regulation may engage in all or some of these strategies as a natural matter of course, those individuals with lesser levels of self regulation may need these assistive devices to increase the efficiency of working memory processing.

Thus far the discussion has used terms such as “attention” and “attentional resources”, and posited that attention is necessary to move information from the sensory register into working memory. The next portion of this chapter will be a discussion regarding attention, its operational definition, and what occurs when we regulate our own attention, and ends with a review of seven methods currently being used to measure self regulation.

**Attention in working memory (in WM).** Matlin (2009) defines attention as, “a concentration of mental activity that allows you to take in a limited portion of the vast stream of information available from both your sensory world and your memory”. Bruning et al., (2004) defines attention as, “a person’s allocation of cognitive resources to
the task at hand” (p. 23). As discussed above, a person must attend to stimuli in sensory memory in order to transfer that information into working memory, where the central executive uses both capacity and efficiency processes and strategies to accomplish goals set by the learner. Because of the limited nature of working memory, a person needs to decide the allocation of resources in working memory to environmental stimuli. Figure 1 illustrates the differences in working memory cognitive resources needed for simple versus complex tasks.

<table>
<thead>
<tr>
<th>Automated Tasks</th>
<th>Least Working Memory Resources</th>
<th>Most Working Memory Resources</th>
<th>Selective Attention Tasks</th>
</tr>
</thead>
</table>

Figure 1: Continuum showing working memory resource allocation by task type

Automaticity may be defined as information that is processed such that it takes up no, or very little, working memory cognitive (or attentional) resource capacity (Schneider & Shiffrin, 1977). As such, automatic tasks require very little attention. In contrast, when one consciously chooses to direct all of their cognitive resource capacity to one task they are choosing to give all of their attention to that task. Figure 1 illustrates the amount of attention given to tasks on a continuum from a state of automaticity (utilizing no working memory resources) to a state of complete selective attention (requiring full use of working memory resources). Selective attention (described below) and divided attention tasks are classified as complex attention. Divided attention tasks are those in which a person tries to give attention to two or more tasks at the same time and do both well. However, the performance on one, or both, of those tasks will suffer.
Another type of complex attention task is that of selective attention, in which a person is consciously instructed to pay attention to some stimuli, and instructed to ignore other stimuli. Normally functioning people are able to choose which stimuli to attend to and which to ignore, but there is a cognitive load issue to this selectivity. An example of this type of task is the Stroop Effect task. I will discuss this in much more detail further in this paper, but to illustrate the point here, a Stroop Task asks a person to, a) say the color of ink a word is printed in and, b) suppress the word itself (which is a color word different from the color of the ink). Focusing on certain stimuli while actively suppressing other information places a cognitive strain on a person’s central executive component due to divided attention, so that performance on the chosen task will take longer to accomplish. This type of task is also more complex than automatic tasks, which as stated above take up little to no attentional capacity. If a person divides their attention in two selective attention strategies, each task will suffer to some degree. The more times a person divides their attention, the more each task will suffer so that eventually that person will reach a point where they are unable to divide their attention among any other tasks and performance on all tasks is minimal.

An example of moving along the continuum in Figure 1 between automatic and selective attention tasks is what happens when a person drives a car. When a person first learned to drive a car they had to selectively attend to the many details required to drive without crashing. Steering the car, paying attention to the outside cars, knowing where you were in the lane, and pressing on the gas pedal all took parts of working memory resources such that there were none left to deal with other tasks. As the driver practiced more and more, those tasks came to require less working memory resources until
eventually many, if not all, of those tasks became automatized. A driver who’s been driving 20 years is able to give the above tasks almost no working memory resources so there are working memory resources available for talking on the phone, fiddling with the radio, texting, etc. that a person who needs more working memory resources might not be able to manage as efficiently or safely. The tie between attentional resources and the central executive have been discussed above. To reiterate, models of working memory assume that the central executive is used to regulate limited attention in the most strategic manner possible. It is prudent at this time to take a moment to elaborate on the importance of the aforementioned information so the importance of the upcoming information regarding self-regulation is put into context. I have discussed the biological constraints of an individual being limited to only 5-9 pieces of information able to be processed at any given time in the working memory. This severely limits the number of actions that can be acted on all the time an individual is conscious. These 5-9 pieces of information process all information coming from the sensory register, integrate existing information already in long term memory with the new incoming information, and make decisions regarding a person’s goals for that information. These size constraints combined with the importance of working memory’s function underscore the necessity of a person’s consciously regulating their attention. Daneman and Carpenter (1980) argued that a person cannot be given more working memory capacity, but they can use their capabilities more efficiently. It is this efficiency that may give a person more functional capacity, thus compensating for biological constraints. When a person consciously regulates their attention, cognitive load demands are reduced, thus allowing a person a longer time frame prior to the onset of cognitive fatigue. In a school context, this
cognitive load reduction may result in longer periods of attention being paid to academic content before the brain shifts focus to something less cognitively demanding. Examples of less demanding tasks might be writing notes to a classmate or watching the classroom activity instead of focusing on academic tasks. So the reader may understand the process and necessity of regulating their attention, the next section of this paper will focus on the process of how a person regulates their attention.

The Nature of Self-Regulation in Learning

The regulatory processes held in the central executive are of critical importance for the demands of readers. Bandura (1986) included self-regulation in his social cognitive theory and argued that the learner engages in self-observation, self-judgment, and self-reaction. This conceptualization was taken further by Zimmerman (1986) who defines self-regulated learning (SRL) as “the degree to which students are metacognitively, motivationally, and behaviorally active participants in their own learning process” (p. 167). Wolters (2003) elucidates this broader conceptualization when he discusses self-regulated learners as possessing a large tool box of cognitive strategies that can be used to accomplish academic tasks. Some of these tools are rehearsal of information (practicing the contents of working memory), organizational (structuring of information within long-term memory) and elaboration strategies (using the meaning of information to help encode it into mental models) (Ashcraft & Radvansky, 2010). Self-regulated learners are aware of, monitor, and adapt their mental processes by use of those strategies in the service of mastering academic content. Therefore, SRL is viewed as an active, intentional process wherein students set goals, select and change learning
strategies, and determine the effectiveness of those strategies in an effort to acquire an academic skill.

Daneman and Carpenter’s (1980) discussion above centers around the issue that since a person has so few working memory resources available (5-9 pieces) that if a person regulates those resources more efficiently, one can gain more “functional” working memory. Being a more regulated learner can help reduce extraneous cognitive load (e.g. being given perspective relevancy instructions) in a reading task, which will increase germane load (the amount of working memory resources available to bring to the reading task). The purpose of the current study is to examine the relationship between a person’s regulatory ability (either high or low self regulators) and perspective relevance instructions to determine how the two impact recall of information and reading time. With this in mind, the next section of this paper will examine measures of self-regulation and discuss the strengths and challenges of same.

**Measures of self-regulation.** Given the importance of self-regulation as outlined so far in this chapter, accurately measuring student’s levels of self-regulation is a crucial first step in determining how to assist learners increase their levels of self-regulation, should it be necessary. Zimmerman (2008) published a description of measures that are currently used to measure academic self-regulation that will be used as the guiding framework for this portion of the review. Some of the instruments measure self-regulation during online processing (while a learning task is happening) and others measure regulation while offline (either before or after a learning experience). In addition, he also included some instruments/designs that were measuring self-regulatory change in a pre/post causal study. Those three have been eliminated from this review due
to their purpose being beyond the scope of this paper. The instruments measuring self-regulatory constructs were not functionally different from those addressed below. Two types of instruments (choice reaction tasks and eye-tracking data) have been added to this review. These tasks were developed for use outside education, but the self-regulatory attentional construct measured is clearly applicable to educational psychology, thus it appropriate they be included. Table 2.1 summarizes the following methods of measuring self-regulation.

**Eye-tracking data.** Eye tracking data is measured by determining the length of time a person allocates attention to a particular piece of information. Rothkopf and Billington (1979) were some of the first educational researchers to use eye-tracking data to record (track) the length of time a reader spent on relevant segments of text information. In this study, participants used a hand switch to advance a slide once they were finished reading the information on that slide. The shutter of the slide machine was wired to a control panel where the length of time and corresponding slide number was recorded. In this case each slide contained anywhere from 1 to 3 complete paragraphs with a total number of syllables known per slide. This allowed output data as a time per syllable recording. Currently the method has changed somewhat because most studies utilizing time tracking are registering a sentence-by-sentence time recording. (McCrudden et al., 2005; Reynolds, Trathen, Sawyer, & Shepard, 1993). There are advantages and disadvantages to utilizing eye-tracking data to measure self-regulatory functions of attention allocation. The primary advantages are that it provides an objective and online measure of self-regulation and is relatively unobtrusive. The primary disadvantages are that this measurement tool collects data regarding which material gets
more or less reading time and makes inferences regarding a person’s working memory regulation instead of being able to measure working memory regulation directly. The second disadvantage is that it is quite costly. Reaction time tasks are another unobtrusive measure of self-regulation of attention, but are offline measures of allocation.

**Choice reaction time tasks.** Choice reaction time tasks are measures of selective attention. These types of tasks (e.g. Wisconsin Card Sorting Task, Stroop Task) are characterized as such because they ask the participant to direct their working memory resources to one variable while suppressing working memory resources to another variable in a timed setting, thus placing cognitive strain on limited resources and central executive resources. The outcome variables are accuracy of selective attention, and time necessary to direct that attention. One complex choice reaction time task mentioned above is the Stroop Task and associated Stroop Effect (Stroop, 1935). In this task participants are asked to look at cards (if done face to face) or look at a computer screen with a color word (e.g. red, green, blue) printed on it in block lettering, but the color of ink the word is printed on is not the same as the word. Therefore cards/screens with the word “red” on it would not be written in red ink, it would be written in either blue or yellow ink. Participants are then asked to name the color of the ink, not the word, thus creating interference by asking them to direct their attention to the color while filtering (or blocking) attention being paid to the word itself. Due to this interference, reactions times are typically longer for this task than simply naming the color of a color swatch card/screen, which is known as the Stroop Effect. The primary benefit of choice reaction time tasks is that they are objective measures of how a person regulates stimuli interference within working memory, and thus more likely to be an accurate measure of
self-regulatory ability when compared to a self-report measure used for this purpose. The primary disadvantage of choice reaction time tasks is that they are not able to measure online learning, while the task is currently happening. Therefore, this becomes a general measure, not one that is task specific. However, the objectivity advantage more than compensates for this disadvantage. The Stroop task is the measure of self-regulatory ability chosen to be used for the current study for four reasons. First, The Stroop Task (1935) provided an outstanding measure of a person’s ability to regulate working memory while overcoming cognitive interference by asking the participant to direct their attention to one variable while suppressing resources to another variable in a timed setting, thus placing cognitive strain on working memory central executive resources.

The second reason the Stroop Task was selected for this study was that it is an objective measure, and thus more likely to be an accurate measure of self-regulatory ability when compared to a self-report measure used for this purpose. The third reason the Stroop Task was selected was that the department of Educational Research, Cognition, and Development already owns license to this software, thus reducing demand for external resources. Lastly, due to its computerized scoring, participants were able to be assigned into self-regulatory treatment condition (SR treatment group), in one session rather than having students have to appear for one session to take the Stroop Task and a second one to actually conduct the study. These factors increased efficiency of study implementation while reducing the probability of mortality.

**gStudy software trace program.** gStudy, another objective measure, was created by Winne, Nesbitt, Kumar, Hadwin, Lajoie, Azevedo et al. in 2006. This program was developed in order to provide an online measure of students’ self-regulatory behaviors
during a computer-based task. Researchers are able to assess attentional information such as making notes on reading, motivational information such as working collaboratively with other students not in the same geographic location, and executive control tasks such as seeking help when not understanding content. All of these variables, and many more, can be recorded, so this program provides a very unobtrusive measure of online learning.

