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Enhancing memory access for less-skilled readers

Emily R. Smith

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ENHANCING MEMORY ACCESS FOR LESS-SKILLED READERS

BY

EMILY R SMITH

B.A., Southern New Hampshire University, 2008

M.A., University of New Hampshire, 2010

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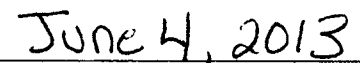
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David B. Pillemer,
Professor of Psychology

Jill McGaughy,
Associate Professor of Psychology

Anne E. Cook,
Associate Professor Educational Psychology,
The University of Utah

Karla A. Lassonde,
Assistant Professor of Psychology,
Minnesota State University, Mankato

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ABSTRACT

ENHANCING MEMORY ACCESS

FOR LESS-SKILLED READERS

By

Emily R Smith

University of New Hampshire, September, 2013

Ericcson and Kintch (1995) suggested that less-skilled readers often have an impoverished representation of text. The results of five experiments demonstrated that the addition of causality enhanced the text representation of less-skilled readers. Experiments 1-3 showed that the addition of causal information enhanced less-skilled readers' ability to detect global inconsistencies. Experiments 4 and 5 showed that the addition of causal information to updating information resulted in less-skilled readers updating to the same extent as skilled readers.

INTRODUCTION

Good comprehension involves the reader being able to engage in processes that

allow a continual integration of incoming information with what came before. When a

reader is skilled at these processes the result is a coherent representation in memory that

reflects the author's intended message, theme, and ideas. In contrast, when readers are

less skilled at these processes they fail to completely execute some of these processes,

resulting in poorer comprehension. An important goal for any theory of comprehension is

to identify the cognitive processes that underlie the differences between skilled and less-

skilled readers; and to the extent that those cognitive processes are malleable, to develop

interventions that will improve less-skilled readers' comprehension.

There have been a number of cognitive functions that have been shown to be

related to lower reading skill, such as limited working memory capacity (e.g., Baddeley,

Gathercole, & Papagno, 1998; Engle, 2002), the inability to suppress irrelevant

information (e.g., Gernsbacher, 1993), and a general lack of domain knowledge to build a

coherent representation (e.g., McNamara, 1997; McNamara & McDaniel, 2004).

However, the one factor that clearly distinguishes skilled from less-skilled readers is less-

skilled readers' inability to construct a memory representation that is both coherent and

readily retrievable.

The primary characteristic that defines a coherent representation is one that

contains a rich set of interconnections among the ideas presented in a text. Many of these

interconnections are both causal in nature and need to be provided by the reader (i.e., they

are only implicitly presented in the text). Thus, one factor that may mitigate the

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impoverished representation that less-skilled readers tend to construct would be to explicitly state implicit causal connections, thereby explicitly creating many of the interconnections that are missed by less-skilled readers. The goal of the present set of experiments is to assess whether explicitly providing less-skilled readers with a rich set of causal relations will allow them to overcome comprehension deficits relative to skilled readers.

In Chapter 1 I will describe models of reading comprehension that lay the groundwork for current theories of text comprehension. I will also review current models and views such as the construction-integration model and the memory-based view of reading comprehension. In Chapter 2 I will describe how a reader maintains comprehension through the updating process, and how causality can assist in this process. In Chapter 3 I will provide a brief overview of the literature on the interaction of working memory capacity, long-term memory organization, and their influence on higher order cognitive process, such as reading skill. In Chapter 4 I will describe how causality can be used as a text based intervention to aid less-skilled readers in integration and updating. Chapter 5 will contain five Experiments to test causality as a text-based intervention followed by a general discussion.

CHAPTER I

MODELS OF READING COMPREHENSION

Text-based Representations

Kintsch and van Dijk (1978) developed a processing model based on propositions to describe text comprehension. Text is represented as a series of connected propositions. Each proposition represents one idea unit. Propositions are connected based on argument overlap; two propositions are considered coherent if they share an argument. Because of a limited working memory capacity, the reader continually holds a small number of propositions at any given time. Kintsch and van Dijk proposed a buffer model in which text is processed in cycles with a limited amount of information encoded and maintained over the cycles. To construct a memory representation, the subset of propositions related to the overall gist of the text remains in working memory. These propositions provide connections for propositions entering on the next cycle.

The propositions in working memory are directly related to comprehension. Kintsch and van Dijk (1978) proposed the leading edge strategy in order to determine which propositions are retained in working memory so that the reader can integrate previously read information with what they are currently reading. The text is represented as a series of hierarchically connected propositions in which importance is reflected by height in the hierarchy. Propositions are held in working memory based on importance and recency in order to maximize the likelihood that propositions encoded on each cycle

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connect with those in working memory. If the reader cannot connect what they are currently reading with propositions in working memory than a coherence break occurs. If a coherence break occurs the reader has two possible options. First the reader can reestablish coherence by searching early portions of the text for necessary propositions (a. reinstatement search, McKoon & Ratcliff, 1980; O'Brien, Duffy, & Myers, 1986). Second, if the exhaustive search fails the reader can maintain coherence by activation of a bridging inference. However, Kintsch and van Dijk assumed this necessary inference will only be made if the exhaustive search failed.

Causal Models

Early causal models broke text down as idea units and connected the idea units on a basis of causal relations (e.g., Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985; Trabasso, van den Broek, & Suh, 1989). There are two major differences between these models and Kintsch and van Dijk (1978). The first is that connections are made based on causal relations rather than argument overlap. The second is that an idea unit can be connected to many other idea units if they share causal relations. This second difference results in a representation that forms an integrated network, where any idea has the potential to be connected to any other idea. There was initially considerable evidence in support of this view (e.g., Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985; Trabasso et al., 1989). However, an assumption of a causal network representation view was that a reader made all possible connections. Such a representation would be impossible for a reader to construct because they could not possibly hold that amount of information in active memory at any given time. Thus, what this representation system

was missing was a process model to limit and constrain the number of causal connections a reader will form.

Fletcher and Bloom (1988) proposed the current-state selection strategy in an attempt to unite Kintsch and van Dijk (1978) and Trabasso & Sperry's (1985) models of text comprehension. Within the current-state selection strategy both text representations and causal connections are necessary to maintain coherence. When selecting propositions to remain in working memory, causality could be one method, however this is done within the limits of working memory. Text is processed in cycles in working memory and the most useful proposition in the causal network might be held in working memory. Within the current-state strategy the reader retains the most recently encountered event until an anaphor is encountered.

None of the early text processing models assumed that readers made elaborate inferences or fully considered the role of general world knowledge in comprehension. Like Kintsch and van Dijk (1978)'s model, Fletcher and Bloom (1988) recognized the processes involved at a text-based level but also recognized that processes are possible at a global level (what is currently being read and general world knowledge), though only if it is necessary for comprehension. However, they failed to provide a processing model for how inferences become activated.

Focus Models

According Sanford and Garrod's (1981) focus theory, readers focus their attention on information about the protagonist and the situation the protagonist is in. In order to maintain this information in focus, Sanford and Garrod proposed a model that included both explicit and implicit focus. Explicit focus included information currently in working

memory while implicit focus included what was not directly in focus but related to the context in working memory. For example, the protagonist would be in explicit focus while scenario based information such as specific characteristics of the protagonist would be in implicit focus. Together explicit focus and implicit focus represented the readers current representation of the text. The number of items that can remain in explicit focus is limited; however, implicit focus is unlimited. Information in explicit focus can be connected to implicit through discourse pointers in a process like resonance theory (e.g., Myers & O'Brien, 1998; O'Brien & Myers, 1999). Unlike resonance, in which concepts become active based on featureal overlap, discourse pointers should direct readers to only what is relevant.

Cook, Halleran, and O'Brien (1998) showed that direct links based on only relevance between explicit and implicit focus could not be assumed. See the sample passage in Table 1. In the experiment, a protagonist (Ken) was introduced followed by a description that was consistent, inconsistent, or neutral with a target sentence that appeared later (e.g., "Ken was taking boxing classes"). For the inconsistent condition, Ken was described as being un-athletic and weak. The description was backgrounded with a filler section and the target sentence was presented. There was a slowdown in reading because the information about Ken in the target sentence served as a signal to reactivate the inconsistent description from earlier in the text. An assumption of the focus model was that there is a direct link from the recent description of Ken to the backgrounded description. According to the resonance model, all backgrounded information can be linked but featural overlap determines activation. In a second experiment, Cook et al. (1998) introduced a second character (Mike). The same

Table 1.
Sample passage from Cook, Halleran, and O'Brien (1998)

Introduction:
Ken and his friend Mike had been looking for summer hobbies for quite some time. They were both college professors and they had the summers off from teaching. This meant that they both had plenty of time to try new things.

First-character consistent elaboration:
Ken was a big man and always tried to keep in shape by jogging and lifting weights. His 250-pound body was solid muscle. Ken loved tough physical contact sports which allowed him to match his strength against another person.

First-character inconsistent elaboration:
Ken was a small man and didn't worry about staying in shape. His small 120-pound body was all skin and bones. Ken hated contact sports, but enjoyed non-contact sports, such as golf and bowling which he could practice alone.

Second-character consistent elaboration:
Mike was a big man and always tried to keep in shape by jogging and lifting weights. His 250-pound body was solid muscle. Mike loved tough physical contact sports which allowed him to match his strength against another person.

Second-character inconsistent elaboration:
Mike was a small man and didn't worry about staying in shape. His small 120-pound body was all skin and bones. Mike hated contact sports, but enjoyed non-contact sports, such as golf and bowling which he could practice alone.

Background:
While walking downtown during their lunch break one day, Ken and Mike passed a new gymnasium. They noticed the display in the window. It was an advertisement for the gym's summer sports program. They started looking at the advertisement and were impressed with the long list of activities that the gym sponsored. As they continued to look over the list, they became very excited. It seemed interesting so Ken and Mike went inside.

Critical sentence:
Ken decided to enroll in boxing classes.

Closing:
He felt this would be the perfect hobby.

---

description of un-athletic and weak was used to describe Mike. The target sentence remained the same (e.g., "Ken was taking boxing classes.") If there is a direct link then when the reader encountered the target sentence there would not be a disruption because the information was consistent with Ken. According to the resonance, model, which is "dumb" and unrestricted, past information about Mike became available due to featural overlap and there will be a disruption. There was a slowdown in reading time, which is inconsistent with a direct link focus model.

Early models of reading comprehension focused on how readers construct representations of the text itself (e.g., Kintsch and van Dijk, 1978; Trabasso and Sperry, 1985). A major limitation of these models was that they did not fully explain how general world knowledge contributed to the comprehension process. New theories began to develop to explain how readers use general world knowledge to comprehend text.

Situation Model

Whereas the earlier discussed models tend to focus on a representation of the text itself, the situation model is a representation of what the text is about. The situation model includes not only information explicitly stated in the text but also the reader's general world knowledge, such as bridging inferences or elaborative inferences. There are five dimensions that can be mapped onto the situation model: time, space, causality, motivation, and protagonist (e.g., Zwann, Langston, & Graesser, 1995; Zwann & Radvansky, 1998). An assumption of the situation model view is that the situation can be thought of as a "snapshot." The situation that is currently in focus holds a higher level of accessibility. When a dimension changes, such as a protagonist moving to a new location, the situation model updates to account for the new spatial location. The "snapshot" of the

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situation now contains the new spatial information while the old spatial information becomes less accessible.

An example of the role of the situation model was demonstrated by Glenberg, Meyer, and Lindem (1987). See the sample passage in Table 2. Glenberg et al. produced passages that introduced a protagonist (John). The protagonist was either associated with a particular object (e.g., "he put on his *sweatshirt*") or disassociated with a particular object (e.g., "he took off his *sweatshirt*"). After several sentences of filler to background information, the participants were given a recognition task to which they responded "yes" or "no" whether the target object was mentioned previously. If the reader only developed a representation of the text itself then the target object would be dropped from active memory independent of whether the protagonist was wearing it or not. In contrast, when the level of representation of the situation model is considered, the reader carried the protagonist in the foreground and any object associated with the protagonist would be maintained in the foreground. Glenberg et al. (1987) found participants were faster when objects were associated with the protagonist than when they were disassociated with the protagonist. The two conditions were similar in references to the protagonist and the object. If the reader was simply focused on the text itself, then there would not be a difference in response time for the two conditions. The results provided evidence that the reader maintained some sort of mental representation of what the text was about. Cook, Gueraud, Was, and O'Brien (2007) extended the findings of Glenberg at el. (1987). One problem with Glenberg at al.'s study was that there was only activation of the associated object after one-intervening sentence. There was not significant activation after two sentences. Cook et al. argued that after one sentence, associated objects may be

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Table 2.
Sample passage from Glenberg, Meyer, and Lindem (1987)

Setting sentence:
John was preparing for a marathon in August.

Critical (associated):
After doing a few warm-up exercises, he put on his sweatshirt and went jogging.

Critical (dissociated):
After doing a few warm-up exercises, he took off his sweatshirt and went jogging.

Filler:
He jogged halfway around the lake without too much difficulty. Further along his rout,
however, John's muscles began to ache.

---

more available to the reader (i.e. activated) but that activation may decay rapidly. However, the associated information may still be more accessible, just not active. To test this idea, Cook et al. used several methodologies to measure activation and accessibility of protagonist-associated and protagonist-disassociated objects.

In Experiment 1 a protagonist, Dorothy was described as either bringing her skates to the park or not. After several sentences of backgrounding information, participants encountered a target sentence that was inconsistent ("Dorothy eagerly put on her skates") or consistent ("Dorothy wished she had a pair of skates") with the dissociated description. Overall, reading times were slower for the inconsistent conditions than consistent, regardless of whether it was the protagonist-associated or dissociated condition. Interestingly, the inconsistency effect was larger when the object was associated with the protagonist than when it was disassociated. The results provided evidence for greater accessibility of objects associated with the protagonist.

In a subsequent naming time experiment Cook et al. (2007) measured activation of objects associated, dissociated, or neutral with the protagonist. In all conditions the object was less available after the filler section than the elaboration section. The results indicated that the increased availability that Glenberg et al. (1987) found may be short lived. Overall, objects associated with the protagonist may be more accessible, leading to integration advantages, rather than more available, or active in working memory.

Construction-Integration Model

Kintsch's (1988, 1998) C-I model consists of two major processes: construction and integration. In the construction phase when a word is read, it quickly activates all associated words through word-based priming. For example if an individual reads "bug"

other related insects will become activated as well as other meanings of the word, such as a spy device. Activation continuously cycles and reverberates in the network accentuating activation of some concept while activation of other concepts is reduced. Appropriate meanings become part of the text representation and inappropriate words are "pruned" away. This cyclical process is the integration phase. Once words and concepts are integrated they can enter long-term memory as a network of associations that can later be activated.

Evidence for the timeframe of the construction and integration phases consists of experiments measuring activation of ambiguous words (e.g., Kintsch & Mross, 1985; Swinney & Hakes, 1976). For example when an individual reads the word "bug" all associated words, even if they are irrelevant, enter working memory. This construction process is rapid. However, after about 250 milliseconds only the context appropriate meaning of the word is activated. During the integration phase all meanings of the word are compared to the context of what is being read and appropriate meanings are connected while the inappropriate meaning decays (see also Myers & Cook, 2004).

Memory-Based text processing View and the Resonance Model

During reading comprehension each time a reader encodes new information; this information sends a signal to all memory. Anything that resonates sufficiently will enter working memory (e.g., Gillund & Shiffrin, 1984; Hintzman 1986; Ratcliff, 1978). According to Ratcliff (1978), resonance is best described by a tuning fork metaphor. Once the tuning fork is struck it sends out a specific frequency, and other tuning forks with the same frequency will resonate in response. The greater the amplitude, the better the match will be. The smaller the amplitude the lesser the match will be. Similar to the

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tuning fork analogy, when a reader encodes a concept it sends a signal to all of memory and concepts with features in common, instead of frequencies, will resonate in response. The most related items resonate most and the search ends when there is a match, or complete lack of match. Cognitive performance on recognition tasks are based on this process and may be affected by distracters and non-matches in memory.

The resonance process shares features in common with Kintsch's (1988) C-I model. In the construction phase, the reader develops a network of associated concepts from the text and general world knowledge. The reader does this through a passive fast-acting process much like resonance. The representation that was then constructed could contain irrelevant or contradictory material. It is during the integration phase that the reader must deal with the information that has been activated.

O'Brien and Myers (1999) developed a variation of the resonance model, as it applies to activation of information during reading (e.g., Myers & O'Brien, 1998). There are several assumptions of the resonance model. The process is unrestrictive, passive and "dumb." The process is unrestrictive in that signals are constantly being sent out to all of memory from previously read text to general world knowledge. Concepts with any degree of overlap of semantic and contextual features will resonate, or becomes active, in working memory. The process is passive in that the reader is not in control of the initial signal that is sent out. That the process is "dumb" means that whatever resonates most will enter working memory regardless of influence on processing or comprehension. The memory-based view has a strong bottom-up emphasis. Resonance allows working memory access to information in long-term memory and general world knowledge.

Concepts and propositions from the text serve as signals to all of memory and the degree to which items in memory resonate is a function of featural overlap. The items that enter working memory then can become signals to other items in memory. However, the signal is not first sent to active memory and then long-term memory; it is sent to all memory in parallel. Therefore the resonance process will continue even without a coherence break. There is a significant amount of evidence that readers are in fact sensitive to global inconsistencies in absence of a coherence break (e.g., Albrecht & Myers, 1995; 1998, Albrecht & O'Brien, 1993; Cook et al., 1998; Hakala & O'Brien, 1995; O'Brien, Rizzella, Albrecht, & Halleran, 1998).

For example, reading a contradiction would cause a slowdown in reading time if the currently read information resulted in co-activation of previously read information (e.g., Albrecht & O'Brien, 1993; Cook et al., 1998; O'Brien et al., 1998). A local coherence break might result in the activation of long-term memory to resolve the break in coherence; however long-term memory can also become reactivated even when there is not a break in local coherence. Albrecht and O'Brien (1993) described a protagonist (e.g., "Mary was a strict vegetarian"). See the sample passage in Table 3. The description was backgrounded, though the protagonist remained in focus. The target sentence (e.g., "Mary ordered a cheeseburger and fries") was consistent, inconsistent, or neutral with the description. The text was locally coherent, but reading times were still disrupted in the inconsistent condition. According to the resonance model, when the reader encountered the target sentence it sent a signal to all of memory about the character, and her eating habits resonated in response. The slowdown in reading of the target sentence is the result of problems during subsequent integration.

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Table 3.
Sample passage from Albrecht and O'Brien (1993)

Introduction:
Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent Elaboration:
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.

Inconsistent Elaboration:
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, had been a strict vegetarian for 10 years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything that was fried or cooked in grease.

Neutral Elaboration:
This was Mary's favorite restaurant because it has a nice quiet atmosphere. Mary frequently ate at the restaurant and had recommended it to all of her friends. She especially liked the cute tables and the country style cloths on them. It made her feel right at home.

Filler:
After about 10 minutes, Mary's friend Joan arrived. It had been a few months since they had seen each other. Because of this Mary and Joan had a lot to talk about and chatted for over a half hour. Finally, the signaled the waiter to come take their orders. They checked the menu one more time. Mary and Joan had a hard time deciding what to have for lunch.

Critical Sentences:
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Closing:
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat. They didn't realize there was so much for them to catch up on.

O'Brien et al. (1998) provided even stronger evidence that the resonance process is unrestricted and "dumb." O'Brien et al. added a qualified elaboration section in which Mary is described as not being a vegetarian anymore. Still readers were disrupted in the inconsistent condition. Since the resonance process is "dumb," information that shares features in common with Mary's eating habits still resonate, even though it might not be correct. Cook et al. (1998) extended the findings by adding a condition in which the inconsistent eating habits was applied to a second character, Joan. However, when readers encountered the target sentence that Mary ordered a cheeseburger there was still a slowdown in reading.

CHAPTER II

UPDATING AND CAUSALITY

Integrating new information during reading results in the updating of the

emerging discourse representation. That readers continually update their discourse

representation is an uncontroversial component of most theories of reading

comprehension (e.g., Gerrig & McKoon, 1998; Gerrig & O'Brien, 2005; Graesser,

Singer, & Trabasso, 1994; Magliano, Trabasso, & Graesser, 1999; Magliano, Zwaan, &

Graesser, 1998; O'Brien & Myers, 1999; Zwaan & Radvansky, 1998). Updating involves

the discounting, changing, or outdating of previously read information; however because

outdated information still resides in memory it can be reactivated and disrupt

comprehension (e.g., O'Brien & Myers, 1999; Zwaan & Radvansky, 1998). For example,

O'Brien et al. (1998) demonstrated that readers were influenced by their initial models of

story characters despite subsequent information refuting those models. In their studies,

participants read an initial description of a character (e.g., "Mary, a health nut, had been a

strict vegetarian for ten years") followed by information that served to outdate that

information (e.g., "Nevertheless, Mary never stuck to her diet when she dined out with

friends"). Even though the initial character information had been outdated, readers

continued to experience comprehension difficulty when the character engaged in an

action that was inconsistent with the initial character information (e.g., "Mary ordered a

cheeseburger and fries").

However, Guéraud, Harmon and Peracchi (2005) found that increasing the amount of updating information eliminated the disrupting impact of outdated information on the comprehension process, even though the outdated information continued to be reactivated Guéraud et al. used the O'Brien et al. (1998) passages and manipulated the amount of information about the protagonist as well as the order of the information presented. For example they provided three sentences about Mary being a vegetarian followed by three sentences elaborating that she was not anymore. When there was an equal amount of information, the target sentence ("Mary ordered a cheeseburger and fries") did not cause a coherence break. The additional consistent information may have allowed the reader to form a complete and accurate representation of the protagonist. Though, in the final experiment they demonstrated that the target sentence may not have disrupted comprehension, but the inconsistent information was still reactivated (for similar findings of reactivation without an impact on comprehension, see Cook et al., 1998; Guéraud & Tapiero, 2003; Long & Chong, 2001; O'Brien, Cook, & Guéraud, 2010). Further, Rapp and Kendeou (2007, 2009) had participants read stories that suggested that characters possessed particular traits (e.g., "Albert is messy."). This information was then outdated with either a simple refutation (e.g., "Albert cared about the condition of his room, even though it currently wasn't up to par.") or with an explanatory refutation for why the earlier inferred trait was incorrect (e.g., "Albert cared about the condition of his room, but had only moved into the apartment yesterday."). Following several sentences that served to background the outdated information, participants read one of two outcomes, either consistent or inconsistent with the trait. Rapp and Kendeou found that when information was outdated with a simple refutation,

the outdated information continued to disrupt comprehension of subsequent information. However, when information was outdated using an explanation, the impact of outdated information was eliminated.

Kendeou, Smith, and O'Brien (2013) argued that one of the reasons the impact of outdated information was eliminated was because readers were provided explanations, which often contain causal links. The causality resulted in a rich integrated network that would have competed for activation. Kendeou et al. adapted passages from O'Brien et al. (1998) and found that providing the reader with causal explanations also reduced the impact of outdated information. For example, participants read initial character descriptions of a protagonist that were either consistent with a target sentence, inconsistent, or contained a causal explanation for why the inconsistent information is no longer true (i.e. she wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat). See Table 4 for an example passage. The target sentence was read more slowly when it followed the inconsistent condition than when it followed either the consistent, or the causal-explanation condition. The results suggested that the outdated information no longer disrupted comprehension. In Experiment 2, a probe verification sentence was included (in the inconsistent and causal conditions) to explore the degree to which the outdated information remained available to the reader. Time to respond to a verification statement was faster when it followed the target sentence than when it preceded the target sentence, suggesting outdated information (vegetarian) was still available to the reader. However, in additional experiments when the causal explanation was increased to three sentences (i.e. She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat. She agreed to begin

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Table 4
Sample passage From Kendeou, Smith, and O'Brien (2013)

Introduction

Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent (Experiment 1)

This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.

Inconsistent (Experiment 1)

This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease.

Causal-Explanation (Experiment 1 &2)

Inconsistent condition plus: She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat.

Causal-Explanation Addition (Experiment 3)

She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat. She agreed to begin eating meat because it would solve her health issues. Her doctor assured her that her iron levels would soon return to normal.

Filler (Experiment 1-3)

After about ten minutes, Mary's friend arrived. It had been a few months since they had seen each other. Because of this they had a lot to talk about and chatted for over a half hour. Finally, Mary signaled the waiter to come take their orders. Mary checked the menu one more time. She had a hard time deciding what to have for lunch.

Target Sentences

Mary ordered a cheeseburger and fries. She handed the menu back to the waiter.

Closing (Experiment 1)

Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.

Comprehension Question (Experiment 1)

Was Mary meeting her husband for lunch?

Probe Verification (Experiment 2 & 3)

Mary used to not eat meat at all.

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eating meat because it would solve her health issues. Her doctor assured her that her iron levels would soon return to normal) there was no longer a slowdown in reading time. Further, the outdated information (vegetarian) was no longer even available to the reader. Thus, the inclusion of a causal explanation created a rich network of information that competed with the outdated information for reactivation when the reader encoded information related to the outdated information and was sufficient to eliminate any measurable impact on comprehension.

The results of Kendeou et al. (2013) fit nicely within the passive reactivation component that is a part of many current models of the comprehension process (e.g., Kintsch, 1988; 1998; Sanford & Garrod, 2005). As the amount and quality of updating information is increased, the amount of activation drawn to the updating information will also increase. This, in turn, decreases the amount of activation that will reach the outdated information. As a result, the proportion of the total amount of information in working memory that is outdated information will be reduced; and its impact on comprehension will be correspondingly reduced.

CHAPTER III

READING SKILL DIFFERENCES

There have been a number of cognitive functions that have been shown to be related to lower reader skill, such as limited working memory capacity (e.g., Baddeley et al., 1998; Engle, 2002), limited lexical access and word level processing (e.g., Perfetti, 1985; 1995; 2007; Perfetti & Hart, 2001; Perfetti, Yang, & Schmalhofer, 2008), the inability to suppress irrelevant information (e.g., Gernsbacher, 1993), and a general lack of domain knowledge to build a coherent representation that is readily retrievable (e.g., McNamara, 1997; McNamara & McDaniel, 2004). However, one factor that clearly distinguishes less-skilled from skilled readers is less-skilled readers' failure to integrate previously read information and general world knowledge with what they are currently reading in the text.