The primary advantage of this instrument is that it is an objective measure of online processing in an unobtrusive manner. The primary disadvantage is that it is still too new for a preponderance of evidence to be collected regarding its validity. In each of the three previous measures data was collected by timed response. Some of the responses were online measures (data collected while the participant is engaged in the task) and some of them were offline measures (data collected while the participant is not engaged in the task). What each of them has in common, however, is that they all collect data unobtrusively for the participant while the task is being performed. The second characteristic they all have in common is that they are all objective measures. This is different from the following four instruments, which collect data via subjective means.

**Think-aloud protocols for hypermedia environments.** While think-aloud protocols were originally designed for face-to-face contexts, Azevedo, Cromley, and Seibert (2004) integrated them into a computer based instrument to measure self-regulation. Participants are instructed to say out loud everything they are thinking while they are doing the task, which includes hyperlinks to access diagrams and animations in addition to text elements. The responses are either open or closed-ended and are registered by trained volunteers who later code them into executive control skills such as planning, monitoring, task demands and motivational skills. In a study by Greene and
Azevedo (2007) researchers used a lesson containing 17,000 words, 107 hyperlinks, and 35 illustrations. After the study, researchers coded 18,000 verbal segments. Results from this study showed that some categories were predictive of mental models that students were building, while some were not. More work needs to be conducted on this protocol so that it is a valid measure of self-regulation. The advantages of this instrument are that it gathers a large amount of online processing data and that it provides very clear indications of what information students are directing their attention to (as well as what they are skipping) when they read text. The primary disadvantage of this is the very labor intensive collection and coding, and the obtrusiveness of the collection measure. There is another element to any think-aloud protocol from the standpoint of attention issues. By dividing a student’s attention between the information being learned, the action of verbally processing their thoughts, and the nature of the hypermedia environment, this task becomes an example of a divided task. From the discussion earlier in this paper, it may be that the divisive nature of this task cognitively overloads attention and/or executive control features such that the outcome results may be confounded. The Motivated Strategies for Learning Questionnaire is a simpler method of self-regulation data collection and storage.

**Motivated strategies for learning questionnaire.** The Motivated Strategies for Learning Questionnaire (MSLQ) was developed by Pintrich, Smith, Garcia, Wilbert and McKeachie (1993). This instrument was designed to be used with college students and has demonstrated acceptable reliability and validity coefficients as well as showing acceptable prediction regarding academic achievement. The scale measures

“(1) task value (extrinsic and intrinsic goal orientation, task value); (2) expectancy
(control beliefs about learning, self-efficacy); and (3) affect (test anxiety). The learning strategies sections is comprised of nine scales which can be distinguished as cognitive, metacognitive, and resource management strategies. The cognitive strategies scales include (a) rehearsal, (b) elaboration, (c) organization, and (d) critical thinking. Metacognitive strategies are assessed by one large scale that includes planning, monitoring, and regulating strategies. Resource management strategies include (a) managing time and study environment; (b) effort management, (c) peer learning, and (d) help-seeking.”

(p. 801)

This task has been designed to measure aspects of attention (rehearsal, organization, elaboration), but also those of central executive functioning (managing time, effort management, planning, monitoring). The primary advantage of this instrument is that it is comprehensive in nature, separating attention skills from executive function skills. There are two primary disadvantages to this instrument. One is that this also does not produce an online measure of learning. Secondly, it is a self-report questionnaire, and as such is a subjective measure. The Learning and Study Strategies Inventory is also subjective in nature.

Learning and study strategies inventory. The Learning and Study Strategies Inventory (LASSI) was developed by Weinstein, Schulte and Palmer (1987). The LASSI is an 80-item self-report instrument that measures metacognitive skills (e.g. selecting main ideas- executive functioning monitoring), will (reflective of motivation) strategies such as general motivation and anxiety, and self-regulatory strategies such as time management (central executive planning) or self-testing in 10 scales that are answered on
a 5 point numeric scale. The primary advantage could also be interpreted as a disadvantage. The fact is that with 10 scales in this inventory, not all of them are strictly self-regulatory from a cognitive perspective. The scales dealing with general motivation (will) are not generally thought to be cognitively self-regulatory in nature. There are two primary disadvantages to this instrument. One is that this also does not produce an online measure of learning. Secondly, it is a self-report questionnaire, and as such is a subjective measure. The Self-Regulated Learning Interview Scale measures very similar constructs as the MSLQ and the LASSI, but does so in a different format.

**Self-regulated learning interview scale.** The Self-Regulated Learning Interview Scale (SRLIS) measures executive control strategies such as planning and goal-setting, motivation strategies such as self-consequences, and attention constructs such as reviewing test and environmental structuring (Zimmerman & Martinez-Pons, 1986). This structured interview format asks students about six scenarios (e.g. preparing for a test) and the outcome data is coded into 14 self-regulatory categories. The primary advantage to this scale is that it does not interfere with online processing. The primary disadvantage of this instrument is that it is also a self-report (and thus subjective) measure as well as a general self-regulation measure as opposed to measuring only one aspect of self-regulation (i.e. attention), and does not produce online data.

The self-regulation instruments in this paper are diverse in terms of offline vs. online processing, obtrusive vs. unobtrusive, and subjective vs. objective measures. It is important to remember that none are of these are really “good” vs. “bad”, even though I have made some choices over others for the purpose of the current study. The most important consideration with any instrument, including self-regulatory measures, is
whether they are appropriate to collect the desired data. Table 2.1 provides a summary of the measures discussed in this section and may assist the reader in comparing the various measures to aid in the determination of a most appropriate measure. The Stroop Task is the measure of self-regulatory ability chosen to be used for the current study for four reasons. First, The Stroop Task (1935) provided an outstanding measure of a person’s ability to regulate working memory while overcoming cognitive interference by asking the participant to direct their attention to one variable while suppressing resources to another variable in a timed setting, thus placing cognitive strain on working memory central executive resources. The second reason the Stroop Task was selected for this study was that it is an objective measure, and thus not as susceptible to an individual’s unintentional bias or perception as some of the other measures discussed in this section may be (e.g. think-aloud protocols, the MSLQ, the LASSI, and the SRLIS). The third reason the Stroop Task was selected was that the department of Educational Research, Cognition, and Development already owns license to this software, thus reducing demand for external resources. Lastly, due to its computerized scoring, participants were able to be assigned into self-regulatory treatment condition (SR treatment group), in one session rather than having students have to appear for one session to take the Stroop Task and a second one to actually conduct the study. These factors increased efficiency of study implementation while reducing the probability of mortality.

The previous portion of this chapter has provided an operational definition of working memory and attention, situated self-regulation within it, and discussed multiple instruments for measuring self-regulatory functions. The next portion of this chapter will
operationally define the concept of reading relevance, discuss theoretical frameworks and
taxonomy of reading relevancy, and end with a section on empirical relevancy studies.
Table 1 Summary of Self-Regulation Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Online Processing</th>
<th>Objective/Subjective</th>
<th>Timed Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye-Tracking</td>
<td>Y</td>
<td>O</td>
<td>Y</td>
</tr>
<tr>
<td>Reaction Time Tasks</td>
<td>N</td>
<td>O</td>
<td>Y</td>
</tr>
<tr>
<td>GStudy Software</td>
<td>Y</td>
<td>O</td>
<td>Y</td>
</tr>
<tr>
<td>Think Aloud Protocol</td>
<td>Y</td>
<td>S</td>
<td>N</td>
</tr>
<tr>
<td>Motivated Learning Strategies Questionnaire (MSLQ)</td>
<td>N</td>
<td>S</td>
<td>N</td>
</tr>
<tr>
<td>Learning and Study Strategies Inventory (LASSI)</td>
<td>N</td>
<td>S</td>
<td>N</td>
</tr>
<tr>
<td>Self-Regulated Learning Interview</td>
<td>N</td>
<td>S</td>
<td>NT</td>
</tr>
</tbody>
</table>

The Nature of Reading Relevancy

Reading is a process that involves decoding words, comprehending the literal meaning of the words, translating the literal words into the meaning of the text as a whole, and understanding grammatical rules. In addition to these, elements of how the text is organized are important also. The placement and type of examples used, as well as text coherency (i.e. idea units flowing one after the other) can facilitate or hinder learning (McCrudden, Schraw, Hartley & Kiewra, 2004). To accomplish these tasks requires many cognitive processes that contribute to the overall cognitive load on working memory. Elements of cognitive load are additive, that is, each one adds to the one before until eventually cognitive load exceeds the working memory capacity of the reader. Texts that induce lower cognitive load help facilitate learning for the reader (McCrudden et al., 2004). Therefore, portions of the aforementioned processes that can be simplified cognitively will help reduce the overall cognitive load of a text. Relevance is one such aspect that can assist in the reduction of cognitive load. Relevance, as it applies to text
processing, is defined as “the extent to which text segments are germane to the reader’s goals and purposes” (Lehman & Schraw, 2002, p. 738). In essence, if a reader is told what information in a reading is most relevant prior to reading, they will focus more working memory resources on that information through a process called goal focusing (McCrudden & Schraw, 2007), which may decrease the overall cognitive load of a text. When a reader regulates their attention resources effectively and for the necessary length of time, relevant information is recalled more than irrelevant information (McCrudden, Schraw & Kambe, 2005; Reynolds, Standiford & Anderson, 1979; Reynolds, Trathen, Sawyer & Shepard, 1993; Rothkopf & Billington, 1979). The remainder of this section will focus on a comparison of theoretical frameworks that seeks to explain the role relevance plays in reading comprehension, seminal works and exemplary research from the text relevancy research literature, organized according to McCrudden and Schraw’s Taxonomy of Relevance Instructions (2007). As this chapter progresses, I will delineate the main findings of the relevance research, as well as discuss the role individual differences play in relevance instructions. This chapter will conclude with a discussion of how the relevance literature contributes to our understanding of learning from text. The next section of this chapter will seek to explicate two theoretical frameworks regarding how relevance functions in text comprehension.

**Theoretical frameworks.** There are two competing frameworks that seek to explain how relevance instructions function within text processing. Both general and specific relevance instructions have been shown to increase learning, although the underlying mechanism of what causes the learning is unclear. The relevance effect is defined as occurring when specific text segments are judged relevant to the reader’s
specific purpose (McCrudden & Schraw, 2007). It is the underlying mechanism that increases learning (thus creating the relevance effect) that, as yet, is unclear. The first theory is that relevance instructions cause more time, and thus effort, to be devoted to certain parts of a text. Relevance instructions including perspective and purpose instructions have been shown to result in increased reading time (Goetz et al., 1983; Kaakinen et al., 2002; Kaakinen et al., 2003). This increased reading time results from longer processing time due to the student having to evaluate all text segments read and decide which are relevant to their designated perspective and which segments are not. Increased overall passage reading time is a reflection of increased attention allocation, which has been shown to result in readers building more complete mental representations of the text. Kaakinen et al. (2002) referred to the reading time as the encoding time hypothesis, and it is presumed to be the mechanism that causes learning in this framework, which I will refer to as the “increased effort” framework (McCrudden et al., 2005). It is noted that in some instances reading times have not increased (Kaakinen et al., 2003).

The second framework I will refer to as the “no increased effort” framework (McCrudden et al., 2005). According to this framework, relevance instructions do not increase overall reading time of a passage. It is presumed that cognitive efficiency (i.e. allocating and using attention and central executive resources efficiently), rather than length of attention allocation, is responsible for learning. Although specific relevancy instructions have been shown to increase learning without increasing overall reading time (McCrudden et al., 2005) in some cases, this finding has not reached a preponderance of
evidence due to conflicting findings. For instance, Ozgungor and Guthrie (2004) found that overall task time increased over the control group.

The no increased effort framework is consistent with Wilson and Sperber’s (2004) “cognitive principle of relevance” which asserts that people need to operate at optimum cognitive efficiency due to the extremely high volume of information being received at any one time. This theory states that humans will seek and evaluate incoming information to reach the highest level of cognitive efficiency. Wilson and Sperber’s (2004) “communicative principle of relevance” is also consistent with the no effort framework. In this theory, in circumstances when a reader devotes attentional resources to particular information that has been consciously made relevant, a state of ostensivity has been achieved.

The conflicting findings between the increased effort and the no increased effort frameworks highlight the need for continued work in the area of relevance in order to increase our understanding of the specific contexts in which general and specific relevance instructions are the most applicable for reading comprehension and efficient use of mental resources. As relevancy studies are reviewed throughout this chapter, I will discuss which of the frameworks apply to each study.

Relevance taxonomy. McCrudden and Schraw conducted a comprehensive review of the research literature regarding text relevance in 2007. Through that review, it was noted that relevance literature has focused on two overarching categories (general relevance instructions and specific relevance instructions) with each of those two categories being further divided into two subcategories.
Specific relevance instructions have been divided into those empirical studies that have focused on asking questions before, during or after reading to orient the reader to specific (e.g. “what” questions) information within the text (targeted text segments) and questions that are asking deeper, more conceptually challenging (e.g. “why” questions) types of questions (i.e., elaborative interrogation). Targeted text segments literature findings indicate that generally there is a benefit to using targeted text directions. Students learn the targeted text better because they are guided in their process of deciding which material in the text is more relevant and which is less (Lapan & Reynolds, 1994; McCrudden et al., 2005; Reynolds et al., 1979, 1993; Rothkopf & Billington, 1979; Rouet, Vidal-Abarca, Erboul, & Millogo, 2001). This literature also shows some studies have found that the reading time for targeted information sometimes takes longer than for non-targeted information while others have found a decrease in reading time or no appreciable difference (Lapan & Reynolds, 1994; McCrudden et al., 2005; Reynolds et al., 1979). Lastly, this research shows that readers’ age and developmental stage can have either a facilitative or inhibitive impact on the effect text relevance has on learning (Lapan & Reynolds, 1994; Reynolds et al., 1993; van den Broek et al., 2001). In addition to targeted text, elaborative interrogation constitutes the second type of specific relevance instructions.

Elaborative interrogation relevancy is facilitated by asking students “why” questions designed to access a reader’s background knowledge or previously read text segments. Elaborative interrogation summary findings indicate that this type of relevancy increases learning for students across different age groups and increases memory for main ideas and facts better when elaborations are self-generated as opposed to more
cognitively passive methods such as rereading or answering verbatim questions (Willoughby, Wood, Desmarais, & Kalra, 1994; Rouet et al. 2001). Lastly, this research shows that background knowledge and interest interact with passage content influencing the effects of elaborative interrogation (Ozgungor & Guthrie, 2004; Willoughby et al. 1994). Specific text relevancy literature has focused on asking questions a reader must answer. General relevancy, in contrast, focuses primarily on having the student read by activating a particular schema (e.g. being a burglar or reading for a particular reason).

General relevance instructions have been divided into empirical studies that have focused on a person’s perspective (e.g. deciding which text information is most relevant if the reader is a burglar) when reading or have focused on a person’s assigned purpose for reading (e.g. pleasure versus studying). The first type of general relevance instructions are those that have focused on the purpose underlying a person’s reading (e.g. for study versus pleasure). In sum, this research has shown that purpose affects generating inferences (van den Broek et al. 2001) and sentence reading times (Lorch et al. 1987). It has also shown that purpose instructions can compensate for text characteristics that create reading difficulties (Lehman & Schraw, 2002; Linderholm & van den Broek, 2002) as well as mediate the influences of working memory capacity and content knowledge (Bräten & Samuelstuen, 2004; Linderholm & van den Broek, 2002). Table 2.2 summarizes the eight purpose relevancy literature studies summarized in the next section.

The second type of general relevance instructions are those that assist readers in choosing a goal by asking them to read from a particular perspective (e.g. as if the reader were to make a decision regarding a particular country to move to). Pichert and Anderson (1977) conducted two seminal studies in which undergraduate participants (63 in the first
study and 113 in the second) were instructed to read prose passages. In the first study, which essentially amounted to a pilot study to determine which units of meaning were important to readers, participants read two passages (the first regarding the layout and contents of a house and the second regarding unusual flora and fauna of an island) and were instructed to read each passage from a particular perspective. One third of the participants in the house passage were instructed to read as if they were burglars, one third as if they were contemplating purchasing the home, and one third as a control group and were given no particular reading instructions. In the flora passage, one third of participants were given instructions to read as if they were a florist who was looking for an isolated place to raise flowers, one third as if they were a shipwreck survivor looking for survival and seeking to get home again, and one third as a control group and were given no particular reading instructions. Results of this study showed that some ideas were more important to a particular perspective, meaning that depending on the perspective a participant had when reading the study he/she would find different things important than someone reading from a different perspective. These results lead the researcher to conduct a second study to determine how these ratings of importance would impact recall and learning of information.

In experiment 2 participants not in Study 1 were randomly assigned to read either the house or the flora passage (again each passage had three read conditions). After being given two minutes to read the assigned passage from the assigned perspective, participants were given a free recall test and instructed to write down as much information from the passage as they could remember (termed learning in this study). Participants returned a week later for a delayed free recall of the information (termed
Researchers noted that previous research had shown that information deemed more important is learned better. After scoring, results from this study furthered empirical understanding by showing that what information is important depends on the perspective from which a person reads a passage. In essence, what is important is determined by the perspective a person brings to the passage.

These findings contribute to the no-increased effort hypothesis discussed above. It is assumed that a reader, having been given a goal (or perspective) from which to read a passage, is then directing working memory resource (regulatory) processes in such a way as to increase learning segments of information germane to that goal more effectively than segments not germane to that goal. It is noted here that Pichert and Anderson did not collect reading time data in this study, so it is not possible to form any other judgment given the hypotheses described above.

Goetz et al. (1983) conducted a similar study as Pichert and Anderson (1977) when they examined importance of particular segments of text and how they impacted learning. They furthered the relevancy literature by tracking reading time of the passage to determine which sentences participants directed their attention to. There were two studies reported in this article as well, the first one serving only as a pilot to determine which sentences in a passage about two boys playing hooky from school would be relevant to someone reading the passage as if they were a burglar or as if they were going to buy the house. This is the same passage used by Pichert and Anderson (1977) and indeed the purpose of the study, as noted by the authors, was to validate which sentences were determined to be most important to which perspective. The findings from
experiment one duplicated the findings of Pichert and Anderson, thus lending validation to the future use of this reading passage.

In experiment two, Goetz et al. utilized 37 policemen enrolled in a summer training course at a university, 35 students enrolled in a real estate course at a local community college, and 34 education students enrolled in an introductory educational psychology course at a university (the same population used in experiment one) to examine the impact perspective instructions would have on learning of relevant information and reading time of relevant sentences. In this study, participants were counterbalanced across the three conditions (homebuyer, burglar, and control) and read the passage on a computer that tracked the reading time of each sentence within the passage. Upon completion of reading, participants completed a free recall measure in which they were asked to write down everything they could remember about the passage.

The findings of this study replicated Pichert and Anderson (1977) when it found that participants recalled information contained within their assigned perspective more than information outside their assigned perspective. In addition, this study found that participants in both relevance conditions spent more time reading the sentences that pertained to their perspective and less time reading sentences that pertained to anything else in the passage. These findings support the increased effort hypothesis discussed above. It is presumed that when a person spends longer reading certain portions of information, they will learn that information better. It is noted that this study did not track delayed recall of data as Pichert and Anderson did due to its being more interested in examining the effects of encoding information rather than the longer term effects of recall.
Schraw, Wade and Kardash (1993) examined the effects of perspective (termed task-based importance) and how perspective interacted with parts of a text made important because of their relation to other portions of a text (e.g. topic sentences or logical relation), termed text-based importance in a series of three experiments. In each of the experiments, the passage used was the same as in the Pichert and Anderson (1977) study, although the study had been modified by the experimenters to make it longer in order to assure there were enough segments relevant to each of the three perspectives (e.g. homebuyer, burglar, and control). In each of the experiments, participants assigned to one of three perspective conditions read the passage and then completed a free recall measure. In experiment one, participants completed a free recall measure in which they were instructed to write as much information as they could remember from the passage. The results from this experiment replicated Pichert and Anderson (1977) and Goetz et al, (1983) findings in that participants recalled more information contained within their perspective than outside their perspective.

Experiment two built upon the initial findings by seeking to examine how text-based and task-based importance interacted with each other, if at all. In this study, two relevance conditions (homebuyer and burglar) read a passage, and completed a standard free recall measure. Results in this study showed that participants in each read condition remembered more information regarding their assigned perspective (task-based importance) regardless of how important that information was in regard to its text-based importance. It was also found that when information was not made relevant by perspective instructions, it was recalled more if it was of high text-based importance.
While this experiment had some useful findings, it raised questions regarding the nature of when and how task-based importance functions during reading text.

Experiment three built upon experiment two by determining when (either at encoding or retrieval) perspective instructions were most beneficial for reader recall of information. As in the first two experiments, participants were randomly assigned to homebuyer or burglar perspective conditions, followed by reading the passage and completing a free recall measure. The difference in this experiment was that participants were also divided into encoding or retrieval importance groups. The design of this study was a 2 (perspective) x 2 (time of perspective) x 3 (high, average, or low text-based importance) x 2 (high or low task-based importance). It was found through this study that participants receiving their perspective at the beginning of reading (encoding) remembered more information than those receiving their perspective at the end of reading (retrieval), although it is important to note that neither of these was statistically significant. Experiment two suggested that receiving task-based importance (perspective) assisted participants in recalling more information than when task-based importance is absent (which was found in experiment three as well), but this difference in experiment three was not statistically significant.

Overall, the results from these experiments show that task-based important segments (homebuyer or burglar) help a reader lessen their dependence on internal text characteristics (e.g. how one sentence relates to the one before it and the one after it). However, when given information is not overtly signified as important, readers will rely on text-based importance. In other words, relevant information helped readers learn more relevant information, but did not decrease the learning of information that the control
group learned. These findings contribute to the no- increased effort hypothesis discussed above. It is assumed that a reader, having been given a goal (or perspective) from which to read a passage, is then directing working memory resource (regulatory) processes in such a way as to increase learning segments of information germane to that goal more effectively than segments not germane to that goal. It is noted here that Schraw, Wade, and Kardash did not collect reading time data in this study, so it is not possible to form any other judgment given the hypotheses described above.

Schraw and Dennison (1994) conducted a series of three experiments to examine how, to what extent, and at what point in the reading process a given perspective influences ratings of interest by the reader. In experiment one sixty undergraduate participants read the Pichert and Anderson (1977) homebuyer/burglar story from one of three perspectives (homebuyer, burglar, or control) and completed a free recall measure. It was found that some of the segments within the text were more interesting than others, even if those segments were in the control group and not in an assigned perspective group. These was attributed to the fact that those sentences in the control group were central to the passage’s main theme and are logically more likely to be designated as more interesting than some other segments. A secondary finding was that segments of the text that were relevant to a reader’s assigned perspective were found to have greater recall than those of the other perspective or the control group.

In experiment two of this series, the same passage and process were used with forty-six undergraduates with one exception. The difference is that in experiment one, there was essentially a pilot study of undergraduates who read the passage and rated the segments as interesting or not, but they were not the same undergraduates as the
participants who completed experiment one. It was suspected that the level of interest might change if the actual participants in experiment two rate the passage for interest and then take the recall measure. In experiment two, participants read the passage from one of three assigned perspectives, rated the segments according to their interest on a 100 point scale, conducted multiplication problems to clear working memory, and then completed the free recall measure. The findings of this experiment showed that participants found segments of the text interesting if they concerned their particular assigned perspective. This is attributed to the activation of an existing schema at the time of perspective assignment (in this case prior to the reading of the passage) that assists readers in the segments they identify as interesting because they are purpose-driven.

Experiment three was much the same as one and two with the exception of the examination of the effect interestingness would have on recall when a certain perspective was assigned before reading (as was done in experiment one and two) or after reading but before recall (as an added condition in experiment three). Findings from this experiment showed essentially the same findings as experiment one and two in that when participants were given an assigned perspective they remembered that information better than information that was not in the assigned perspective. This finding was found in the participants that received their perspective before they read the passage and those that received their perspective after they read the passage but before the free recall measure.