In order to integrate previously read information and general world knowledge with what is currently in focus; cues in the current text must activate previous information so it becomes part of active working memory. Further, working memory capacity is limited so information in long-term memory must be efficiently organized in order to increase the likelihood that relevant, not just related, information will resonate in response and enter working memory within the limits of attentional focus.

In the following chapter I will provide a brief overview of literature on how less-skilled readers have problems integrating what they are currently reading with what they

previously read and general world knowledge. I will then describe the interaction of working memory capacity, long-term memory organization, and their subsequent influence on reading skill.

A Problem with Integration

Local coherence refers to mapping each proposition in an incoming sentence to other propositions currently active in working memory, whereas global coherence involves mapping incoming propositions to information encountered earlier in the text and to relevant world knowledge (beyond the span of working memory). Current models of text processing suggest that at least two processes are involved in achieving coherence: activation and integration (e.g., Kintsch, 1988). When new information is encountered other memory traces are automatically activated. Whether particular memory traces are activated is a function of the extent to which a memory trace shares features in common with the incoming text (e.g., Albrecht & Myers, 1995; O'Brien & Albrecht, 1992).

Long and Chong (2001) addressed whether less-skilled readers fail to achieve global coherence due to failure in activation of prior information or because of difficulty with the integration process. Long and Chong used the contradiction paradigm with passages from Cook et al. (1998) which was a replication and extension of Albrecht and O'Brien (1993). Skilled and less-skilled readers read passages in which a target sentence was either consistent or inconsistent with the global information, or prior information in the text. Long and Chong added an additional condition which measured local coherence as well, by only separating the elaboration condition from the target sentence by one sentence. Skilled readers were disrupted only when the first character was described in a manner inconsistent with the target sentence. This occurred in both the local and global

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conditions. Less-skilled readers however, did not show the inconsistency effect at the global condition. In the local condition the target sentence was read more slowly when the first character was inconsistent with the target sentence and when the second character was described in a way that was inconsistent with the target sentence. Less-skilled readers did not detect the inconsistency at a global level and had an inaccurate representation at the local level.

In a second experiment Long and Chong (2001) replicated the probe verification experiment by Cook et al. (1998). Cook et al. found evidence that the target sentence served to reactivate information from the previous elaboration. Interestingly both character elaborations were reactivated, even though the target sentence only described the first character. The results of Long and Chong's second experiment replicated Cook et al. Readers responded to probes about both characters faster after the target sentence than before it. The results suggested that global information did become reactivated for less-skilled readers. The lack of a slowdown in reading may be due to a failure during integration and not activation.

Stiegler and O'Brien (in prep) conducted a study that expanded Long and Chong (2001). Stiegler and O'Brien adapted passages from Albrecht and O'Brien (1993) which described one character, Ken as a thin man who didn't worry about staying in shape and avoided contact sports. See the sample passage in Table 5. The passage continued for six filler sentences that described Ken walking around town during his lunch break. The purpose of the filler sentences was to ensure that information about Ken's fitness level was no longer active in working memory. The filler sentences were followed by a target action, (Ken enrolled in boxing lessons), which was inconsistent with the character

Table 5
Sample passage from Stiegler and O'Brien (in prep)

Introduction
Ken had been looking for a hobby for quite some time. With his new job, he had four
days a week free which would give him plenty of time to devote to a hobby.
Consistent
Ken was a big man and always tried to keep in shape by jogging and lifting weights. His
250
pound body was solid muscle. Ken loved tough physical contact sports which allowed
him to
match his strength against another person.
Inconsistent
Ken was a small man and didn't worry about staying in shape. His small 120 pound body
was all skin and bones. Ken hated contact sports, but enjoyed non-contact sports, such as
golf and bowling which he could practice alone.
Filler
While walking downtown, Ken passed a new gymnasium. He noticed the display in the
window. It was an advertisement for their summer sports program. Ken started looking at
the advertisement and was impressed with the long list of activities that the gym
sponsored. As he continued to look over the list, he became very excited. It seemed
interesting so Ken went inside.
Target
Ken decided to enroll in boxing classes.
He felt this would be the perfect hobby.
Closing
Ken signed-up for the class and paid the registration fees. He couldn't wait for the class to
begin. Ken exited the gym and continued his walk downtown.

Comprehension question
Was Ken looking for a hobby
Probe Verification
Ken was a very small and thin man.

---

description earlier in the text. Participants had to confirm that verification probes, which targeted outdated information, were true (Ken was a very small thin man). Skilled and less-skilled readers responded to probes more quickly when they appeared after the elaboration region than when they appeared after the filler section. Probes were also verified more quickly when they appeared after the target sentence than when they appeared after the filler section. The results showed that the target sentence activated information about the character description mentioned earlier in the text for both skilled and less-skilled readers.

In a second experiment, reading time on the target sentences was measured to determine whether skilled and less-skilled readers monitored global coherence. In the local condition reading times for the target sentences were disrupted for both skilled and less skilled readers when the sentence contained inconsistent character actions. However, when the elaboration information was separated by distance from the target sentence, reading times were disrupted for only the skilled readers. The results suggested that the information about the character information was activated for both skilled and less-skilled readers and integrated into their developing text representation at the local level. However, at the global level the information was activated and integrated into their developing text representation for only skilled readers.

In a subsequent recall experiment skilled and less-skilled readers showed better recall of the elaboration regions and target sentences in the locally inconsistent condition than in the locally consistent condition. Skilled readers showed better recall of the elaboration regions and target sentences in the globally inconsistent condition than in the globally consistent condition whereas less-skilled readers did not. For less-skilled

readers, prior inconsistent information was not integrated at the global level which was evidenced by a lack of improved recall of the inconsistent information. Consistent with Long & Chong (2001), prior text concepts became activated for less-skilled readers; however, the information was not integrated into the text representation, which prevented a text representation that was both locally and globally coherent.

Working Memory Capacity

Good comprehension requires sufficient working memory capacity. A reader must be able to process and remember relations between ideas in the text, detect inconsistencies, and maintain memories of described events. Knowledge from long-term memory must become active or available to the reader and then must be integrated with what is currently being read. Working memory is a temporary storage where all this information is held and operated on (e.g., Baddeley & Hitch, 1974). Working memory capacity is clearly related to how information during reading is processed and understood. Therefore it makes sense that a deficit in working memory capacity would be related to lower comprehension.

Traditionally simple working memory capacity can be defined as the number of items that can be held active at the same time. For example, in a digit span or word span task participants are given a number of items and then tested to see what the largest set they can recall is over a very limited period of time (e.g., Baddeley, 1986; Baddeley & Hitch, 1974; Carpenter & Just, 1989; Daneman & Carpenter, 1980). There are also complex working memory capacity tasks that include a processing task in addition to maintaining a digit or word span. One of the more popular complex working memory capacity tasks is a reading span task developed by Daneman and Carpenter (1980), which

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is regarded as a measure of working memory capacity for language processing. In the processing component of the reading span task participants read sets of sentences such as "His head sat on his shoulders like a pear on a dish." After each set participants would be asked to repeat back the last word of the sentence in the most recent set.

According to Cowan's (1999) embedded process model of working memory, working memory consists of the active part of long-term memory as well as part of that active memory that is in focus through attention and awareness. Active long-term memory is not capacity limited, but limited by time (approximately 10-20 seconds) and information becomes inactive through decay or interference (e.g., Cowan, Lichty, & Grove, 1990; Cowen et al., 1994; Cowan, Saults, & Nugent, 1997). Attentional focus capacity is limited to 4+/-1 unrelated items, however chunking and organization can raise the capacity limit (see Watkins, 1974). Therefore items can be activated but not in attentional focus of the reader. Attentional focus can be controlled through a central executive system that is based on individual goals and motivation. There are also involuntary aspects to what an individual attends to such as concepts that enter working memory through cues in the text. Further, when stimuli are unchanged habituation occurs so that attentional resources can be focused elsewhere (e.g., Wood & Cowan, 1995).

There is some evidence that less-skilled readers' failure to integrate information while reading is directly related to working memory capacity and limitations of attentional focus (e.g., Burton & Daneman, 2007; Cowan, 1999; Kane & Engle, 2004; McKay & Kane, 2012; Unsworth, 2007; Unsworth & Engle, 2007; Unsworth, Spillers, & Brewer, 2012). Working memory capacity is clearly related to how information during

reading is processed and understood. Therefore it makes sense that a deficit in working memory capacity would be related to lower comprehension. However some researchers have gone as far as to claim that the mechanism responsible for the integration of new into old information is executive attention, not working memory capacity (e.g., Engle & Kane, 2004; McVay & Kane, 2012) and also that attention predicts reading skill (e.g., Unsworth & Engle, 2007). There is little doubt that attention plays a role in reading comprehension; however it is most likely the case that the interaction of both working memory capacity with an attentional focus and long-term memory accessibility are all related to individual differences in reading skill.

Information in attentional focus can serve as cues to increase the likelihood that related information in long-term memory becomes activated. Correlational work has suggested that working memory capacity is related to long-term memory and long-term memory accounts for correlations between working memory capacity and higher order cognitive constructs such as intelligence (e.g., Mogle, Lovett, Stawski, & Sliwinski, 2008; Unsworth, 2010; Unsworth, Brewer, & Spillers, 2009). Retrieval from long-term memory is an important component of working memory processes and also part of the reason for individual differences in working memory (e.g., Cowan, Baddeley, Elliott, & Norris, 2003; Kane & Engle, 2000; Radvansky & Copeland, 2006; Unsworth, 2007). Specifically, differences in working memory capacity are due to differences in search and retrieval of information in long-term memory (e.g., Unsworth & Engle, 2007; Unsworth et al., 2012).

For example, Unsworth and colleagues (e.g., Unsworth, 2007; Unsworth & Engle, 2007; Unsworth et al., 2012) described a model of working memory similar to Shiffrin

(1970) to account for differences in the search process between working memory and long-term memory. There are directed and automatic components to the search process. Directed components can include certain items in attentional focus such as goals, plans, monitoring and strategies of the reader. The automatic component of the search process involves cues in the text that are part of attentional focus. These cues automatically send signals out to all of memory and highly related items in long-term memory can become part of attentional focus. Unsworth and colleagues suggested that individual differences in working memory capacity (and therefore higher order cognitive processes) are due to differences in the search process. Specifically, individuals with low working memory capacity are not generating appropriate retrieval cues to initiate the necessary search process. Unsworth et al. predicted that if low working memory capacity individuals were provided explicit, more constrained cues then that would result in equal recall between high and low working memory capacity individuals.

Unsworth et al. (2012) had high and low working memory capacity individuals recall a list of previously studied related words using cued or free recall. Working memory capacity was measured using an operation span, reading span, and symmetry span measures. Participants were given four lists of 24 words each. Each list was comprised of four different categories (6 words in each). In the free recall condition participants were instructed to recall as many words as they could in 2 minutes. In the cued recall condition participants were provided one of the four category labels and instructed to recall those items. Overall, low working memory capacity individuals had retrieval deficits compared to high working memory capacity individuals in the free recall condition. Once category labels were provided in the cued recall condition, the difference

in recall between high and low capacity individuals was reduced, but not eliminated. Unsworth et al. argued that the difference in cued recall was due to "cue overload," or proactive interference. For low working memory capacity individuals, the cue to the correct word list in long-term memory resulted in too much irrelevant information entering working memory. To test this idea, in a second experiment the procedure was the same except two categories had three words in the list and two categories had nine related words in the list. High and low working memory capacity individuals showed a difference with cued recall for the long list of words but there was no difference with the short list of words.

The results of Unsworth et al. (2012) are consistent with other working memory capacity research (e.g., Shipstead & Engle, 2013; Unsworth & Engle, 2007). Individual differences in working memory capacity were due to accurate retrieval from long-term memory. Specifically, low working memory capacity individuals had difficulty constraining long-term memory searches. The cue from information in focus did not lead to recall of appropriate information in long-term memory due to proactive interference. Unsworth and colleagues suggested one way to help low working memory capacity individuals constrain the search and retrieval process would be to provide specific cues that activate a small, more specific set of information from their long-term memory representation (e.g., Unsworth et al., 2012).

Attentional focus and awareness, as part of working memory, has an influence on memory processes such as reading comprehension. Information that is active and in focus can cause other related information from long-term memory to become activated and in focus. Information in attentional focus in working memory can serve as cues to activate

related information in long-term memory that is necessary for comprehension. However, the amount of information that a person can attend to is limited. Information that is necessary for comprehension needs to be readily available and salient to become part of attentional focus in working memory. Often for comprehension to occur, specific information must be activated at the same time in order to be combined in working memory which will lead to new connections that are stored in long-term memory (e.g., Cowan, 1999). The literature on differences in working memory capacity would suggest that manipulating specific cues that are in focus would potentially constrain the long-term memory search so appropriate information is active. However, if long-term memory is not efficiently organized, past information that is necessary for comprehension may not be interconnected or highly accessible, therefore that past information may become activated but not integrated because it was not part of attentional focus.

The focus of the experiments in this dissertation is not on individual differences in capacity of working memory or attentional focus, though both undoubtedly play a role in reading comprehension. The focus of the experiments is on text interventions that aid less-skilled readers in effectively organizing long-term memory so that relevant, necessary information is more likely to become part of the attentional focus in working memory when activated by cues in the text.

Organization of Long-term memory and Situation Model Comprehension

There is little dispute that working memory capacity is related to many aspects of reading comprehension, such as anaphor resolution (e.g., Miyake, Just, & Carpenter, 1994; Perfetti, 1989), production of inferences, (e.g., Haviland & Clark, 1974; Kintsch & van Dijk, 1978; Long, Oppy, & Seely, 1994; Magliano & Millis, 2003; Oakhill & Yuill,

1996; Singer, Andrusiak, Reisdorf, & Black,1992), as well as standardized test performance (SAT; Daneman & Hannon, 2001). However, that relation may be limited to the text-based level of comprehension. Also working memory capacity may not be a predictive factor involved in development of a situation model, or what the text is about. Radvansky and Copeland (2004) argued that very little research has looked at working memory and situation model processing specifically. Much of the research on the relation between working memory capacity and reading comprehension has focused on text-based levels, or have questionable working memory capacity measures (e.g., Anderson & Pickert, 1978; Dixon, Lefevre, & Twilley, 1988).

In an attempt to compare working memory capacity and measures of situation model processing specifically, Radvansky and Copeland (2004) tested participants on several situation model processing measures as well as memory span tests (word span test, Daneman & Carpenter's (1980) reading span test, Turner & Engle's (1989) operation span test, and Shah & Miyake's (1996) spatial span test). The situation model processing measures included memory for event descriptions, both general and specific (e.g., Radvansky, Gerard, Zacks, & Hasher, 1990; Radvansky, Zwaan, Curiel, & Copeland, 2001), functionality of aspects of text (e.g., Glenberg, 1997; Radvansky & Copeland, 2000), detection of inconsistencies (e.g., O'Brien & Albrecht, 1992), and causal connections in reading (e.g., Trabasso & Van den Broek, 1985; Trabasso & Sperry, 1985).

To detect inconsistencies participants read passages with three sentences in the text that were either consistent or inconsistent with the protagonist's original location. For example, a protagonist David was walking along the banks of a river. Several

sentences later the participants read a target sentence that was either consistent, "David walked farther down the river," or inconsistent, "David walked outside to the river," with the original location. Reading times on the target sentences were measured. Participants were then given a recognition test with several types of different verification probes that required them to answer if the sentence appeared previously or not. Different probes were designed to test if the reader comprehended the passages at a surface level, text-based level, and situation model level. For example, the ability to discriminate between a paraphrased and inference probe was assumed to be an index of a text-based understanding. Radvansky and Copeland (2004) argued that the ability to discriminate between inference probes and incorrect probes provided an index of situation model understanding. Overall, the results indicated that working memory span tasks were more related to text-based measures of comprehension. There was no clear evidence that working memory tasks are related to situation model measures.

For the purpose of this dissertation, I am not arguing that working memory capacity is irrelevant to reading comprehension. Clearly working memory capacity is related at least at the text-based level. If working memory capacity was impaired there would certainly be implications for reading comprehension. However, I will focus on the interaction of working memory and long-term memory, more specifically availability of knowledge in long-term memory. Recently, Was (2010) tested whether long-term memory accounted for unique variance in comprehension distinct from variance accounted for by working memory measures. Working memory was measured using the ABCD working memory task (Woltz, 1988). Participants were presented with statements that defined order to the letters ("B comes before A"). After three statements, participants

were asked to select a response of eight possible orders. Was (2010) found that individual differences in activation of long-term memory accounted for a large amount of unique variance in reading comprehension (see Was & Woltz, 2007 for a similar finding is a study of listening comprehension).

Updating a situation model requires processing that goes beyond the limits of traditional working memory capacity. The reader must have ready access to networks of information in long-term memory. The focus of the current experiments is that less-skilled readers are indeed encoding what they read, and previously read text and general world knowledge become activated. However, the problem is that readers are not integrating what they are currently encoding with previously read information and general world knowledge. Ericsson and Kintsch (1995) argued that deficits in working memory capacity is not enough to explain individual differences in higher order cognitive processes, such as reading comprehension. Working memory has attention driven limits therefore in order to perform higher order tasks individuals must have activation and availability of long-term memory networks (e.g., Just & Carpenter, 1992; Just, Carpenter, & Keller, 1996). Less-skilled readers are not developing an effectively organized long-term memory structure of what the text is about. Therefore they fail to build a coherent representation of the text.

Reading skill therefore depends on how easily previously read information and general world knowledge can be accessed or retrieved from long-term memory. Differences in reading skill could be partially explained by less-skilled readers not developing an effectively organized long-term memory structure of what the text is about.

CHAPTER IV

INTERACTION OF READING SKILL AND CAUSALITY

Causal information has not been as effective at eliminating the impact of outdated information for less-skilled readers as skilled readers. For example Steiner and O'Brien (in prep) compared the impact of outdated information on skilled and less-skilled readers after presenting them with a simple causal explanation for why the previous information was no longer true. Participants were presented with passages that were adapted from Kendeou et al. (2012). Without the causal information, both skilled and less-skilled readers were disrupted by the inconsistent information, as was evidenced in a slowdown in reading. However in the condition with the causal sentence, the outdated information did not disrupt reading for skilled readers; but less-skilled readers continued to be disrupted, suggesting that causal information was more effective in updating for skilled readers than less-skilled readers. In a subsequent experiment, a free recall test was used to assess whether less-skilled readers were as effective as skilled readers at encoding the causal information.

After participants finished reading the passages, they were given recall booklets. Each page of the booklet provided a recall cue for a particular passage. The cue for each passage was a phrase or paraphrase from the introduction of the passage. For example, the recall cue for one passage was "Carol had always wanted to be a construction worker." Both skilled and less-skilled recalled significantly more information about the

original description of the character and the target sentence of the inconsistent and causal passages compared to the consistent passages.

These results, in combination with the evidence from the reading times, indicate that skilled and less-skilled readers use causal information to a different extent. Causal information is encoded for both skilled and less-skilled readers. However, skilled readers fully integrate causal information into their representation of the text, while less-skilled readers do not make full use of the causal information and do not benefit from it as much.

The primary characteristic that defines a coherent representation is one that contains a rich set of interconnections among the ideas presented in a text. Many of these interconnections are both causal in nature and need to be provided by the reader (i.e. they are only implicitly presented in the text) (e.g., Klin, 1995; Wiley & Myers, 2003, for an example of causal inferences readers make). Causal information inherently provides a rich network of connections to readers' background knowledge (e.g., O'Brien, 1987; Trabasso & Suh, 1993; Trabbaso & van den Broek, 1985) and generally results in a rich, elaborated network of information. The richness of the causal explanation increases the amount of activation it draws, thereby ensuring that it is returned to active memory. At the same time that causal information draws activation to itself, it draws activation away from irrelevant information. Reading comprehension is a complex task that likely involves many cognitive processes. If less-skilled readers are not creating or utilizing these causal connections in long-term memory then irrelevant information may be more likely to enter their working memory, which would compete with relevant information, thus causing insufficient comprehension.

Thus the evidence suggests that less-skilled readers are less efficient at making use of causal relations, often missing causal links that would strengthen, bolster, and enrich memory. This may be a significant factor that impedes their comprehension relative to skilled readers.

The goal of the present set of experiments is to compare how skilled and less-skilled readers utilize causal information and to determine if providing less-skilled readers with additional causal information will serve to overcome their comprehension deficits.

Previous research has shown that less-skilled readers have difficulty maintaining global coherence (e.g., Long & Chong, 2001; McNamara & O'Reilly, 2009). At a local level both skilled and less-skilled readers are disrupted by the inconsistency (Mary was described as vegetarian but later orders a cheeseburger) as evidenced by a slowdown in reading the target sentence. However, at the global level skilled readers are disrupted, but less-skilled readers are not, even though the inconsistent information was encoded. Less-skilled readers' inability to detect a global violation may be due to a failure during integration and not activation.

The results of Long and Chong (2001) and Stiegler and O'Brien (in prep) are consistent with the theory that less-skilled readers are not developing an efficiently organized long-term memory network of what the text is about. When an inconsistent character description is separated from a target sentence at a local level, the character description is in focus for both skilled and less-skilled readers, so they notice the inconsistency. However, when an inconsistent character description is separated from a target sentence at a global level the character description is not as in focus. Skilled readers have developed effectively organized long-term memory networks of what the

text is about. When they read the target sentence about Mary's eating habits previously read information and general world knowledge is highly accessible and becomes activated for integration. If less-skilled readers have not developed an effectively organized long-term memory of previously read information then as they read, past information necessary for comprehension may not be most salient, or in focus. Less-skilled readers will not have the necessary prior information highly available for integration. Therefore less-skilled readers' failure to develop an effectively organized long-term memory network explains why less-skilled readers are disrupted by the inconsistency at the local level but not the global.

One factor that may mitigate the impoverished representation that less-skilled readers tend to construct would be to explicitly state implicit causal connections, thereby creating many of the interconnections that are missed by less-skilled readers. In the following experiments explicit causal connections will be provided as a text intervention to aid less –skilled readers in developing a richer representation of the text in long-term memory. In Experiments 1-3 inconsistent information will contain explicit causal connections to increase the likelihood that inconsistent information will enter working memory and less-skilled readers will detect global inconsistencies. In Experiments 4-5 causality will be used to aid less-skilled readers in updating their representations of the text.

CHAPTER V

EXPERIMENTS

Experiments 1-3

Experiments 1 and 2 were designed to replicate Long and Chong (2001) and

Stiegler and O'Brien (in prep). In Experiment 1, consistent and inconsistent information

was presented at a local level for both skilled and less-skilled readers. In Experiment 2,

consistent and inconsistent information was presented at a global level for both skilled

and less-skilled readers. Experiment 3 was a reading time study with consistent and

inconsistent conditions presented to less-skilled readers at a global level, however in the

inconsistent condition the initial information about Mary (she is a vegetarian) was written

so that it contained a causal sentence explaining why she was a vegetarian (i.e. Mary had

been a strict vegetarian for years because she was an animal rights activist and against

animal cruelty.)

Experiment 1

Participants

Participants were 48 undergraduate students at the University of New Hampshire

who received course credit for their participation in the experiment.

Materials

Across all Experiments participants were placed into either a skilled readers group

or a less-skilled readers group based on their performance on the Gates-MacGinitie

Reading test (MacGinitie & MacGinitie, 2000). The skilled readers scored from 75

percent to 100 percent on the test (M= 85%); less-skilled readers scored from zero

percent to 60 percent (M= 48%). The test is comprised of 11 short passages, followed by

three to six multiple choice reading comprehension and vocabulary questions, giving the

test a total of 48 questions. These questions vary in their degree of difficulty; some

answers can be found directly in the text, while others require the reader to make

inferences to reach the correct answer. Participants had a total of 20 minutes to complete

the test.

Across all experiments participants read 24 experimental passages, which were

adapted from O'Brien et al. (1998). In Experiment 1 each passage was divided into five

sections: introduction, elaboration, transition, two critical sentences, and conclusion. See

table 6 for an example passage. Each passage began with two to three introductory

sentences that served to establish the story line of the passage. This was followed by one

of two elaboration conditions: consistent and inconsistent. The consistent-elaboration

section described characteristics of the protagonist that would later support the action

mentioned in the critical target sentence. The inconsistent-elaboration section contained

character traits that conflicted with the execution of this action. For Experiment 1 the

transition was written so that only two short sentences separated the initial elaboration

and the critical sentences, keeping the information available at a local level. Reading

times were collected for the two critical sentences. Each passage ended with a

comprehension question that did not address information concerning the protagonist

profile. These were presented to ensure that participants were carefully reading each

passage, and the questions required an equal number of "yes" or "no" responses. Two

Table 6.
Sample Passage for Experiment 1

Introduction
Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating
anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week.
Mary never worried about her diet and saw no reason to eat nutritious foods.

Inconsistent
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease.

LOCAL
Mary checked the menu and specials one more time. She was having a hard time deciding what to have for lunch.

Target
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Closing
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.
Comprehension question
Was Mary meeting her husband for lunch?

---

material sets were created with twelve passages in each of the two different conditions. Across the two sets, each experimental passages appeared only once in each of the two conditions.

Procedure

Across all Experiments prior to the reading time phase of the experiment, participants were given the Gates-MacGinitie reading test. Participants were assigned as skilled or less-skilled readers based on their performance. Both skilled and less-skilled participants were randomly assigned to one of the three material sets. Each participant ran individually in a session for approximately 45 minutes. All of the passages were presented on a computer monitor controlled by a Dell 386 microcomputer.

Participants were instructed to rest their right thumb on a line-advance key, their right index finger on a "yes" response key, and their left index finger on a "no" response key. At the beginning of each trial, the word "READY" was displayed in the center of the screen. To begin reading the passages, the participants pressed the line-advance key. Each press of this key erased the current line of text on the screen and presented the next line. Participants were instructed to read at a normal, comfortable reading pace. Comprehension time was measured as the time between key presses.

Before beginning with the experimental passages, the participants completed three practice passages to ensure that they understood the procedure of the experiment and had no questions. When the participants reached the end of the passage, the final line of text was erased and replaced with the word "QUESTIONS", which appeared in the middle of the screen for 2000 milliseconds. This was followed by a comprehension question, and the participants responded "yes" or "no" by pressing the appropriate response key. If a

participant responded incorrectly to a comprehension question, the word "ERROR"

appeared in the center of the screen for 750 milliseconds.