To this date in the research discussed here, there have been no studies that have taken into account a person’s individual differences when examining relevancy instructions. Kaakinen et al. (2002) were the first researchers to examine how differences within a person interact with perspective instructions. In their study of sixty-four college
students, the researchers used an eye-tracking device to collect information regarding which sentences were looked at more often than others, administered a free-recall measure, and examined how participants’ working memory spans affected recall of the assigned perspective (Honduras information or Pitcairn information). Researchers created a text that is approximately 800 words and describes four remote countries (Andorra, Anguilla, Pitcairn, and Honduras). The prose text discusses location and geography, climate, government, economy and transportation, and population and language of each of the countries in a compare-contrast prose rhetoric style. Findings from this study showed that participants recalled statistically significantly more relevant information than non-relevant information. It also showed that participants spent more time looking at relevant information than non-relevant information. Thirdly, eye-tracking data showed that readers with high working memory span were able to determine relevant data when reading it for the first time while low working memory span readers were only able to do so when looking back at the information- having already read and passed this information without longer eye fixations on relevant text the first time.

The researchers postulate two different possibilities for this finding, which they’ve framed in regards to Daneman and Carpenter’s (1980) working memory span capacity versus efficiency discussed above. The first possible reason is that low working memory span readers lack the necessary capacity to determine what information is relevant at first read and the second is that high working memory span individuals work more efficiently either by accessing long term memory stores quicker or by regulating working memory resources toward the relevant information. These findings support the increased-effort hypothesis discussed above.
A second study examining the influence of individual differences on perspective relevancy was conducted by Kaakinen et al. (2003) in which researchers sought to examine how a person’s level of prior knowledge would impact/interact with perspective instructions. In this publication of two studies Kaakinen et al. sought to examine if differences in working memory capacity and prior knowledge would have an impact on remembering perspective relevant information. In experiment one, 47 participants read expository texts regarding familiar diseases (e.g. chicken pox, flu) and unfamiliar diseases (e.g. trigeminusneuralgy, typhus). Prior to reading the texts participants were assigned a particular perspective to read from and reading times of relevant and non-relevant text were collected. After reading, a free recall measure regarding both texts was administered. In experiment two, 16 participants followed the same process as experiment one, with one exception. In this experiment, participants read both texts, but without a reading perspective assigned. From this data, baseline reading times were collected that were then compared with the reading data from experiment one.

It was found through these two experiments that all participants in the treatment group showed increased recall of perspective relevant information. Readers with high working memory span read the high prior knowledge information without needing more time to do so like the low working memory span group did. This finding is attributed to Daneman and Carpenter’s (1980) supposition that high span readers use their working memory attention resources more efficiently. It was also found that both low and high span readers benefited from perspective relevance instructions when reading an unfamiliar text, in which they could not use prior knowledge. It was discovered that high span readers allocate extra attention resources during their initial reading of the text,
whereas the low span readers allocate extra attention resources when they look back at relevant information after the initial read. The authors attribute this to the supposition that higher working memory span readers allocate attention resources more efficiently than lower span readers. The authors are trying to attribute efficiency to capacity, something suggested by Daneman and Carpenter (1980). However, it may be that a person’s self-regulatory ability of working memory resources (instead of the capacity of those resources) may provide a more accurate understanding of why perspective relevance instructions show the efficacious results they consistently do. It is noted that the reading time data was mixed and thus does not provide support for either the increased effort or the no-increased effort hypothesis.

A third study examining high or low levels of working memory span was conducted by Di Vesta and Di Cintio (1997). In this study of 180 undergraduates researchers were exploring how working memory span differences interact with two different reading perspectives. Participants were given the memory span test developed by Daneman and Carpenter (1980) and from these results were divided into three working memory span groups (high, medium, and low). They then read the homebuyer/burglar passage developed by Pichert and Anderson (1977). Once the passage had been read, participants completed a free recall measure in which they were told to write down everything they could remember about the passage. Once that was completed, participants completed a task designed to empty working memory of the information just read. After that, the treatment group was divided into two groups (one given the initial perspective to remember, and one given the opposite perspective to remember while
being told that thinking of the opposite perspective might help them remember additional
details about the initial perspective) and all were given a second free recall measure.

Results from this study were interesting in that low working memory span
treatment participants did not remember any additional ideas after the switch in
perspective. In contrast, high working memory span participants did remember additional
ideas after the perspective switch. Authors attributed this finding to “bypass available
capacity constraints and, thereby, avoid overloading.” (p. 227) Thus they are positing the
difficulty of retrieval to be caused by too much cognitive load demand due to having to
keep both perspectives in working memory at the same time. They posit that both
perspectives overload the biological constraints of attentional resources. However, these
results may be just as likely to be caused by lower levels of self-regulatory ability in
switching back and forth between the two perspectives, thus the recall of information
suffers. Read time data was not collected in this study, so it is not possible to attribute
this finding to the prevailing effort hypothesis. The current study on self-regulatory
abilities may provide additional data with which to inform this Di Vesta and Di Cintio
study.

The last study to date examining individual differences is that of McCrudden and
Schraw (2010). The previous studies regarding individual differences have focused on
using working memory span to explain how relevance instructions assist readers.
McCrudden and Schraw examined how verbal ability, a measure of crystallized
intelligence (Brody, 1992) might explain the efficacious effects of perspective relevancy
instructions. Eighty-one undergraduate participants were given a vocabulary measure and
divided into high and low verbal ability based on the scores. Participants then read the
passage regarding countries developed by Kaakinen (2002) discussed above. The treatment group was randomly assigned to either the perspective where they focused on Pitcairn or where they focused on Honduras while being told to read the passage as if they were going to be moving to the assigned country and what information would they need to remember if they were to decide the good and bad sides of living in this country for several years. Once participants read the passage, participants were given a short demographics questionnaire to gather information and to empty working memory. Once completed, participants filled out a free recall measure wherein they wrote down all information they could remember about the passage.

The results of this study showed that all treatment condition readers spent more time reading relevant information than non-relevant information. However, those with higher verbal ability recalled even more relevant information and read relevant information faster than participants with lower verbal ability. It was also found that high and low verbal ability recalled relevant information better than non-relevant, but those with higher verbal ability recalled even more than those with lower verbal ability. It was also found that the perspective and verbal ability were having these effects separately from each other. In other words, verbal ability was not responsible for explaining the effect perspective relevance has on recall and time. This finding is not surprising since the goal of exploring individual differences is trying to determine biological differences, but this study was examining crystallized intelligence (or learned facts). Overall passage reading time data was not collected so it is not possible to attribute this study to the prevailing hypothesis.
<table>
<thead>
<tr>
<th>Author</th>
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<tbody>
<tr>
<td>Pichert and Anderson (1977)</td>
<td>N</td>
<td>NA</td>
<td>Increased learning of segments relevant to a learning goal (perspective)</td>
</tr>
<tr>
<td>Goetz et al. (1983)</td>
<td>Y</td>
<td>N</td>
<td>Increased learning of segments relevant to a learning goal (perspective). Increased time spent on perspective relevant segments</td>
</tr>
<tr>
<td>Schraw et al. (1993)</td>
<td>N</td>
<td>NA</td>
<td>Perspective instructions assist readers in determining which information is important but when they are not present, readers will revert to text-based characteristics</td>
</tr>
<tr>
<td>Schraw and Dennison (1994)</td>
<td>N</td>
<td>NA</td>
<td>Readers will identify certain segments of a passage as interesting if those segments have been overtly identified as relevant</td>
</tr>
<tr>
<td>Kaakinen et al. (2002)</td>
<td>Y</td>
<td>N</td>
<td>Readers recall more and spend more time reading relevant segments. High wms readers spend more time on relevant information on first pass while low wms readers spend more time on relevant information on look backs. High wms readers recalled more relevant information than low wms</td>
</tr>
<tr>
<td>Kaakinen et al. (2003)</td>
<td>Y</td>
<td>N</td>
<td>Increased recall of relevant segments for treatment group. High wms read text they had prior knowledge of faster than those with low wms. Both high and low wms readers benefit from relevance instructions when reading text of which they have no prior knowledge</td>
</tr>
<tr>
<td>DiVesta and DiCintio (1997)</td>
<td>N</td>
<td>NA</td>
<td>Perspective group recalls more than control group. High wms group recalls more than low wms. Switching perspectives causes low wms to lose information initially recalled, creating support for dependence on relevance instructions.</td>
</tr>
<tr>
<td>McCrudden and Schraw (2010)</td>
<td>Y</td>
<td>NA</td>
<td>Increased reading time and recall for relevant information. Higher verbal ability group had faster reading time and more recall than lower group.</td>
</tr>
</tbody>
</table>
Main Conclusions

Table 2 provides a concise summary of the perspective relevance literature. Some findings from this literature have been very consistent across studies. The first among them is the finding that reading material deemed relevant to a reader’s purpose is remembered better (Pichert & Anderson, 1977; Goetz et al., 1983; Schraw et al., 1993; Schraw & Dennison, 1994; Kaakinen et al., 2002, 2003; Di Vesta & Di Cintio, 1997; McCrudden & Schraw, 2010). Second is the finding that the four studies that have examined reading time of relevant information have shown that individuals spend more time reading information that is relevant to the assigned perspective than information that is not (Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010). Third among them is the work that has investigated the relationship among material rated “important”, “relevant”, “interesting” and the recall of those types of information. It was found that information is rated as important or interesting if it pertains to a particular goal for reading and is recalled better (Pichert & Anderson, 1977; Schraw & Dennison, 1994; Schraw et al, 1993). Other relevancy work has shown mixed results when attempting to examine how individual traits interact with perspective relevance instructions.

Since 1997 work in this area has largely investigated the relationship between individual characteristics and perspective relevance instructions. Three studies have sought to explain the increased recall effect of relevance instructions through the lens of Daneman and Carpenter’s (1980) working memory efficiency versus capacity argument. All three have shown increased recall of relevant information when compared to control groups, but there have been some differences when looking at readers with high and low working memory span. High working memory span readers tend to spend more time on
relevant segments when reading the passage the first time (Kaakinen et al., 2002), have higher recall than low working memory span readers when reading a text with which they have prior knowledge of the subject matter - although both high and low working memory span show relevance effects when reading a low prior knowledge text (Kaakinen et al., 2003), and high working memory span readers tend to recall more relevant information than low working memory span individuals (DiVesta & DiCintio, 1997; Kaakinen et al., 2002). Low working memory span individuals, by contrast, spend more time when looking back at relevant information instead of at initial read (Kaakinen et al., 2002), and lose more previously recalled information when an alternate schema is activated at recall thus disrupting the assigned perspective at reading (DiVesta & DiCintio, 1997). These results are consistent with Daneman and Carpenter’s argument that the efficiency of the working memory central executive may make allowances for the biological span constraints of working memory. However, it is important to note that none of these measures have attempted to explicitly measure working memory central executive efficiency; instead, they have measured span in order to make inferences regarding efficiency. The current study extends the literature by providing a measure of working memory interference, which may provide a more accurate measure of working memory efficiency.

The last study in the individual differences perspective relevance literature has sought to explain the increased recall effect of relevance instructions through a measure of intellectual functioning utilizing high and low verbal ability. Primary findings are that high verbal ability readers show a faster reading time and more recall than readers with low verbal ability. However, verbal ability measures do not measure fluid intelligence, a
genetic predisposition, and instead measure crystallized intelligence, which is typified by information learned in a formal educational setting such as mathematics facts and historical information (Brody, 1992). The current study extends the literature by utilizing a measure of fluid intelligence in order to gain a more accurate understanding of the working memory central executive mechanism at work when a reader is given perspective relevance instructions. The end of this chapter contains hypotheses for this study that are reflective of the literature reviewed above.

**Hypotheses**

The purpose of this study was to examine the relationship between a reader’s regulation of working memory resources [self-regulation (SR)] and relevancy instructions. There were two main research questions. The first question was whether relevance instructions, self-regulatory ability, or an interaction of the two have an impact on recall of relevant information. Previous research has shown that giving participants specific information to read for increases recall for that information (Di Vesta & Di Cintio, 1997; Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010; Schraw & Dennison, 1994; Schraw et al., 1993). Some of these studies have examined individual differences in this process (Di Vesta & Di Cintio, 1997; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010) while others have not (Goetz et al., 1983; Schraw & Dennison, 1994; Schraw et al., 1993). Therefore, it was hypothesized that recall of relevant information would be greater than non-relevant information in the treatment group. It was further hypothesized that participants with a high level of self-regulatory ability would recall more relevant information than those with low levels of self-regulatory ability or the control participants.
The second question for this study was whether relevance instructions, self-regulatory ability, or an interaction of the two would have an impact on reading time of information. Previous results have shown that readers spend more time reading information that has been deemed relevant to the perspective they’ve been assigned (Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010). The current study investigated how individual differences in a person’s ability to regulate their attention would affect the segments of text a person spent more time reading. Therefore, it was hypothesized that treatment participants would take more time to read relevant information than non-relevant information, and reading time of participants in the high self-regulatory group would be significantly shorter than reading time of participants in the low self-regulatory group.
Chapter 3

Methodology

Participants

One hundred-thirty four students from undergraduate educational psychology courses participated in the study. Participants ranged in age from 18-54 years (M=24.38). There were 103 females (78%) and 29 males (22%). Participants’ class standing varied with two freshmen (1.5%), 22 Sophomores (16.7%), 69 Juniors (52.3%), and 35 Seniors (26.5%). Participants reported grade point averages ranging from 2.0–4.0 (M=3.25).

Five participants had read the passage previously, two participants inadvertently wiped their data after collection by logging out of the computer system, and two participants failed to complete demographic information (which contained the question of whether they had read the passage previously); therefore, these participants were omitted from all subsequent analyses to obviate any potential confounds. The final number of participants for analysis was 125.

Design

The design was a 3 (self-regulation high, medium, and low) (assigned through a trichotomized split as determined by the score on the Stroop Task) x 2 (encoding instructions: Pitcairn perspective versus control condition randomly assigned by computer code written into the menu discussed below) x 2 (type of segment: relevant to Pitcairn, non-relevant) design with approximately 20 participants in each cell. The self-regulation and encoding instruction variables were between-subjects manipulations in which each participant was in only one of the four possible groups. The type of segment variable was a within-subjects variable in which each participant had scores for relevant and control information. Thus, the design was analyzed using a series of 2 x 2 x 2 mixed-
model analyses of variance (ANOVAs). Scores on the Stroop test ranged from 4.26 to 112.91 with a mean of 56.9 and sd of 19.79. Scores were trichotomized by dividing the sample into upper, middle and lower thirds using scores of 63.83 and 46.68 as the upper and lower cutscores.

Materials

The reading passage used for this study was one used by Kaakinen et al. (2002), which was originally written in Finnish and translated into English. McCrudden and Schraw (2010) used the English text with several minor changes that did not affect meaning, but rendered metric measures of distance into common American measurements in feet and miles. This text was approximately 1,161 words and described four remote countries (Andorra, Anguilla, Pitcairn, and Honduras). The prose text discussed location and geography, climate, government, economy and transportation, and population and language of each of the countries in a compare-contrast prose rhetoric style. Although participants read the entire passage, Kaakinen et al. (2002) chose to focus on Honduras and Pitcairn as the two relevance manipulations. It was found that participants remembered more information about Pitcairn than Honduras. It may be that there is some text characteristic that allows this material to be recalled more than the information regarding the other three countries. Thus, it was the material for Pitcairn that was considered relevant information for the current study. Participants in the experimental condition were asked to focus on Pitcairn information, while participants in the control condition were asked to read the text for meaning. The reading passage is included as Appendix D.
The vocabulary measure used in this study was the same measure used by McCrudden and Schraw (2010). This measure was a standard 36-item vocabulary instrument published by Educational Testing Service used to assess verbal ability of participants. The purpose of using this measure was to allow greater comparison between the current study’s verbal ability measure and McCrudden and Schraw’s (2010) measure of verbal ability. The items on this measure consisted of a one-word stem and five distracters. Participants were instructed to choose the distracter that most closely matched the meaning of the stem word. The vocabulary measure is included as Appendix G.

**Procedure**

At the beginning of the 1 hour session, participants chose a seat in the computer lab at random. Once the session began the students were informed they would be doing a series of tasks that would pop up on the computer in front of them once they entered their participant identification number, which would be given to them on an instruction sheet by the researcher. They were told that between the directions on the screen and the instructions on the instruction sheet they should self-pace through the tasks. Please see figure 2.1 for a visual display of the sequence of events contained within this study.

Once students had been informed of the previous, they were instructed to choose the first task on the menu in front of them and follow the tasks as outlined. The first task was an informed consent completed on the computer. This informed consent form was a standard form with verbiage consistent with University of Nevada, Las Vegas’ Office for Research Integrity regulations and is included as Appendix B. Appendix A contains the approved IRB form for the study.
Once that task was completed, students moved on to the second task, which was a computer administered version of the Stroop Task. The high, medium, or low regulation groups were determined by a trichotomous split of performance on a computerized version of the Stroop Task. The high regulation group were those with the fastest performance times, which indicates a faster capability of filtering out stimuli unnecessary for completing a task, while the medium and low attention group will be those with slower filtering performance. Of the several options available for the measurement of self-regulation discussed in Chapter 2 (e.g. eye-tracking data, Motivated Strategies for Learning Questionnaire, the Learning and Study Strategies Inventory), the Stroop Task was selected for this study for several reasons. First, The Stroop Task (1935) provided an outstanding measure of a person’s ability to regulate working memory while overcoming cognitive interference by asking the participant to direct their attention to one variable while suppressing resources to another variable in a timed setting, thus placing cognitive strain on working memory central executive resources. In this task participants were asked to look at a computer screen with a color word (e.g. red, green, blue) printed on it in block lettering, but the color of ink the word was printed in was not the same as the word. For example, screens with the word “red” on it was not written in red ink, it was written in either blue or yellow ink. Participants were then asked to name the color of the ink, not the word, thus creating interference by asking them to direct their attention to the ink color while filtering (or blocking) attention being paid to the word itself. Due to this cognitive interference, reactions times are typically longer for this task than simply naming the color of a color swatch or reading a color word with ink in the same color would be.
The second reason the Stroop Task was selected for this study was that it is an objective measure, and thus more likely to be an accurate measure of self-regulatory ability when compared to a self-report measure used for this purpose. The third reason the Stroop Task was selected was that the department of Educational Research, Cognition, and Development already owns license to this software, thus reducing demand for external resources. Lastly, due to its computerized scoring, participants were able to be assigned into self-regulatory treatment condition (SR treatment group), in one session rather than having students have to appear for one session to take the Stroop Task and a second one to actually conduct the study. These factors increased efficiency of study implementation while reducing the probability of mortality.

Once participants completed the Stroop Task, they continued with the third task, which was to read the directions to the passage and then the passage (these directions are included as Appendix C). Treatment and control group directions are included as Appendix D. Control group participants read directions on the computer stating all of the same information as the SR treatment group with the exception that they were instructed to read the passage to understand the information regarding all four countries, instead of only the Pitcairn information. Then participants read the passage about four remote countries one sentence at a time from the computer (a copy of the passage is included as Appendix D). Directions on the computer informed SR treatment group participants to read the passage at a comfortable pace for them, to click the space bar to progress to the next sentence, their inability to return to portions of the text once they have clicked past them, and to read the passage paying particular attention to information that would be good and bad to know if they were going to be moving to Pitcairn for an extended period.
of time. In other words, they were instructed to read the passage to ascertain which pieces of information contained in the passage would make their stay in Pitcairn pleasurable and which pieces of information contained in the passage would make their stay in Pitcairn unpleasant.

Participants proceeded to their fourth task, a demographics and information sheet. There was some general information asked (e.g. year in school, age, gender, and overall college grade point average). There was also some specific information asked (e.g. have they ever read the passage before (possible responses being yes, no, or uncertain), and what their level of knowledge of Pitcairn was prior to reading this passage with a score of 1 to 5 [1 meaning very little knowledge of Pitcairn prior to reading the passage and 5 meaning very much knowledge]). A sample demographics questionnaire is included as Appendix E.

The fifth task of the session was a free recall measure. Participants in both the SR treatment group and the control group were instructed to type in everything they could remember about the countries contained within the passage. They were encouraged to convey each and every detail about the passage. These instructions are included as Appendix F.

The sixth, and last, task of the session was a vocabulary measure. Participants indicated their choice of the meaning of a stem word by clicking on the box containing the corresponding meaning. The measure is included as Appendix G. Once students completed this sequence of six computerized menu tasks they were told to notify the researcher, leave their instruction sheet on their keyboard, and exit the computer lab. As that happened, the researcher thanked them for their participation.
Figure 2 Sequence of tasks
CHAPTER 4

RESULTS

Data Analysis Procedures

Factorial mixed-model ANOVAs were calculated with regard to the recall, reading time, and vocabulary variables and are reported in their respective portions below. The first set of analyses compared recall and reading time performance using the trichotomized Stroop score and relevance intervention as the independent variables. The second set of analyses compared recall and reading time using the median vocabulary test score and relevance intervention as the independent variables. It should be noted that the vocabulary test constituted a replication phase in which vocabulary data was collected after the treatment intervention and the recall phase. For this reason, performance on the vocabulary test may be affected by the treatment and recall phases.

Stroop Test (Self-Regulation of Attention) X Relevance

Recall. The free recall instrument was scored by summing the number of sentences a participant recalled from the passage. Sentences that were labeled relevant were any sentence pertaining to the country of Pitcairn (of which there are 20) and are those italicized and shaded in the reading passage in Appendix C. All other segments were considered control sentences. Participants recalling any idea unit from a sentence were given one point for that sentence. Ideas/sentences recalled by the participant that were generally incorrect were given a score of 0 points. These scores were summed such that each participant received a score of 0 – 20 for relevant sentences (Pitcairn), and a score of 0 - 55 for sentences that were not relevant (all other countries). Twenty Recall booklets were systematically selected for inter-rater agreement with 85% initial
agreement. Following discussion in which the two raters evaluated the discrepancies to determine participants’ intention and meaning of the recall sentences, 100% agreement was reached. Following scoring of sentences, an Analysis of Variance (ANOVA) was conducted to determine main effects and interactions.

The proportion of relevant (i.e., 20 sentences) and non-relevant segments (i.e., 55 sentences) were computed to make the two scores comparable. The factorial mixed-model ANOVA results with recall as the dependent variable showed a statistically significant ordinal treatment type (e.g. control versus treatment) x segment type (e.g. Pitcairn sentences versus other country sentences) interaction, $F_{(1,119)} = 30.76, p < 0.0005, \eta^2_p = 0.21$. An ordinal interaction is one in which the lines that connect the two points of the independent variables do not intersect. In this case we know that the treatment group recalled the Pitcairn sentences statistically significantly more than the sentences from the other countries. Partial eta squared is a measure of the strength or magnitude of the effect of the experimental manipulation. In this case we know that 21% of the variance in the recall score is explained by the treatment type x segment type interaction. Neither the treatment type x segment type x self-regulation three-way interaction, the self-regulation x segment type interaction, nor the treatment type x self-regulation interaction was statistically significant, all $p$-values $\geq .67$. Simple effects and simple contrasts were requested following the significant treatment type x segment type interaction. A review of the simple effects of the treatment type x segment type interaction within treatment type demonstrated significant pairwise comparisons between the recall for the treatment group (Pitcairn information: $M = .34, SD = .20$; information of other three countries: $M = .11, SD = .09$), $F_{(1,119)} = 98.00, p = 0.0005, \eta^2 = 0.45$, and the control group (Pitcairn
information $M = .24, SD = .19$; information of other three countries: $M = .20, SD = .15$, $F_{(1,119)} = 4.45, p = 0.04, \eta^2 = 0.04$, with both groups recalling significantly more Pitcairn information than the other three countries combined.