Results

Across all Experiments the reading times for both critical sentences were

recorded. Reading times that were greater than 2.5 standard deviations from the mean

were discarded. This resulted in the loss of less than 3% of data for each experiment. In

all experiments reported, *F1* refers to tests against an error-term based on participant

variability and *F2* refers to tests against an error-term based on item variability. All

analyses reported are significant at the .05 alpha level unless otherwise indicated.

The mean reading times of the first and second critical sentences in Experiment 1

for skilled and less-skilled readers are presented in Table 7. Across all experiments

separate analyses of variance were conducted on the first and second target sentences. For

skilled readers reading times for the first target sentence was read more slowly when it

followed the inconsistent condition than when it followed the consistent condition, F1

$(1,22) = 53.01$, MSe $= 28,496$; F_2 $(1,22) = 14.29$, MSe $= 68,248$. Reading times for the

second target sentence was also read more slowly when it followed the inconsistent

condition than when it followed the consistent condition, F1 $(1,22) = 9.89$, MSe $=$

17,895; however it did not reach significance by items (p= .27).

For less-skilled readers reading times for the first target sentence was read more

slowly when it followed the inconsistent condition than when it followed the consistent

condition, F1 $(1,22) = 16.73$, MSe $= 37,639$; F_2 $(1,22) = 9.15$, MSe $= 67,939$. Reading

times on the second critical sentence did not show an effect for consistency (p=.14).

Table 7.
Experiment1: Mean Reading Times as a Function of Consistency and Reading Skill

LOCAL LEVEL	Consistent	Inconsistent
Skilled	1911 (384)	2266 (442)
Less-skilled	1869 (467)	2098 (493)

Reading times for the target sentences containing inconsistent character actions disrupted reading for both skilled and less-skilled readers at the local level. The results are consistent with Long and Chong (2001) and Stiegler and O'Brien (in prep).

Experiment 2

Participants

Participants were 48 undergraduate students at the University of New Hampshire who received course credit for their participation in the experiment.

Materials

The materials were the same as in Experiment 1 with one exception; the transition was re-written so that 6 sentences separated the initial elaboration and the critical sentences at a global level. See table 8 for an example passage.

Results

The mean reading times of the first and second critical sentences in Experiment 2 for skilled and less-skilled readers are presented in Table 9. For skilled readers reading times for the first target sentence was read more slowly when it followed the inconsistent condition than when it followed the consistent condition, $F1$ $(1,22) = 69.23$, MSe $= 34,465$; F_2 $(1,22) = 52.15$, MSe $= 31,151$. Reading times for the second target sentence did not differ. ($p = .33$). Reading times did not differ for less-skilled readers. (p's$>.21$).

Skilled readers detected the inconsistency whereas less-skilled readers did not. The results are consistent with Long and Chong (2001) and Stiegler and O'Brien (in prep). Less-skilled readers are not detecting inconsistencies at a global level.

Ericsson & Kintsch (1995) argued that poor comprehension may be due to an inability to encode information effectively in long-term memory so that more information

Table 8.

Sample Passage for Experiment 2 & 3

Introduction
Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating
anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week.
Mary never worried about her diet and saw no reason to eat nutritious foods.

Inconsistent (Experiment 2)
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease.

Inconsistent Causal (Experiment 3)
This was Mary's favorite restaurant because it had fantastic health food. Mary had been a strict vegetarian for years because she was an animal rights activist and against animal cruelty. She was serious about her diet and refused to eat anything that was fried or cooked in grease.

GLOBAL
After about ten minutes, Mary's friend arrived. It had been a few months since they had seen each other. Because of this they had a lot to talk about and chatted for over a half hour. Finally, Mary signaled the waiter to come take their orders. Mary checked the menu one more time. She had a hard time deciding what to have for lunch.

Target
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Closing
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.
Comprehension question
Was Mary meeting her husband for lunch?

Table 9.
Experiment 2: Mean Reading Times as a Function of Consistency and Reading Skill

GLOBAL LEVEL	Consistent	Inconsistent
Skilled	1749 (424)	2195 (574)
Less-Skilled	1955 (381)	1987 (397)

can become available the reader as information is cued in the text. The results are consistent with the idea that less-skilled readers are not developing an effectively organized long-term memory structure of what the text is about. Therefore they fail to build coherent representations of the text. The primary characteristic that defines a coherent representation is one that contains a rich set of interconnections among the ideas presented in a text. Many of these interconnections are causal in nature and need to be provided by the reader. Skilled readers are proficient at generating this implicit information whereas less-skilled readers are not. One factor that may mitigate the impoverished representation that less-skilled readers tend to construct would be to explicitly provide "implicit" causal connections, thereby creating many of the interconnections that are present in the representation of skilled readers.

In Experiment 3 the inconsistent condition was rewritten so that the initial information about Mary (i.e. she is a vegetarian) contained a causal sentence explaining why she was a vegetarian. Because causality provides a rich set of interconnections, presumably when the less-skilled reader reads the target sentence (Mary ordered a cheeseburger and fries) the inconsistent information will be more readily retrievable, so that they will notice the inconsistency – even when it's at a global level.

Experiment 3

Participants

Participants were 24 undergraduate students at the University of New Hampshire who received course credit for their participation in the experiment.

Materials

The materials were the same as in Experiment 2 with one exception; the inconsistent elaboration was rewritten so that it contains a causal sentence explaining why she was a vegetarian (i.e. Mary had been a strict vegetarian for years because she was an animal rights activist and against animal cruelty.) See table 8 for an example passage.

Results

The mean reading times of the first and second critical sentences in Experiment 3 for less-skilled readers are presented in Table 10. Now, with the addition of the causal explanation in the inconsistent condition, less-skilled readers read the first target sentence more slowly when it followed the inconsistent condition than when it followed the consistent condition, F1 $(1,22) = 23.57$, MSe $= 26,121$; F_2 $(1,22) = 17.61$, MSe $= 45,203$. Reading times for the second target sentence was also read more slowly when it followed the inconsistent condition than when it followed the consistent condition by subjects, F1 $(1,22) = 4.96$, MSe $= 25,643$; but failed to reach significance by items (p=.17)

Experiments 4-5

The findings in Experiments 1-3 showed that the addition of causal information allowed less-skilled readers to detect a global inconsistence. The goal of Experiments 4 and 5 was to determine if the addition of causal updating information could now eliminate that disruption.

In Experiment 4, one causal sentence was added to the inconsistent elaboration. In Experiment 5 the amount of updating information was increased to three sentences of causal explanation. In Experiment 4 one sentence of causal explanation should be sufficient to eliminate the impact of outdated information for skilled readers; however

Table 10.

Experiment 3: Mean Reading Times as a Function of Consistency and Reading Skill

GLOBAL LEVEL	Consistent	Inconsistent Causal
Less-skilled	1946 (464)	2172 (433)

less-skilled readers will need more causal explanation to eliminate the impact of outdated information. Steiner and O'Brien, (in prep) found that when an initial character description was outdated with one causal sentence, the outdated information did not disrupt reading of a target sentence at a local level for skilled readers; but less-skilled readers continued to be disrupted, suggesting that causal information was more effective for skilled readers than less-skilled readers. If the network representation of memory is slightly impoverished for less-skilled readers then they will miss potential connections that skilled readers will not. With one causal sentence, clearly less-skilled readers encoded the updating information because Steiner and O'Brien (in prep) found the causal-explanation condition was faster than the inconsistent condition. However, less-skilled readers are clearly not as effective at using causal connections as high skilled readers, because the consistent condition was still faster than the causal-explanation condition. Therefore, in Experiment 5 if the causal connections are enhanced by adding additional causal sentences to the outdating information then the less-skilled readers should show the same pattern of reading time as the skilled readers.

Experiment 4

Participants

Participants were 72 undergraduate students at the University of New Hampshire who received course credit for their participation in the experiment.

Materials

In Experiments 4 participants read 24 experimental passages, which were adapted from O'Brien et al. (1998). See table 11 for an example passage. In addition to the 24 experimental passages, there were 12 filler passages that were similar to the consistent

Table 11.
Sample Passage Experiments 4-5

Introduction
Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.
Inconsistent
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease.
Causal (Experiment 4)
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease. *She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat.*

Causal (Experiment 5)
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease. *She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat. Mary recently had blood work done. Her lack of iron was causing her to become anemic.*

Filler local level
Mary checked the menu and specials one more time. She was having a hard time deciding what to have for lunch.

Target
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Closing
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.
Comprehension Question
Was Mary meeting her husband for lunch?

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elaboration versions of the experimental passages. These passages were included to ensure that there were at least as many consistent passages as potentially inconsistent passages. Each passage was divided into five sections: introduction, elaboration, transition, two critical sentences, and conclusion. Each passage began with two to three introductory sentences that served to establish the story line of the passage. This was followed by one of three elaboration conditions: consistent, inconsistent, and causal-explanation. The consistent-elaboration section described characteristics of the protagonist that would later support the action mentioned in the critical target sentence. The inconsistent-elaboration section contained character traits that conflicted with the execution of this action. The causal-explanation elaboration section was created by using the inconsistent elaboration and adding one causal-explanation sentence that outdated the inconsistent characteristic by providing a causal explanation for why the inconsistent characteristic was no longer true. To ensure that less-skilled readers had every opportunity to detect the inconsistency (in spite of the causal explanations), all elaborations and target sentences appeared in the local coherence conditions (similar to Experiment 1). Reading times were collected for the two critical sentences.

Three material sets were created with eight passages in each of the three different conditions. Across the three sets, each experimental passages appeared only once in each of the three conditions.

Results

The mean reading times of the first and second target sentences in Experiment 4 for skilled and less-skilled readers are presented in Table 12. For skilled readers reading times for the first target sentence revealed a main effect of consistency F_1 (2,66) = 12.79,

Table 12.

Experiment 4: Mean Reading Times as a Function of Consistency and Reading Skill

	Consistent	Inconsistent	Causal_1 sentence
Skilled	1819 (506)	2056 (545)	1795 (478)
Less-skilled	1684 (474)	2134 (688)	1884 (499)

MSe = 58,820; F_2 (2,42) = 14.64, MSe = 38,009. Planned comparisons confirmed that the first target sentence was read more slowly when it followed the inconsistent condition than when it followed both the consistent condition, F1 (1,33) = 14.12, MSe = 143,832; F_2 (1,21) =21.88, MSe = 79,469, and the causal condition, F1 (1,33) = 17.28, MSe = 142,461; F_2 (1,21) = 16.59, MSe = 96,346. Reading times did not differ for the consistent and causal conditions (p's>.58). Reading times on the second target sentence did not show a main effect for consistency (p=.08).

For less-skilled readers reading times for the first target sentence revealed a main effect of consistency F_1 (2,66) = 21.73, MSe = 84,279; F_2 (2,42) =21.29, MSe = 47,701. Planned comparisons confirmed that the first target sentence was read more slowly when it followed the inconsistent condition than when it followed both the consistent condition, F1 (1,33) = 26.81, MSe = 272,184; F_2 (1,21) = 31.53, MSe = 128,784, and the causal condition, F1 (1,33) = 21.12, MSe = 106,505; F_2 (1,21) =9.14, MSe = 118,996. However, the first target sentence was also read more slowly when it followed the causal condition than the consistent condition, F1 (1, 33) = 11.37, MSe =126,984; F_2 (1, 21) = 24.61, MSe = 38,429. Reading times on the second target sentence also revealed a main effect of consistency F_1 (2, 66) = 6.67, MSe = 49,929; F_2 (2, 42) = 8.76, MSe = 27,097.

Thus, for skilled readers, the causal sentence was effective in eliminating any disruption causes by the inconsistent information. In contrast, although less-skilled readers were slower in the inconsistent condition than in either the consistent or causal condition, reading times in the causal condition were still longer than in the consistent condition. Less-skilled readers were able to benefit from the causal information but did

not make as effective use of the causal information as skilled readers. The results are consistent with Steiner and O'Brien (in prep).

In Experiment 5 three causal sentences were added to the inconsistent elaboration. If the amount of causal information is increased to three sentences then the impact of outdated information for less-skilled readers should be eliminated.

Experiment 5

Participants

Participants were 72 undergraduate students at the University of New Hampshire who received course credit for their participation in the experiment.

Materials

The materials were the same as Experiment 4, however the causal information was increased to 3 sentences (adapted from Kendeou et al., 2013). See table 11 for an example passage.

Results

The mean reading times of the first and second target sentences in Experiment 5 for skilled and less-skilled readers are presented in Table 13. For skilled readers reading times for the first target sentence revealed a main effect of consistency F_1 (2,66) = 19.81, MSe = 51,344; F_2 (2,42) =18.01, MSe = 34,865. Planned comparisons confirmed that the first target sentence was read more slowly when it followed the inconsistent condition than when it followed both the consistent condition, F1 (1,33) = 22.39, MSe = 122,901; F_2 (1,21) =24.56, MSe = 73,729, and the causal condition, F1 (1,33) = 30.24, MSe = 109,918; F_2 (1,21) = 34.94, MSe = 56,401. Reading times did not differ for the consistent and causal conditions (p's>.55). Reading times on the second target sentence also

Table 13.
Experiment 5: Mean Reading Times as a Function of Consistency and Reading Skill

	Consistent	Inconsistent	Causal_3 sentences
Skilled	1822 (425)	2099 (471)	1795 (373)
Less-skilled	1913 (456)	2251 (642)	1918 (529)

revealed a main effect of consistency by subjects F_1 (2, 66) = 5.93, MSe = 35,958; but failed to reach significance by items (p=.17).