The simple contrasts results of the treatment type x segment type interaction within segment type demonstrated that the treatment group recalled more Pitcairn information ($M = .34, SD = .20$) than the control group ($M = .24, SD = .19$), $F_{(1,119)} = 7.64, p = 0.01, \eta^2 = 0.06$, while the control group recalled significantly more information for the other three countries combined ($M = .20, SD = .15$) than the treatment group ($M = .11, SD = .09$), $F_{(1,119)} = 16.75, p = 0.0005, \eta^2 = 0.12$.

Following the ordinal interaction, the segment type main effect was statistically significant, $F_{(1,119)} = 75.54, p = 0.0005, \eta^2 = 0.38$, with participants recalling significantly more Pitcairn information ($M = .29, SD = .20$) overall than the information of the other three countries combined ($M = .15, SD = .13$).

**Reading time.** Reading time data was accounted for by figuring the milliseconds spent on each word in each sentence of the passage. The number of words per sentence were then divided by the total number of words possible for each sentence in order to control for sentence length. These proportions were then summed by country to obtain a words-per-sentence per country measure.

Results of the factorial mixed-model ANOVA with reading time as the dependent variable showed that the treatment type x segment type interaction was statistically significant, $F_{(1,119)} = 10.03, p = 0.002, \eta^2_p = 0.08$. Neither the treatment type x segment type x self-regulation three-way interaction, the self-regulation x segment type interaction, nor the treatment type x self-regulation interaction was statistically
significant, all \(p\)-values \(\geq .64\). Simple effects and simple contrasts were requested following the significant interaction. An inspection of the simple effects of the treatment type by segment type interaction within treatment type demonstrated that the pairwise comparison between the reading time for Pitcairn (\(M = .37, SD = .12\)) and the other three countries combined (\(M = .40, SD = .12\)) for the control group was statistically significant, \(F_{(1,119)} = 21.29, p = 0.0005, \eta^2 = 0.15\), with control group participants taking significantly longer time reading the other three countries combined when compared to reading time for Pitcairn sentences. All other pairwise comparisons were not statistically significant, all \(p\)-values \(\geq 0.91\).

The simple contrasts results of the treatment type by segment type interaction within segment type demonstrated that the reading time among the Pitcairn and the three combined countries between the treatment and control groups was not statistically significant, all \(p\)-values \(\geq .07\). Although not statistically significant, the treatment group exhibited shorter reading times for both the Pitcairn sentences and the sentences of the other three countries combined when compared to control group.

A significant main effect was also interpreted in the presence of an ordinal interaction. The segment type main effect was statistically significant, \(F_{(1,119)} = 11.07, p = 0.001, \eta^2 = 0.09\), with participants spending significantly more time reading the sentences of the other three countries combined (\(M = .38, SD = .13\)) when compared to the Pitcairn sentences (\(M = .36, SD = .11\)).

**Vocabulary Test (Verbal Ability) X Relevance**

**Recall.** Descriptive statistics were conducted regarding the verbal ability variable. Scores on the verbal ability measure were divided into a high and low verbal ability split
determined by the bottom half of the cases forming the low verbal ability and the top half of the cases as the high verbal ability. This was done in order to conform to the intent of McCrudden and Schraw (2010) while allowing for commensurate comparison between self-regulation and verbal ability in the replication portion of the study. Means and standard deviations for this measure were as follows; $M = 15.34$, $SD = 3.54$ with the two groups (low and high verbal ability) normally distributing.

The factorial mixed-model ANOVA results with recall—a proportion of words per sentence—as the dependent variable demonstrated a statistically significant ordinal treatment type x segment type interaction, $F_{(1,121)} = 30.76$, $p < 0.0005$, $\eta^2_p = 0.20$. Neither the treatment type x segment type x verbal ability, the verbal ability x segment type, nor the treatment type x verbal ability interaction was statistically significant, all $p$-values $\geq .28$. Simple effects and simple contrasts were requested following the significant treatment type x segment type interaction. A review of the simple effects of the treatment type x segment type interaction demonstrated significant pairwise comparisons between the recall for the treatment group (Pitcairn information: $M = .34$, $SD = .20$; information of other three countries: $M = .11$, $SD = .09$), $F_{(1,121)} = 94.83$, $p = 0.0005$, $\eta^2 = 0.44$, and the control group (Pitcairn information: $M = .24$, $SD = .19$; information of other three countries: $M = .20$, $SD = .15$), $F_{(1,121)} = 4.51$, $p = 0.04$, $\eta^2 = 0.04$, with both groups recalling significantly more Pitcairn information than the other three countries combined.

The simple contrasts results of the treatment type x segment type interaction within segment type demonstrated that the treatment group recalled more Pitcairn information ($M = .34$, $SD = .20$) than the control group ($M = .24$, $SD = .19$), $F_{(1,121)} = 7.26$, $p = 0.01$, $\eta^2 = 0.06$, and the control group recalled significantly more information
for the other three countries combined ($M = .20, SD = .15$) than the treatment group ($M = .11, SD = .09$), $F_{(1,119)} = 16.97, p = 0.0005, \eta^2 = 0.12$.

Following the ordinal interaction, the segment type main effect was statistically significant, $F_{(1,121)} = 71.56, p = 0.0005, \eta^2 = 0.37$, with participants recalling significantly more Pitcairn information ($M = .29, SD = .20$) overall than the information of the other three countries combined ($M = .15, SD = .13$). The verbal ability main effect was also statistically significant, $F_{(1,121)} = 8.40, p = 0.004, \eta^2 = 0.07$, with participants who exhibited high verbal ability recalling significantly more for both Pitcairn and the other three countries combined than participants with low verbal ability.

**Reading time.** Results of the factorial mixed-model ANOVA with reading time as the dependent variable showed that the treatment type x segment type interaction was statistically significant, $F_{(1,121)} = 9.24, p = 0.003, \eta^2_p = 0.07$. Neither the treatment type x segment type x verbal ability interaction, the verbal ability x segment type interaction, nor the treatment type x verbal ability interaction was statistically significant, all $p$-values $\geq .56$. Simple effects and simple contrasts were requested following the significant interaction. An inspection of the simple effects of the treatment type x segment type interaction within treatment type demonstrated that the pairwise comparison between the reading time for Pitcairn ($M = .37, SD = .12$) and the other three countries combined ($M = .40, SD = .12$) for the control group was statistically significant, $F_{(1,121)} = 21.22, p = 0.0005, \eta^2 = 0.15$, with control group participants taking significantly longer time reading the other three countries combined when compared to reading time for Pitcairn sentences. All other pairwise comparisons were not statistically significant, all $p$-values $\geq 0.80$. 

The simple contrasts results of the treatment type x segment type interaction within segment type demonstrated that the reading time among the Pitcairn and the three combined countries between the treatment and control groups was not statistically significant, all $p$-values $\geq .12$. Although not statistically significant, the treatment group exhibited shorter reading times for both the Pitcairn sentences and the sentences of the other three countries combined when compared to control group.

Significant main effects were also interpreted in the presence of an ordinal interaction. The segment type main effect was statistically significant, $F(1,121) = 11.47$, $p = 0.001$, $\eta^2 = 0.09$, with participants spending significantly more time reading the sentences of the other three countries combined ($M = .38$, $SD = .13$) when compared to the Pitcairn sentences ($M = .36$, $SD = .11$).
Chapter 5

Discussion

The last chapter has five sections. The first begins with a discussion regarding self-regulation and verbal ability and ends with general conclusions of the study. The next section discusses theoretical and advancements to knowledge information, the third section discusses limitations of the present study, the fourth discusses educational implications, while the last section discusses areas for future research.

Self-Regulation

This study had two main goals. The first was to replicate McCrudden and Schraw’s (2010) study examining individual differences in recall and reading times of relevant information when taking into account a person’s individual differences in verbal ability (a measure of crystallized intelligence). The second goal was to extend the literature using a measure of self-regulation (a measure of fluid intelligence), which was measured using the Stroop task. I posed two questions about the relationship between self-regulation and relevancy instructions. The first question was whether relevance instructions, self-regulatory ability, or an interaction of the two have an impact on recall of relevant information. The second question for this study was whether relevance instructions, self-regulatory ability, or an interaction of the two would have an impact on reading time of information. To answer these questions, the following hypotheses were postulated.

Recall. I hypothesized that recall of relevant information (Pitcairn segments) would be greater than non-relevant information (segments from the other three countries in the passage) for the treatment group when compared to the control group. While a
main effect in this study showed that all participants in the study recalled the relevant sentences more than the non-relevant, the interaction showed the treatment group recalling double the number of relevant sentences than non-relevant. Previous research has shown similar findings in that giving participants specific information to read for increases recall of that information (Di Vesta & Di Cintio, 1997; Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010; Pichert & Anderson, 1977; Schraw & Dennison, 1994; Schraw et al., 1993).

I also hypothesized that participants with a high level of self-regulatory ability would recall more relevant information than those with low levels of self-regulatory ability or the control participants. Findings from the current study did not support this hypothesis. The main effect between self-regulatory grouping and recall of information was not significant. Effectively, this means there was no statistical difference in the amount of recall within the three levels of self-regulatory abilities. Previous literature has shown mixed results when examining recall of relevant information when taking into account individual differences. Kaakinen et al. (2003) showed no differences in recall when comparing low and high working memory span. However, DiVesta and DiCintio (1997), Kaakinen et al. (2002), and McCrudden and Schraw (2010) have all shown that when comparing the higher level of the individual difference to the lower level of the construct, the higher level of the construct has recalled statistically more relevant information. The findings of the current study are in alignment with Kaakinen et al. (2003) showing no differences between the higher and lower levels of the individual differences construct, thus providing more competing information rather than providing information toward a preponderance of evidence regarding this issue. This suggests that
the effect of an individual difference variable on relevance may depend on the specific measure (e.g., vocabulary versus self-regulation), the characteristics of the sample, or the experimental materials.

**Reading time.** Analogous to the recall hypotheses described above, I hypothesized that treatment participants would take more time to read relevant (Pitcairn) information than non relevant information. This hypothesis was not supported by the current study. While this study showed that all participants in the study read the Pitcairn sentences faster than those of the other countries, it also showed the control group reading the Pitcairn sentences statistically faster than those of the other countries. Previous results have shown that readers spend more time reading information that has been deemed relevant to the perspective they have been assigned (Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010); therefore the current study is in contention with established literature. However, this finding is beneficial to the relevancy literature because it shows this material takes less time to read but results in higher recall (see discussion above).

I also hypothesized that reading time of relevant segments for participants in the high self-regulatory group would be significantly shorter than reading time of participants in the low self-regulatory group. This finding was not borne out in the current study. The interaction between self-regulatory grouping and reading time of information was not significant. Effectively, this means there was no statistical significance in the length of time it took participants in the high versus medium versus low level of self-regulatory ability to read Pitcairn sentences. Previous literature has not shown this finding. McCrudden and Schraw (2010) found that when comparing the higher to lower levels of
verbal ability, those with higher verbal ability showed times being significantly different than those with lower verbal ability. Kaakinen et al., (2002) found that participants with higher levels of working memory span spent more time on relevant information when reading it for the first time while those with lower levels spent more time on relevant information only after coming back to that information. Kaakinen et al. (2003) determined high working memory span readers read text they had prior knowledge of faster than text in which they had no prior knowledge.

**Verbal Ability**

The second goal of this study was to replicate McCrudden and Schraw’s (2010) study in which they determine that high or low verbal ability has a statistical impact on a reader’s recall and reading time of relevant information and that verbal ability makes an independent contribution to recall and reading time of the passage. The findings of the current study demonstrate that relevant information has a higher level of recall, takes less time to read, and demonstrates that verbal ability has an impact on relevancy instructions.