For less-skilled readers reading times for the first target sentence revealed a main effect of consistency F_1 (2, 66) = 26.31, MSe = 51,397; F_2 (2,42) = 10.53, MSe = 48,372. Planned comparisons confirmed that the first target sentence was read more slowly when it followed the inconsistent condition than when it followed both the consistent condition, F1 (1,33) = 32.30, MSe = 127,202; F_2 (1,21) =29.85, MSe = 54,946, and the causal condition, F1 (1,33) = 34.85, MSe = 114,929; F_2 (1,21) = 9.42, MSe = 149,475. Now, reading times did not differ for the consistent and causal conditions (p's>.75). Reading times on the second target sentence did not reach significant (p=.08).

Now, for both skilled and less-skilled readers, reading times on a target sentence were slower in the inconsistent condition than both the consistent and causal conditions. More importantly reading times in the consistent and causal condition did not differ for skilled or less-skilled readers. Thus, with the addition of two more causal sentences, less-skilled readers' pattern of comprehension matched that of skilled readers.

CHAPTER VI

GENERAL DISCUSSION

There is considerable evidence that less-skilled readers often fail at maintaining

global coherence. Specifically, less-skilled readers do not detect inconsistencies when

they occur at a global level (e.g., Long and Chong, 2001; Stiegler & O'Brien, in prep).

Less-skilled readers are failing to integrate what they are currently reading with

previously read text and general world knowledge. One of the reasons less-skilled readers

don't maintain global coherence is because they don't gain sufficient access to

backgrounded information. One potential way to increase accessibility of global concepts

is to provide causal links. Causal information inherently provides a rich network of

connections to readers' background knowledge (O'Brien, 1987; Trabasso & Suh, 1993;

Trabbaso & van den Broek, 1985) and generally results in a rich, elaborated network of

information. The richness of the causal explanation increases the amount of activation it

draws, thereby ensuring that it is returned to active memory. Causality enriches the

representation of text in memory and this can facilitate the comprehension process,

especially for less-skilled readers.

The current experiments investigated whether providing less-skilled readers with

an explicit set of causal relations allowed them to overcome comprehension deficits

relative to skilled readers. Experiments 1 and 2 replicated the finding of Long and Chong

(2001) and Stiegler and O'Brien (in prep). In Experiment 1, consistent and inconsistent information was presented at a local level for both skilled and less-skilled readers. For both skilled and less-skilled readers, reading times for the first target sentence were read more slowly when it followed the inconsistent condition than when it followed the consistent condition. In Experiment 2, consistent and inconsistent information was presented at a global level for both skilled and less-skilled readers. Reading times for the first target sentence for skilled readers continued to be read more slowly when it followed the inconsistent condition than when it followed the consistent condition. However, reading times for the first target sentence for less-skilled readers did not differ between the inconsistent and consistent condition. Skilled readers detected the inconsistency whereas less-skilled readers did not. The results were consistent with Long and Chong (2001) and Stiegler and O'Brien (in prep). Less-skilled readers did not detect inconsistencies at a global level.

In Experiment 3 the inconsistent global character description was written so that it contained a causal explanation, or causal chain, which served to enhance the activation of targeted global information, thereby increasing the likelihood that less-skilled readers would detect a global inconsistency. With the addition of the causal explanation in the inconsistent condition, less-skilled readers did in fact read the first target sentence more slowly when it followed the inconsistent condition than when it followed the consistent condition. The slowdown makes clear that with the addition of the causal explanation, the inconsistent information becomes sufficiently activated to disrupt comprehension.

The results in Experiments 1-3 showed that the addition of the causal information in the inconsistent description allowed less-skilled readers to detect a global

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inconsistency. The goal of Experiments 4 and 5 was then to determine if the addition of

causal updating information could eliminate that disruption. Across the two experiments

the amount of causal information in the causal explanation condition was systematically

increased. Steiner and O'Brien (in prep) found that when an initial character description

was outdated with one causal sentence, the outdated information did not disrupt reading

of a target sentence at a local level for skilled readers; but less-skilled readers continued

to be disrupted, suggesting that causal information was more effective for skilled readers

than less-skilled readers. Experiment 4 replicated Steiner and O'Brien. One sentence of

causal explanation was sufficient to eliminate the impact of outdated information for

skilled readers; however less-skilled readers were able to benefit from the causal

information but did not make as effective use of the causal information as skilled readers.

Therefore, in Experiment 5 three causal sentences were added to the inconsistent

elaboration. In Experiment 5 for both skilled and less-skilled readers, reading times on a

target sentence were slower in the inconsistent condition than both the consistent and

causal conditions. More important reading times in the consistent and causal condition

did not differ for skilled or less-skilled readers. Thus, with the addition of two more

causal sentences, less-skilled readers' pattern of comprehension matched that of skilled

readers.

Ericsson & Kintsch (1995) argued that poor comprehension may be due to an

inability to encode information effectively in long-term memory so that more information

can become available to the reader as information is cued in the text. The current set of

results is consistent with the idea that less-skilled readers are not developing an

effectively organized long-term memory structure of what the text is about. Therefore

they fail to build coherent representations of the text. Causal information inherently provides a rich network of connections in readers' background knowledge (Kendeou et al., 2012; O'Brien, 1987; Trabasso & Suh, 1993; Trabasso & van den Broek, 1985) and generally results in a rich, elaborated network of information. In Experiment 3, by enriching the representation of the inconsistent character description using causality, its subsequent accessibility was increased. It was then more likely to become strongly activated and part of attentional focus in working memory. Less-skilled readers were then able to detect the inconsistency similar to skilled readers. In Experiment 4, both skilled and less-skilled readers benefited from causal explanations, but less-skilled readers did not benefit to the same extent. In Experiment 5, the causal explanation was increased to three sentences, which was then sufficient to eliminate the disruption of outdated information for less-skilled readers. As the amount and quality of updating information was increased, the amount of activation drawn to the updating information was also increased. This, in turn, decreased the amount of activation that reached the outdated information. As a result, the proportion of the total amount of information in working memory that was outdated information was reduced; and its impact on comprehension was correspondingly reduced. For skilled readers, one sentence of causal a causal explanation was sufficient to reduce the amount of outdated information in working memory, but less-skilled readers needed more. The results of Experiments 4 and 5 are also consistent with the idea that less-skilled readers are not constructing efficient long-term memory networks. Outdated, no longer correct, information is extremely pervasive and continues to become activated even if it disrupts comprehension. For skilled readers the one sentence of causal explanation was sufficient to overpower the disrupting effect

of outdated information. However, less-skilled readers needed more elaboration of the causal information (explicit connections among ideas in the text) in order for that network in long-term memory to overpower the disrupting effect of outdated information.

There is some opposing evidence that suggests text cohesion (i.e. explicit connections among ideas in the text) can have an adverse effect on less-skilled readers' ability to comprehend the text, specifically on the interaction between text cohesion, reading skill and prior knowledge (e.g., O'Reilly & McNamara, 2007; Ozuru, Dempsey, & McNamara, 2009). O'Reilly and McNamara found that low knowledge readers benefited from highly cohesive text however high knowledge readers benefited from highly cohesive text only when they had high reading skill. Further less-skilled, high knowledge readers had worse comprehension for highly cohesive text.

In an attempt to clarify the results of O'Reilly and McNamara (2007), Ozuru et al. (2009) had participants read high and low cohesion versions of biology texts. Participants then answered text-based, local bridging and global bridging comprehension questions. Ozuru et al. found similar effects for text cohesion and individual differences. The effect of text-cohesion on reading skill depended on the reader's prior knowledge. Ozuru et al. attempted to pull apart the three-way interaction. Less-skilled readers and high knowledge readers both performed worse on text-based questions with highly cohesive text. There was a marginal benefit of text cohesion only for low knowledge, high skilled readers. All effects were limited to performance on text-based comprehension questions; however that does not mean increased text cohesion is limited to text-based compression. The inability to detect an influence of cohesion at global levels of comprehension was most likely due to the nature of the science text. Readers may lack a full understanding of

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the science text because they are just learning about the topic, so comprehension at a global level is a more difficult. Overall, Ozuru et al. argued that with regard to reading skill, skill is necessary to manage information in highly cohesive text. However, their argument was based on topics that readers have limited knowledge of such as biology or chemistry; therefore it was difficult to actually understand the relation between text cohesion and reading skill without the influence of prior knowledge.

Prior knowledge of a topic can have a large influence on reading comprehension, especially if the text itself is insufficient (i.e. connections between the ideas in the text are not explicit) to build a coherent representation (e.g., Kintsch, 1988, 1998). Prior knowledge can enhance text comprehension for less-cohesive text (e.g., Chi, Feltovich, & Glaser, 1981). Though both reading skill and prior knowledge have an influence on text comprehension, Haneman & Daneman (2001) argued that reading skill and prior knowledge contribute to comprehension processes in different ways. Prior knowledge helps readers fill in gaps in the text and reading skill involves relating multiple ideas in order to build an integrated, coherent understanding of the text. However, the concepts and ideas that need to be integrated can come from prior general world knowledge, so it makes sense that general world knowledge and reading skill would interact.

In the current set of experiments the results indicated that highly cohesive text (i.e. explicit causal connections) helped less-skilled readers integrate previously read information with what they were currently reading. Less- skilled readers demonstrated evidence of better comprehension by detecting inconsistencies. The results are inconsistent with some previous research on text cohesion and individual differences such as reading skill and prior knowledge (e.g., O'Reilly & McNamara, 2007; Ozuru et

al, 2009). The difference in results may be because in the current experiments participants read narratives that were meant to require very little prior knowledge about specific concepts, unlike scientific texts in previous studies. It's possible that the interaction of text cohesion and reading skill in prior studies was heavily influenced by the reader's prior knowledge. Also in the current experiments the dependent measure of comprehension was reading time for a target sentence that was inconsistent with previous information, not text-based comprehension questions. It would be interesting to investigate whether providing explicit causal links would have the same beneficial influence on less-skilled readers (i.e. detecting the inconsistency) if general world knowledge of the topic of the text was manipulated.

Using causality to enrich long-term memory representations is only one possible text intervention to aid less-skilled readers in the integration process. Findings from the working memory capacity literature has shown that providing explicit cues would direct the search and retrieval process in long-term memory, at least for low working memory capacity individuals (e.g., Unsworth, 2007; Unsworth & Engle, 2007; Unsworth et al., 2012). Therefore one possible avenue for future research would be to provide less-skilled readers with explicit retrieval cues in an attempt to increase activation of inconsistent character descriptions so that it is available for integration. However, if long-term memory is not efficiently organized, previously read information that is necessary for comprehension might become activated but not enough to be part of attention focus, therefore less-skilled readers may have a problem with integration.

In general, providing less-skilled readers will additional explicit causal information can enhance and enrich their representation of text in memory so that their

comprehension processes approach that of skilled readers. Causality can be used to increase the likelihood that information necessary for comprehension will be activated and become part of attentional focus in working memory (i.e. Experiment 3). Enriching updating information with a causal explanation also increases the text representation (i.e., Experiment 4), resulting in less-skilled readers being able to overcome the disrupting effects of outdated information. But clearly, they need more information than skilled readers (i.e., Experiment 5). Thus, providing less-skilled readers with explicit causal links as they encode information can help them develop a stronger text representation in long-term memory. As cues in the text elicit activation of previously read information, that previously read information is now more likely to become part of attentional focus in working memory and therefore integrated with what is currently in focus.

LIST OF REFERENCES

Albrecht, J. E. & O'Brien, E. J. (1993). Updating a mental model: Maintaining both local and global coherence. JEP:LMC, 19, 1061 - 1070.

Albrecht, J. E., & Myers, J. L. (1995). Role of context in accessing distant information during reading. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 21*(6), 1459-1468

Albrecht, J. E., & Myers, J. L. (1998). Accessing distant text information during reading: Effects of contextual cues. *Discourse Processes, 26*(2-3), 87-107

Anderson, R. C., & Pichert, J. W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal Of Verbal Learning & Verbal Behavior, 17*(1), 1-12.

Baddeley, A. D. (1986). *Working memory.* New York: Oxford University Press.

Baddeley, A., Gathercole, S., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological Review*, 105, 158-173.

Baddeley, A. D., & Hitch, G. J. (1974). Working Memory. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 47-90). San Diego: Academic Press.

Burton, C., & Daneman, M. (2007). Compensating for a limited working memory capacity during reading: Evidence from eye movements. *Reading Psychology, 28*(2), 163-186.

Carpenter, P.A. & Just, M.A. (1989). The Role of Working Memory in Language Comprehension, in *Complex Information Processing: The Impact of Herbert A. Simon* eds. D. Klahr, K. Kotovsky, Lawrence Erlbaum Associates Inc. Hillsdale, NJ, 31-52.

Chi, M., Feltovich, P., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5, 121e152.

Daneman, M., & Hannon, B. (2001). Using working memory theory to investigate the construct validity of multiple choice reading comprehension tests such as the SAT. Journal of Experimental Psychology: General, 130, 208e223.

Conway, A.R.A. & Engle, R.W. (1994). Working memory and retrieval: A resource-dependent inhibition model. *Journal of Experimental Psychology: General,* 123(4), 354-373.

Conway, A.R.A., & Engle, R.W. (1996). Individual differences in WM capacity: More evidence for a general capacity theory. *Memory,4*, 577–590.

Cook, A. E., Guéraud, S., Was, C. A., & O'Brien, E. J. (2007). Foregrounding effects during reading, revisited. *Discourse Processes, 44*(2), 91-111.

Cook, A. E., Halleran, J. G., & O'Brien, E. J. (1998). What is readily available during reading? A memory-based view of text processing. Discourse Processes, 26(2&3), 109-129.

Cook, A. E., & Myers, J. L. (2004). Processing discourse roles in scripted narratives: The influences of context and world knowledge. *Journal Of Memory And Language, 50*(3), 268-288.

Cowan, N. (1999). An Embedded-Processes Model of working memory. In A. Miyake, P. Shah   (Eds.) , *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 62-101). New York, NY US: Cambridge University Press.

Cowan, N., Baddeley, A. D., Elliott, E. M., & Norris, J. (2003). List composition and the word length effect in immediate recall: A comparison of localist and globalist assumptions. *Psychonomic Bulletin & Review, 10*(1), 74-79.

Cowan, N., Keller, T. A., Hulme, C., Roodenrys, S., McDougall, S., & Rack, J. (1994). Verbal memory span in children: Speech timing clues to the mechanisms underlying age and word length effects. *Journal Of Memory And Language, 33*(2), 234-250.

Cowan, N., Lichty, W., & Grove, T. R. (1990). Properties of memory for unattended spoken syllables. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 16*(2), 258-269.

Cowan, N., Saults, J., & Nugent, L. D. (1997). The role of absolute and relative amounts of time in forgetting within immediate memory: The case of tone-pitch comparisons. *Psychonomic Bulletin & Review, 4*(3), 393-397.

Daneman, M., & Carpenter, P. A. (1980). "Individual differences in working memory and reading." *Journal of Verbal Learning and Verbal Behavior* 19, 450-466.

Daneman, M., & Hannon, B. (2001). Using working memory theory to investigate the construct validity of multiple-choice reading comprehension tests such as the SAT. *Journal Of Experimental Psychology: General, 130*(2), 208-223.

Dixon, P., LeFevre, J., & Twilley, L. C. (1988). Word knowledge and working memory as predictors of reading skill. *Journal Of Educational Psychology, 80*(4), 465-472.

Engle, R. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science,* 11, 19-23.

Engle, R. W., & Kane, M. J. (2004). Executive Attention, Working Memory Capacity, and a Two-Factor Theory of Cognitive Control. In B. H. Ross (Ed.) , *The psychology of learning and motivation: Advances in research and theory, Vol. 44* (pp. 145-199). New York, NY US: Elsevier Science.

Ericcson, K. A., and Kintch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211-245.

Fletcher, C. R., & Bloom, C. P. (1988). Causal reasoning in the comprehension of simple narrative texts. *Journal of Memory and Language,* 27, 235-244.

Gernabacher, M. A. (1990). *Language comprehension as structure building.* Hillsdale, N.J:Erlbaum.

Gernsbacher, M. (1993). Less-skilled readers have less efficient suppression mechanisms. *Psychological Science,* 4, 294-298.

Gerrig, R. J., & McKoon, G. (1998). The readiness is all: The functionality of memory-based text processing. *Discourse Processes,* 26(2-3), 67-86.

Gerrig, R. J., & O'Brien, E. J. (2005). The Scope of Memory-Based Processing. *Discourse Processes,* 39(2-3), 225-242.

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. *Psychological Review,* 91(1), 1-67

Glenberg, A. M. (1997). What memory is for. *Behavioral And Brain Sciences, 20*(1), 1-55.

Glenberg, A. M., Meyer, M., & Lindem, K. (1987). Mental models contribute to foregrounding during text comprehension. *Journal of Memory and Language,* 26, 69-83.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text   comprehension. *Psychological Review,* 101, 371-395.

Guéraud, S., Harmon, M. E., & Peracchi, K. A. (2005). Updating situation models: The memory- based contribution. *Discourse Processes,* 39(2&3), 243-263.

Guéraud, S., & Tapiero, I. (2003, July). *Mechanisms of reactivation and integration in the Resonance Model: Some new evidences.* Paper presented at 13th Annual Meeting of the Society for Text and Discourse, Madrid, Spain.

Hakala, C. M., & O'Brien, E. J. (1995). Strategies for resolving coherence breaks in reading. *Discourse Processes, 20*(2), 167-185.

Haviland, S. E., & Clark, H. H. (1974). What's new? Acquiring new information as a process in comprehension. *Journal of Verbal Learning & Verbal Behavior,* 13, 512-521.

Hintzman, D. L. (1986). "Schema abstraction" in a multiple-trace memory model. Psych. Review, 93, 411-428.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99*(1), 122-149.

Just, M., Carpenter, P. A., & Keller, T. A. (1996). The capacity theory of comprehension: New   frontiers of evidence and arguments. *Psychological Review, 103*(4), 773-780.

Kane, M. J., & Engle, R. W. (2000). Working-memory capacity, proactive interference, and divided attention: Limits on long-term memory retrieval. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 26*(2), 336-358.

Kendeou, P., Smith, E. R., & O'Brien, E. J. (2013). Updating During Reading: Why Causality Matters. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psych Review,* 95, 163-182.

Kintsch, W. (1998). *Comprehension: A paradigm for cognition.* New York, NY US: Cambridge University Press.

Kintsch, W., & Mross, E. F. (1985). Context effects in word identification. *Journal Of Memory And Language, 24*(3), 336-349.

Kintsch, W. & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psych Review,* 85, 363-394.

Klin, C. M. (1995). Causal inferences in reading: From immediate activation to long-term memory. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 21*(6), 1483-1494.

Long, D. L., & Chong, J. L. (2001). Comprehension skill and global coherence: A paradoxical   picture of poor comprehenders' abilities. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 27(6), 1424-1429.

Long, D. L., Oppy, B. J., and Seely, M. R. (1994). Individual differences in the time course of inferential processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 1456-1470.

Magliano, J. P., and Millis, K. K. (2003). Assessing reading skill with a think-aloud procedure. *Cognition and Instruction, 21*, 251-283.

Magliano, J. P., Trabasso, T., & Graesser, A. C. (1999). Strategic processing during comprehension. *Journal of Educational Psychology*, 91(4), 615-629.

Magliano, J. P., Zwaan, R. A., & Graesser, A. (1999). The role of situational continuity in narrative understanding. In H. van Oostendorp, S. R. Goldman, H. van Oostendorp, S. R. Goldman (Eds.) , *The construction of mental representations during reading* (pp. 219-245). Mahwah, NJ US: Lawrence Erlbaum Associates Publishers.

McKoon, G., & Ratcliff, R. (1980). The comprehension processes and memory structures involved in anaphoric reference. *Journal of Verbal Learning & Verbal Behavior*, **19**, 668-682.

McKoon, G., & Ratcliff, R. (1992). Inference during reading. *Psychological Review*, **99**, 440-466.

McNamara, D. (1997). Comprehension skill: A knowledge-based account. In Shafto Langley (Eds.) *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society* (pp. 508-513). Hillsdale, NJ: Erlbaum.

McNamara, D., & McDaniel, M. (2004). Suppressing irrelevant information: Knowledge activation or inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30, 465-382.

McVay, J. C., & Kane, M. J. (2012). Drifting from slow to "d'oh!": Working memory capacity and mind wandering predict extreme reaction times and executive control errors. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 38*(3), 525-549.

Miyake, A., Just, M., & Carpenter, P. A. (1994). Working memory constraints on the resolution of lexical ambiguity: Maintaining multiple interpretations in neutral contexts. *Journal Of Memory And Language, 33*(2), 175-202.

Mogle, J. A., Lovett, B. J., Stawski, R. S., & Sliwinski, M. J. (2008). What's so special about working memory? An examination of the relationships among working memory, secondary memory, and fluid intelligence. *Psychological Science, 19*(11), 1071-1077.

Myers, J. L., & O'Brien, E. J. (1998). Accessing the discourse representation during reading. *Discourse Processes*, **26**, 131-157.

Oakhill, J., and Yuill, N. (1996). Higher order factors in comprehension disability: Processes and remediation. In C. Cornaldi and J. Oakhill (Eds.*)*, *Reading comprehension difficulties: Processes and Intervention*. Mahwah, NJ: Erlbaum.

O'Brien, E. J. (1987). Antecedent search processes and the structure of text. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13, 278-290.

O'Brien, E. J. & Albrecht, J. E. (1992). Comprehension strategies in the development of a mental model. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18(4), 777-784.

O'Brien, E. J., Cook, A. E., & Guéraud, S. (2010). Accessibility of outdated information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*, 979-991.

O'Brien, E. J., Duffy, S. A., & Myers, J. L. (1986). Anaphoric inference during reading. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 12*(3), 346-352.

O'Brien, E. J., & Myers, J. L. (1999). Text comprehension: A view from the bottom up. In S. R. Goldman, A. C. Graesser, & P. van den Broek (Eds.), *Narrative comprehension, causality, and coherence: Essays in honor of Tom Trabasso* (pp. 36-53). Mahwah, NJ: Erlbaum.

O'Brien, E. J., Rizzella, M. L., Albrecht, J. E., & Halleran, J. G. (1998). Updating a situation model: A memory-based text processing view. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 24(5), 1200-1210.

O'Reilly, T., & McNamara, D. S. (2007). Reversing the reverse cohesion effect: Good texts can be better for strategic, high-knowledge readers. *Discourse Processes*, *43*(2), 121-152.

Ozuru, Y., Dempsey, K., & McNamara, D. S. (2009). Prior knowledge, reading skill, and text cohesion in the comprehension of science texts. *Learning And Instruction*, *19*(3), 228-242.

Perfetti, C. A. (1985). *Reading ability*. New York, NY US: Oxford University Press.

Perfetti, C. (1989). There are generalized abilities and one of them is reading. In L. B. Resnick Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 307- 336). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Perfetti, C. A. (1995). Cognitive research can inform reading education. *Journal Of Research In Reading*, *18*(2), 106-115.

Perfetti, C. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies Of Reading*, *11*(4), 357-383.

Perfetti, C. A., & Hart, L. (2001). The lexical basis of comprehension skill. In D. S. Gorfein (Ed.) , *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity* (pp. 67-86). Washington, DC US: American Psychological Association.

Perfetti, C., Yang, C., & Schmalhofer, F. (2008). Comprehension skill and word-to-text integration process. *Applied Cognitive Psychology*, *22*(3), 303-318.

Radvansky, G. A., & Copeland, D. E. (2000). Functionality and spatial relations in memory and language. *Memory & Cognition*, *28*(6), 987-992.

Radvansky, G. A., & Copeland, D. E. (2004). Working memory span and situation model processing. *The American Journal Of Psychology*, *117*(2), 191-213.

Radvansky, G. A., & Copeland, D. E. (2006). Memory retrieval and interference: Working memory issues. *Journal Of Memory And Language*, *55*(1), 33-46.

Radvansky, G. A., Gerard, L. D., Zacks, R. T., & Hasher, L. (1990). Younger and older adults' use of mental models as representations for text materials. *Psychology And Aging*, *5*(2), 209-214.

Radvansky, G. A., Zwaan, R. A., Curiel, J. M., & Copeland, D. E. (2001). Situation models and aging. *Psychology And Aging*, *16*(1), 145-160.

Rapp, D. N. & Kendeou, P. (2007). Revising what readers know: Updating text representations during narrative comprehension. *Memory and Cognition*, 35(8), 2019-2032.

Rapp, D. N. & Kendeou, P. (2009). Noticing and revising discrepancies as text unfolds. *Discourse Processes*, 46, 1-24.

Ratcliff, R. (1978). A theory of memory retrieval. *Psych Review*, 85, 59-108.

Sanford, A. & Garrod, S. (1981). *Understanding written Language: Explorations of comprehension beyond the sentence.* New York, NY: John Wiley & Sons.

Sanford, A. & Garrod, S. (2005). Memory-Based approaches and beyond. *Discourse Processes*, 39, 205-225.

Shah, P., & Miyake, A. (1996). The separability of working memory resources for spatial thinking and language processing: An individual differences approach. *Journal Of Experimental Psychology: General, 125*(1), 4-27.

Shiffrin, R. M. (1970). Forgetting: Trace erosion or retrieval failure?. *Science, 168*(3939), 1601- 1603.

Shipstead, Z., & Engle, R. W. (2013). Interference within the focus of attention: Working memory tasks reflect more than temporary maintenance. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 39*(1), 277-289.

Singer, M., Andrusiak, P. Reisdorf, P., and Black, N. (1992). Individual differences in bridging inference processes. *Memory and Cognition, 20*, 539-548.

Steiner, K. L., & O'Brien, E. J. (in prep). Individual differences in updating information during reading.

Stiegler & O'Brien (in prep). Reading skill and the maintenance of local and global coherence.

Swinney, D. A., & Hakes, D. T. (1976). Effects of prior context upon lexical access during sentence comprehension. *Journal Of Verbal Learning & Verbal Behavior, 15*(6), 681-689.

Trabasso, T. & Sperry, L. L. (1985). Causal relatedness and importance of story events. *Journal of Memory and Language,, 24*, 595-611.

Trabasso, T., & Suh, S. (1993). Understanding text: Achieving explanatory coherence through on-line inferences and mental operations in working memory. *Discourse Processes,* 16(1-2), 3-34.

Trabasso, T., & Van den Broek, P. (1985). Causal thinking and the representation of narrative events. *Journal of Memory and Language,* 24(5), 612-630.