**Recall and Reading Time.** This study showed that all participants in the study recalled the relevant information (Pitcairn) more than non-relevant and that the treatment group recalled 10 times more relevant sentences than non-relevant. This is consistent with previous literature in which DiVesta and DiCintio (1997), Kaakinen et al. (2002, 2003), and McCrudden and Schraw (2010) found differences when comparing low and high levels of the individual difference they were examining.

As a main effect, this study showed that all participants in the study read the Pitcairn sentences faster than those of the other countries while the interaction between treatment and segment showed the control group read the Pitcairn sentences statistically
faster than those of the other three countries (Goetz et al., 1983; Kaakin et al., 2002, 2003; McCrudden & Schraw, 2010). Of special interest to the relevance intervention, the treatment group took no longer to read relevant sentences than the control group, but recalled 10 times more relevant information.

In addition, the verbal ability measure was found to have an impact on recall of all sentences. Readers with high verbal ability recalled more of all sentence types (both relevant and non-relevant) than readers with low verbal ability. This is consistent with the findings of McCrudden and Shraw (2010) and Kaakinen et al. (2002, 2003), who found higher levels of individual differences beneficial within the context of relevancy.

Conclusions

There are two general conclusions that can be drawn from this study. The first is that relevance instructions result in increased recall and focused reading times for relevant information when compared to the control group. Previous literature has shown consistent findings in this regard (Di Vesta & Di Cintio, 1997; Goetz et al., 1983; Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010; Pichert & Anderson, 1977; Schraw & Dennison, 1994; Schraw et al., 1993). This suggests that the relevancy effect is quite robust in nature. Due to the consistency of findings across 35 years and multiple researchers, it would seem that a preponderance of evidence has been reached regarding this aspect of the relevance literature.

Second, this study provides mixed evidence when examining individual differences. It does not provide evidence that a person’s level of self-regulatory ability has any significant impact on reading times or recall of relevant information. This means that participants with high, medium, or low levels of self-regulation do not vary in the
amount of recall or the length of time it takes to read relevant information. This study does provide a finding that high verbal ability readers recalled more information than low verbal ability readers. Previous literature has shown mixed results when examining recall of relevant information when taking into account individual differences. While the previous work of Kaakinen et al. (2002, 2003) examined individual differences in working memory span, their work centered on attention being focused on either a first pass of the material or a second pass of the material (2002) and background knowledge of a text (2003). While differences existed between levels of the individual construct being measured, those studies are not deemed similar enough to allow for comparison to the current study in regards to theoretical significance. However, DiVesta and DiCintio (1997), and McCrudden and Schraw (2010) have shown that when comparing the higher level of the individual difference to the lower level of the construct, the higher level of the construct has recalled statistically more relevant information. The mixed findings between the current study and established literature allow room within the theoretical community for clarity on the issue of individual differences and how they interact with the relevance effect. This issue leads to the theoretical contributions of this work.

**Theory and the Advancement of Knowledge**

**Contributions to Theory**

The current study contributes to educational theory in two ways. The first is in regards to the self-regulation measure. The use of this measure sought to extend the relevancy literature by examining whether a measure of self-regulation of working memory interference affected text processing separately or in combination with relevance instructions. The Stroop interference task used in this study was hypothesized to provide
an accurate measure of working memory efficiency rather than using working memory span as a proxy for efficiency (Daneman & Carpenter, 1980). The present findings suggest that a person’s level of self-regulation efficiency as measured by the Stroop task does not appear to have an impact on relevancy instructions, which is not consistent with Daneman and Carpenter’s (1980) argument that working more efficiently has an impact on functional use of working memory resources, presumably because it compensates for the small amount of information that can be stored there at a single instance in time.

The second theoretical contribution is in regards to the individual differences literature. This study showed that regardless of a person’s individual differences in verbal or self-regulatory ability, relevancy instructions have a significant impact on recall and reading time of information deemed relevant. The current findings further strengthen the theoretical perspective that relevancy instructions are effective regardless of any individual difference a reader brings to the academic situation.

**Advancement of Knowledge**

The findings of the current study are important in the advancement of knowledge in two ways. The first is that these findings highlight the robustness of the relevancy effect. While this is a fairly small body of literature to date (eight studies in the literature prior to this study), it has unanimously shown that using perspective relevancy instructions promote better recall (Pichert & Anderson, 1977; Goetz et al., 1983; Schraw et al., 1993; Schraw & Dennison, 1994; Kaakinen et al., 2002, 2003; Di Vesta & Di Cintio, 1997; McCrudden & Schraw, 2010) and increased reading times of information deemed relevant to readers’ assigned perspective for reading (Goetz et al., 1983;
Kaakinen et al., 2002, 2003; McCrudden & Schraw, 2010). These findings support the Goal-Focusing Model proposed by McCrudden and Schraw (2007). In this model, it was postulated that giving readers relevance instructions assists in establishing a specific goal which directs working memory resource allocation that guides reading/learning. The findings in the current study strengthen support for this model and assist in establishing a preponderance of evidence regarding the robust nature of relevancy instructions in a growing body of literature.

The second contribution to knowledge of these findings is that while self-regulatory ability did not provide contributions to the theory in explaining why relevancy instructions function as they do, it does add to the literature in an important way. This study provided a measure of understanding that self-regulation does not compensate for the relevancy effect in how it functions for a reader. This non-compensatory knowledge is equally as important as if it were a finding that supported compensatory knowledge. Understanding both negative and positive findings is important to further knowledge in this area and help one to understand the limitations of the present study.

**Limitations of the Present Study**

While this study made some important contributions to the literature, no study is without limitations. There are two potential limitations to this literature. The first may be that the Stroop task doesn’t provide an adequate measure of cognitive interference. This would have to allow for the possibility that cognitive interference does in fact play a part in explaining why relevancy effects function as they do, but was unable to be seen in this study. There is no reason to suspect that this is the case from the administration of this study, but the potential must be acknowledged.
Secondly, there may be the potential that, overall, the participants had higher levels of self-regulation than the population as a whole. Even though the participants normally distributed with regard to self-regulatory ability, when compared to the general population, these students may have generally higher levels of self-regulatory ability. It may be presumed that students enrolled in college courses, and self-reporting a mean grade point averages of 3.25 may not suffer detrimental effects of low self-regulatory ability. The educational implications of this work underscore this point.

**Educational Implications**

This study has two main practical educational implications. The first is that relevancy instructions appear to be impervious to a person’s level of self-regulation or verbal ability, as demonstrated in this study as well as McCrudden and Schraw (2010). Recall of relevant information and reading time of relevancy information appear to be equally assisted by relevancy instructions for those people who are high or low in their level of individual difference being measured. This is important because it means that instructors can use this equally effective instructional technique for all ability levels in their classrooms.

Secondly, relevancy instructions are an easy and effective strategy to implement in a classroom. With class sizes at all time highs, student ability levels varying greatly, and continued increased emphasis on student achievement scores, strategies that take little time to implement and increase student achievement are of particular importance. This strategy has implications from a teacher perspective well as a student perspective. From a student perspective, McCrudden and Schraw’s Goal-Focusing Model (2007) assists the student in focusing their attention on the most salient information in a reading
passage. This relevancy effect is beneficial for the student in terms of enhanced recall and shortened reading times of relevant information (McCrudden & Schraw, 2007). Because of enhanced information recall, it is plausible to postulate that relevance instructions may result in higher student achievement in the classroom. From an instructional perspective, teachers could learn to use perspective relevance instructions in a professional development session in a timely manner and integrate their success into the classroom quickly and efficiently. This leads to some directions for future research.

Directions for Future Research

While the work regarding the relevance effect appears to be pretty robust, it is by no means conclusive. There needs to be continued work to determine if, or indeed how, individual differences interact with the relevance effect. While the current study found no statistical significance with regard to self-regulation, it may be that utilizing a longer or more complex passage would allow potential SR effects to be seen. It is also possible other individual difference factors such as self-efficacy, how confident a person feels regarding the subject matter, or how interested a person is in the information may influence relevancy instructions. Human learning is a complex skill and more work needs to be done in these areas to continue to shed light on the impact of individual differences on the relevancy effect. Indeed, until the research community understands the underlying mechanisms at work to explain why the relevancy effect functions as it does, there can be no lasting theoretical insight into this issue. Therefore, continued work needs to be conducted to continue to explore the underlying mechanisms responsible for the effectiveness of perspective relevancy instructions.
Given the existing body of relevancy literature, future research in this area needs to branch out to other populations. The current body of research primarily investigates relevancy instructions as they relate to college students. However, relevancy instructions should be examined in other educational contexts. It would be beneficial to explore the depth of interaction with upper elementary students, middle school, and high school students. It may be that the self-regulatory skills of these populations will interact differently with relevancy instructions. It also may be the case that relevancy instructions function differently with these different populations. Given the current state of relevancy instruction research, it seems this body of research could benefit from exploration in all of the aforementioned areas.
DATE: April 27, 2011

TO: Dr. Gregory Schraw, Educational Psychology

FROM: Office of Research Integrity – Human Subjects

RE: Notification of review by Ms. Josi dos Santos, CIP

Protocol Title: Interactive Effects of Working Memory Self-Regulatory Ability and Relevance Instructions on Text Processing

Protocol # 1104-3794M

This memorandum is notification that the project referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)2.

PLEASE NOTE:
Upon Approval, the research team is responsible for conducting the research as stated in the exempt application reviewed by the ORI – HS and/or the IRB which shall include using the most recently submitted Informed Consent/Assent Forms (Information Sheet) and recruitment materials. The official versions of these forms are indicated by footer which contains the date exempted.

Any changes to the application may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a Modification Form. When the above-referenced project has been completed, please submit a Continuing Review/Progress Completion report to notify ORI – HS of its closure.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.
Appendix B

INFORMED CONSENT
Department of Educational Psychology

TITLE OF STUDY: The Relationship of Relevance Instructions and Working Memory Efficiency on Text Processing
INVESTIGATOR(S): Gregg Schraw, Nancy Hamilton
CONTACT PHONE NUMBER: 702-371-3143

Purpose of the Study
You are invited to participate in a research study. The purpose of this study is to understand how a student’s working memory functional efficiency impacts recall and reading time when relevance instructions are either present or not.

Participants
You are being asked to participate in the study because you are an undergraduate student enrolled in EPY 303 (Introduction to Educational Psychology) or EPY 451 (Introduction to Classroom Assessment) in the Educational Psychology Department.

Procedures
If you volunteer to participate in this study, you will be asked to do the following: Complete a computerized version of a task interference program called the Stroop Task, read a passage, complete a short demographics questionnaire, and complete a free recall of information from the reading passage.

Benefits of Participation
There may not be direct benefits to you as a participant in this study. There are few direct benefits to the research subjects from participation in this study. We hope to learn better, more effective reading strategies to assist you, and future students you teach.

Risks of Participation
There are risks involved in all research studies. The risks to you due to participation in this study are minimal.

Cost/Compensation
There will not be financial cost to you to participate in this study. The study will take one (1) hour of your time and be completed in a one hour time block. You will be
compensated for your time in the form of one research credit towards your EPY303 or EPY451 research requirement.

**Contact Information**

If you have any questions or concerns about the study, you may contact Nancy Hamilton at 371-3143. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact the UNLV Office for the Protection of Research Subjects at 702-895-2794.

**Voluntary Participation**

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study by contacting either of the researchers.

**Confidentiality**

All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for three (3) years after completion of the study. After the storage time the information gathered will be shredded (hardcopies) or deleted (electronic data).

**Participant Consent:**

I have read the above information and

agree to participate in this study. □

do NOT agree to participate in this study. □

Participant Name (Please Type)
Appendix C

Instructions for Passage Reading

Relevance Instructions for Treatment Group:

The following text introduces four remote countries: Pitcairn, Anguilla, Andorra, and Honduras. Imagine that you are a research scientist and you are about to leave for Pitcairn to conduct research. It is likely that your stay in this remote country will last for several years and that you need to live in Pitcairn permanently for that time. Read the following text so that you can decide what good sides and what bad sides there are in your new home country—conditions that probably make you enjoy your stay or alternatively make you suffer. To review: What good and what bad sides are there in Pitcairn as your new home country? Please read the passage at a comfortable pace for you, to click the space bar to progress to the next sentence, and you will not be able to return to portions of the text once you have clicked past them.

(Adapted from Kaakinen et al., 2002)

Instructions for Control Group:

The following text introduces four remote countries: Pitcairn, Anguilla, Andorra, and Honduras. Read the following text so that you can remember as much information as possible about the four countries. Please read the passage at a comfortable pace for you, to click the space bar to progress to the next sentence, and you will not be able to return to portions of the text once you have clicked past them.
Appendix D

A REMOTE PLACE IN THE WORLD

All around the world, there are small, remote countries that few people have even
heard of. These small countries live their own quiet life in the shadow of larger
countries. Among these lesser known countries, there are some very interesting
countries with colorful characteristics and history. In the following text, four such
countries are introduced: Honduras, Andorra, Anguilla and Pitcairn.

Location and Geography

Anguilla is one of the several islands located between the Caribbean Sea and the
Atlantic Ocean, east of Puerto Rico. Its name means “Eel Island” and it is also
called “Snake Island” because of its long and narrow shape. The entire island is
flat: the highest point is only 200 feet above the sea level. The southern shore is
surrounded by a coral reef, and the island has several magnificent beaches covered
with white sand. Pitcairn, on the other hand, is located in the middle of the Pacific
Ocean over 3,000 miles from New-Zealand. Pitcairn is a volcano by origin, and
it rises more than 1,400 feet above sea level. The overall area of Pitcairn is only
about three square miles.

Andorra is a small mountainous country located in the eastern Pyrenees
mountains
between France and Spain. Its landscape consists of rugged mountain
tops and deep gorges and valleys. Honduras is located in Central America and is
also mostly mountainous. However, its north shore, which faces the Caribbean
Sea, and its south shore, which faces the Pacific Ocean, are surrounded by lowland.
In the lowland, the typical type of vegetation is rainforest, whereas the
mountains are mostly covered with alpine trees.

Climate

In Anguilla, the yearly rainfall is small, and the climate is extremely hot and dry.
Pitcairn’s yearly precipitation, on the other hand, is high, about 79 inches. Pitcairn’s
climate is mild and the average temperature is around 68 degrees Fahrenheit.
Andorra’s climate also is characterized by ample precipitation throughout
the year. The yearly rainfall can even exceed 79 inches. In the winter, this leads
to a long-lasting snow cover, and many of the mountain passes between Andorra
and France can be cut off by snow.

The climate in Honduras varies considerably in different parts of the
country. On the coast, it rains a lot, and dangerous hurricanes appear frequently.
The temperature is well above 68 degrees Fahrenheit. In the mountains, the precipitation
is much less and temperature is much lower than in the coastal area.

History
In 1790, rebels of the British warship Bounty settled in Pitcairn with 12 Tahitian women who had accompanied them onboard. The island was so remote that another European ship did not pass by it for 18 years. Until 1969 Anguilla belonged to the autonomous state of Saint Kitts-Nevis-Anguilla. The people of Anguilla rose against the government and declared independence. As a result of this, British paratroops and policemen occupied the island, and it was subdued under the British crown.

Columbus sailed to the shore of Honduras in 1502. The country was then a part of the Maya-Aztec realm. Later the country was conquered by the Spaniards, against whom the native inhabitants constantly rebelled. The country obtained its independence in 1838. Andorra, on the other hand, has been independent since about 800 A.D.

Government

Andorra is a monarchy with a prince or princess, which has maintained its independence mostly because the remote upper valleys of the Pyrenees have very little strategic or economic significance. The Spanish bishop of Urgel and the president of France jointly secure the territorial integrity of Andorra. The legislative power in Andorra is held by the 28-member parliament. Honduras, on the other hand, is a republic with a president. The political situation in Honduras has been considerably more peaceful than in the other Central-American countries, although it has experienced 139 rebellions. Anguilla is a British colony. Pitcairn also constitutes a British colony, which has autonomous status.

Economy

Most inhabitants of Andorra do not pay taxes at all. The state revenue consists of tourism, export of electricity, and publication of postal stamps. This small principality is also planning to strengthen its banking business to speed up its development as a tax haven. The economy of Honduras is based entirely on its production of coffee and bananas. The country’s economy is fully dependent on the price fluctuation of these products.

Due to its extremely dry climate and its sparse soil, it is almost impossible to farm in Anguilla. The income of the islanders is totally dependent on tourism and British subsidies. Individuals and private business are not taxed at all in the island.

Pitcairn’s population, on the other hand, earns its living from cattle, fishing, and agriculture. Sweet potatoes, sugar-cane and a variety of fruits and vegetables are grown on the island.

Transportation

Anguilla has an airport, which serves regular flights to neighboring islands and to the U.S. Pitcairn does not have such good connections. There is no airport or harbor on the island. The only way to get to Pitcairn is by taking a boat from
Tahiti to its surrounding waters and then by rowing to the island, provided that the weather is good. Due to its bad connections, all mail to the island takes about 6 months.

Andorra does not have an airport or railways. All traffic is routed to the main highway which passes through the country. Honduras is still developing a ground transportation system. The road network is sparse, and the roads look more like cart tracks. Compared to the poor ground transportation system, air traffic in this mountainous country is fairly well developed.

Population and Language

The population of Honduras is 5.8 million and consists mostly of descendants from native inhabitants. Honduras is also somewhat of a melting pot for immigrants, as there is a sizeable European community in the country. The population increases at a rate of 3% per year. The official language of Honduras is Spanish, although Creole English and indigenous languages are spoken in the country as well. Spanish is also spoken in Andorra, although the country’s official language is Catalan. The population of Andorra is about 65,000. Population growth has approached 7 percent in some years due to immigration. To become a citizen of Andorra, the person needs to be a third-generation immigrant.

In Pitcairn, there are 60 inhabitants, all of whom live in a small village named Adamstown. The islanders are descendants of the British rebels who settled the island. The people of Pitcairn live in accordance with a set of fairly strict rules. For example, every inhabitant between 16 and 60 years of age has to take part in public service of some sort. The population of the island varies somewhat, because the youngsters need to move to another island to attend school. As a British colony, English is spoken in Pitcairn, which is also its official language. In Anguilla, which is larger than Pitcairn, there are some 6,800 people. The inhabitants are predominantly black. English is spoken in Anguilla too.

Note. The text to be read by participants does not include italics. To assist readers in the identification of relevant sentences, Pitcairn-relevant sentences have been italicized. This text has been adapted from materials from “Perspective Effects on Online Processing,” by J. K. Kaakinen, J. Hyönä, and J. M. Keenan, 2002, Discourse Processes, 33, 159-173.
Appendix E
Demographics Instrument

Participant ID: __________________________

Age: __________________

College Grade Point Average Currently: __________________________

Current Class Standing: Freshman
Sophomore
Junior
Senior
Other

Gender: Male
Female

Have you ever read this passage prior to today?
Yes
No

Please rate your level of knowledge of Pitcairn prior to reading this passage:

1  2  3  4  5
(very little knowledge)  (a great deal of knowledge)

or no knowledge)
Appendix F

Free Recall Measure

Directions:

In the space below, please type everything you can remember from the reading passage. Please take your time and be thorough, making sure to include as many main ideas and details as possible.
Appendix G

Verbal Ability Vocabulary Measure

VOCABULARY TEST -- VA

This is a test of your knowledge of word meanings. Look at the sample below. One of the five numbered words has the same meaning or nearly the same meaning as the word above the numbered words. Mark your answer on YOUR ANSWER SHEET by circling the number in front of the word that you select.

jovial
1-refreshing
2-scar
3-thickset
4-wise
5-jolly

The answer to the sample item is number 5; therefore, a circle would be put around number 5 ON YOUR ANSWER SHEET.

Your score will be the number marked correctly. There is no penalty for guessing. Try to answer every question.

You will have 10 minutes for this test. When you have finished STOP. Do not go on until you are asked to do so.

MAKE NO MARKS ON THE QUESTION FORM

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

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REPRODUCED UNDER LICENSE
1. mumble
   1-speak indistinctly
   2-complain
   3-handle awkwardly
   4-fall over something
   5-tear apart

2. perspire
   1-struggle
   2-sweat
   3-happen
   4-penetrate
   5-submit

3. gush
   1-giggle
   2-spout
   3-sprinkle
   4-hurry
   5-cry

4. massive
   1-strong and muscular
   2-thickly populated
   3-ugly and awkward
   4-huge and solid
   5-everlasting

5. feign
   1-pretend
   2-prefer
   3-wear
   4-be cautious
   5-surrender

6. unwary
   1-unusual
   2-deserted
   3-lincautious
   4-sudden
   5-tireless

7. veer
   1-change direction
   2-hesitate
   3-catch sight of
   4-cover with a thin layer
   5-slide

8. orthodox
   1-conventional
   2-straight
   3-surgical
   4-right-angled
   5-religious

9. stripuling
   1-stream
   2-narrow path
   3-analnaging
   4-lad
   5-beginner

10. salubrious
   1-mirthful
   2-indecet
   3-salty
   4-mournful
   5-healthful

11. limpid
   1-lazy
   2-crippled
   3-clear
   4-hot
   5-slippery

12. procreate
   1-sketch
   2-inhabit
   3-imitate
   4-beget
   5-encourage

13. replete
   1-full
   2-elderly
   3-resentful
   4-discredited
   5-restful

14. frieze
   1-fringe of curls on the forehead
   2-statue
   3-ornamental band
   4-embroidery
   5-sherbet

15. treacle
   1-sewing machine
   2-framework
   3-lease
   4-apple butter
   5-molasses

16. ignominious
   1-inflammable
   2-alike
   3-unintelligent
   4-disgraceful
   5-mysterious

17. abjure
   1-make certain
   2-arrest
   3-renounce
   4-abuse
   5-lose

18. duress
   1-period of time
   2-distaste
   3-courage
   4-hardness
   5-compulsion

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19. bayonet
   1-small tent
   2-basket
   3-helmet
   4-sharp weapon
   5-short gun

20. astound
   1-scold severely
   2-make angry
   3-surprise greatly
   4-drive out
   5-ascertain

21. contamination
   1-contradiction
   2-contempt
   3-warning
   4-pollution
   5-continuation

22. amplify
   1-electrify
   2-expand
   3-cut off
   4-signify
   5-supply

23. mural
   pertaining to
   1-growth
   2-manners
   3-the eyes
   4-war
   5-a wall

24. hale
   1-glad
   2-fortunate
   3-tall
   4-robust
   5-ready

25. meander
   1-marvel
   2-predict
   3-slope
   4-forget
   5-wind

26. burnish
   1-polish
   2-wave
   3-dye
   4-heat
   5-consume

27. duplicity
   1-extent
   2-double-dealing
   3-agreement
   4-claverness
   5-overlapping

28. mundane
   1-worldly
   2-obstinate
   3-deafening
   4-servile
   5-penniless

29. deleterious
   1-injurious
   2-hysterical
   3-critical
   4-slow
   5-thinned out

30. nascent
   1-colorful
   2-broad
   3-unpleasant
   4-floating
   5-beginning

31. prolific
   1-freely
   2-reproductive
   3-prehistoric
   4-talented
   5-temperamental
   6-frivolous

32. paroxysm
   1-bleach
   2-disaster
   3-storm
   4-fit
   5-revolution

33. antipodal
   1-outmoded
   2-slanted
   3-melodious
   4-opposite
   5-four-footed

34. acrimony
   1-promptness
   2-boredom
   3-divorce
   4-stupidity
   5-bitterness

35. lissome
   1-lonely
   2-young
   3-dreamy
   4-supple
   5-dainty

36. succinct
   1-sudden
   2-concise
   3-prosperous
   4-literary
   5-cunning

DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

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