Trabasso, T., Van Den Broek, P., & Suh, S. (1989). Logical necessity and transitivity of causal relations in stories. *Discourse Processes, 12,* 1-25.

Turner, M., and Engle, R. (1989). Is working memory capacity task dependent? *Journal-of-Memory-and-Language, 28,* 127-154.

Unsworth, N. (2007). Individual differences in working memory capacity and episodic retrieval: Examining the dynamics of delayed and continuous distractor free recall. *Journal Of Experimental Psychology: Learning, Memory, And Cognition, 33*(6), 1020-1034.

Unsworth, N. (2010). On the division of working memory and long-term memory and their relation to intelligence: A latent variable analysis. *Acta Psychologica, 134,* 16-28

Unsworth, N., Brewer, G. A., & Spillers, G. J. (2009). There's more to the working memory–fluid intelligence relationship than just secondary memory. *Psychonomic Bulletin & Review, 16,* 931–937

Unsworth, N., & Engle, R. W. (2007). The nature of individual differences in working memory capacity: Active maintenance in primary memory and controlled search from secondary memory. *Psychological Review, 114,* 104–132.

Unsworth, N., Spillers, G. J., & Brewer, G. A. (2012). Working memory capacity and retrieval limitations from long-term memory: An examination of differences in accessibility. *The Quarterly Journal Of Experimental Psychology, 65*(12), 2397-2410.

Was, C. A. (2010) Individual differences are more than just working memory: The case for available long-term memory. *Individual Differences Research, 8,* 132-139.

Was, C. A., & Woltz, D. J. (2007). Reexamining the relationship between working memory and comprehension: The role of available long-term memory. *Journal Of Memory And Language, 56*(1), 86-102

Watkins, M. J. (1974). When is recall spectacularly higher than recognition?. *Journal Of Experimental Psychology, 102*(1), 161-163.

Wiley, J & Myers, J. L. (2003). Availability and accessibility of information and causal inferences from scientific text. *Discourse Processes 36,* 109-129.

Woltz, D. J. (1988). An investigation of the role of working memory in procedural skill acquisition. *Journal Of Experimental Psychology: General, 117*(3), 319-331.

Wood, N. L., & Cowan, N. (1995). The cocktail party phenomenon revisited: Attention and memory in the classic selective listening procedure of Cherry (1953). *Journal Of Experimental Psychology: General, 124*(3), 243-262.

Zwaan, R. A., Langston, M. C., & Graesser, A. C. (1995). The construction of situation models in narrative comprehension: An event-indexing model. *Psychological Science, 6*(5), 292-297.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin,* 123(2), 162-185.

APPENDIX A
EXPERIMENTAL PASSAGES

Introduction:
Robin loved to spend time at the ocean watching the waves crash against the rocks. She enjoyed the sun and the cool breeze that came off the water.

Consistent:
Robin was a strong swimmer and worked every summer as a lifeguard. Yet she had always preferred swimming in the ocean to lying on the beach. She loved the feeling of being suspended in the deep ocean water as the waves rolled past.

Inconsistent:
However, Robin was a poor swimmer and had avoided the water ever since grade school. She dreaded the feeling of being suspended in the ocean as the waves rolled past. She had always preferred staying on the shore to swimming in the water.

Inconsistent Causal: (exp3)
However, Robin was a poor swimmer. She avoided the water because she almost drowned when she was younger. She dreaded the feeling of being suspended in the ocean as the waves rolled past. She had always preferred staying on the shore to swimming in the water.

Causal: (exp 4 & 5)
Because Robin was jealous of all the people swimming in the ocean, she decided to get over her fear. She started taking swimming lessons with her friends. She was determined to learn how to swim in the ocean and not let the deep water frighten her anymore.

Filler:
As a favor, Robin was house-sitting for a friend. It was a small cottage along a private beach. Her friend was on a business trip and would return in a week. Because she would be alone for a few days, Robin searched the newspaper for something to do. She didn't want to go to a movie. As she continued looking through the paper, she circled an advertisement.

As a favor, Robin was house-sitting for a friend and needed something to do, so she looked through the newspaper and circled an advertisement.

Target:
Robin had decided to try scuba diving.
She thought that it sounded interesting.

Closing:
She decided to pursue the idea early the next morning. She put the paper beside the phone, and then flipped through the T.V. guide looking for something interesting to watch that evening.

Was Robin house-sitting for a friend?

Introduction:
Peter had just finished talking on the phone with his friend Lisa. The next day was Labor Day and Lisa suggested that they go to the company picnic.

Consistent:
Peter loved picnics. He was a very social person and enjoyed the opportunity to meet others. The people Peter worked with joked about how much he talked to anyone who would listen. They claimed that if he worked more and talked less he would be much more productive.

Inconsistent:
Unfortunately, Peter had just contracted mononucleosis. The doctor said that he was still in the most contagious stage, and needed to be very careful. In fact, Peter was under strict orders to avoid contact with others. The doctor said it would be best if he stayed in bed.

Inconsistent Causal: (exp3)
Unfortunately, Peter had just contracted mononucleosis. The doctor said that he had to stay in bed because he was fighting a high fever and was in the most contagious stage. In fact, Peter was under strict orders to avoid contact with others.

Causal: (exp 4 & 5)
Because all of his friends were going to be at the picnic, Peter decided to ignore the doctor. He had not missed a picnic in all the years he worked for the company. Peter was a social person and wanted to see his friends.

Filler:
The picnic was the highlight of the year. The company really wanted to treat its employees well. Peter had worked for the company for 5 years and really enjoyed his work. He had had other jobs that were much less satisfying. His past employers did not treat the employees nearly as well. This year's picnic was to start at nine in the morning.

local
The company picnic was always the highlight of the year and this year was scheduled to start at nine in the morning.

Target:
Peter told Lisa to pick him up at eight.
He wanted to be the first one to arrive.

Closing
Peter was certain that the picnic would be fun. He had attended the previous year, and had a great time. This year was sure to be even better.
Did Peter talk to Lisa on the phone?

Introduction:
Chris really enjoyed outdoor activities. He was an athletic person and participated in many sports. He pursued athletics for the benefit of personal improvement and the fun of friendly competition.

Consistent:
Chris looked forward to winter sports. He found the cold brisk weather refreshing. In fact, he was planning on spending his vacation in the mountains. Each winter he tried a new sport and in past seasons he had tried skating, tobogganing, ice-fishing and snowmobiling.

Inconsistent:
He loved the warm spring weather and the hot days of summer. Since he couldn't stand the cold weather, he spent his winter vacations in the tropics. Each year he tried a new warm-weather sport and in the past he had tried windsurfing, swimming, and surfing.

Inconsistent Causal: (exp3)
He especially loved summer. Chris avoided winter weather because he was having early signs of arthritis in his knees that only hurt in the cold. He spent winter vacations in the tropics. As long as it was warm he could try new warm-weather sports like windsurfing and swimming.

Causal (exp 4 & 5)
Because Chris was visiting his father in the mountains this winter, he had to learn some new winter sports.
He knew his father would want him to try cold weather sports with him. His father always enjoyed skating, ice-fishing, and snowmobiling.

Filler:
Chris was an air-traffic controller at the airport in Boston. Because his job was very stressful and demanding, his boss scheduled a short vacation for the employees every few months. He thought the mini vacations were a great idea. He used them as an opportunity to get away from the hectic pace of work. During his time off, Chris was able to relax.
Local
Chris's boss scheduled a vacation for the employees every few months so Chris used his time off to get away and have some fun.

Target:
This year he had tried downhill skiing.
Chris quickly learned to ski downhill.

Closing:
He could not believe the freedom and excitement he felt while skiing down the mountain.   He had so much fun that he went and bought himself a pair of skis.

Was Chris a police officer?

Introduction:
Peggy had gained 40 pounds during her pregnancy. Recently, she started dieting and exercising daily in order to regain her youthful figure. She wanted to fit into her old clothes.

Consistent:
Peggy's daughter, Janie, who was now two-years-old loved to run around while Peggy did her sit-ups. In fact, Janie walked with her mommy everywhere she went. Still, Peggy never had to worry because she always knew Janie was walking right behind her.

Inconsistent:
Peggy's daughter, Janie, who was 10-months-old, was barely able to pull herself up. In fact, she had just recently learned how to crawl. Janie always stayed on a mat, while Peggy was exercising. This made life easier for Peggy because she always knew where Janie was.

Inconsistent Causal: (exp3)
Peggy's daughter, Janie, was 10-months-old. She always stayed on a matt while Peggy was exercising because her muscles hadn't developed enough yet to pull herself up or crawl. This made life easier for Peggy because she always knew where Janie was.

Causal: (exp 4 & 5)
Because Janie would always watch her big brother walk around, she quickly learned how to walk herself.
Janie did everything earlier than expected because she had her older brother to show her how.
Janie's newly acquired skill made it much harder for Peggy to get her exercise done.

Filler:
Peggy developed an exercise routine that fit nicely into her daily schedule. However, finding time to exercise was not her biggest problem with trying to lose weight. Her biggest problem was that her friends always wanted to go out to eat. She never knew what to order from the menu. She would usually just get salads. Suddenly the phone rang and Peggy went across the room to answer it.

While Peggy was getting started with her daily exercise routine the phone rang so she went across the room to answer it.

Target:
Janie stood up and walked to her mom.
She tugged hard on her mother's pants.

Closing:
Peggy bent over and placed the phone next to Janie's ear. Her dad was on the line and gave her a cheery hello. She smiled when she heard his voice.

Did Peggy fit into her old clothes?

Introduction:
Jackie was just beginning her second semester as a freshman at a local university. She had spent all her savings last semester on going out with friends. One of her friends suggested babysitting to make extra money.

Consistent:
Jackie loved playing with children. In fact, she started taking courses in child development to help her understand them better. She unfortunately did not have any younger siblings. She hoped to have a big family and have lots of children when she was older.

Inconsistent:
Jackie did not like children at all. She just did not understand them and thought they were a pain. If her friends had younger siblings, Jackie would always suggest that they hang out at her house in order to avoid spending time with younger children.

Inconsistent Causal: (exp3)
Jackie did not like children at all. She avoided children because she didn't understand them and was afraid of them. If her friends had younger siblings, Jackie would always suggest that they hang out at her house in order to avoid spending time with younger children.

Causal: (exp 4 & 5)
However, Jackie knew she had to take any job that was available because she needed to make money quickly.
Watching children was perfect because it allowed her to get paid immediately. She did not even have to wait for a paycheck.

Filler:
Jackie really enjoyed school. She was an exceptional student and got all A's her first semester. She was considering majoring in Psychology, Sociology, or even Anthropology because she really enjoyed those topics in high school. However, her parents preferred that she major in something more practical. They suggested the she major in Business or Accounting. She knew she still had three more years to figure things out.

Jackie really enjoyed school and was an exceptional student, but she was more concerned about her current income situation rather than her schoolwork.

Target:
Jackie started babysitting regularly.
She would take any job that she could.

Closing:
She decided that she would go out a lot less with friends this semester. Next year she would try to get a job working at the coffee shop downtown.

Introduction
Carol had always wanted to be a construction worker. It was hard getting started but she found this job two years ago. It was exciting for her and she couldn't have been happier.

Consistent
Carol especially enjoyed working on the beams of skyscrapers, high above the city. She was thrilled by the high winds and the view. She felt exhilarated watching the activity on the street far below. In fact, she always volunteered to work on the high beams.

Inconsistent
Carol was extremely scared of heights and would only work on the ground level. She even refused to climb anything higher than a step ladder. While the others worked on the upper levels she worked on projects where she could stay safely on the ground.

Inconsistent Causal: (exp3)
Carol was extremely scared of heights. She would only work on the ground level because of a serious fall she had six years ago. While the others worked on the upper levels she worked on projects where she could stay safely on the ground.

Causal (exp 4 & 5)
Because this was disrupting her life, her therapist suggested she try to do exciting activities involving heights.
As a result of these activities, Carol was able to work in high areas easily. Now, she no longer needed to depend on coworkers to do any part of her job.

Filler
Carol always ate lunch with her fellow workers. She was well liked and felt that she belonged. They were a friendly group of people she could depend on. She thought of them as a family and had developed several close friendships. In fact, one of her co-workers, Lori, invited Carol to join her on a trip. As Lori described the weekend adventure, Carol became very excited.

Her co-worker, Lori, invited Carol to join her on a trip. As Lori described the weekend adventure, Carol became very excited.

Target
She now really wanted to go skydiving.
Carol immediately accepted the offer.

Closing
To celebrate, she offered to take Lori out to dinner. Over dinner they finalized the plans for the trip. They would leave Lori's house the following Saturday at 6 am.

Was Carol liked by her co-workers?

Introduction
Bill had always enjoyed walking in the early morning and this morning was no exception. During his walks, he would stop to talk with some of his neighbors.

Consistent
Bill had just celebrated his twenty-fifth birthday. He felt he was in top condition and he worked hard to maintain it. In fact, he began doing additional workouts before and after his walks. He could now complete a mile run with hardly any effort.

Inconsistent
Bill had just celebrated his eighty- first birthday. He didn't feel as strong as he was twenty years ago. In fact, Bill began using a cane as he hobbled along on his morning walks. He could not walk around the block without taking numerous breaks.

Inconsistent Causal: (exp3)
Bill had just celebrated his eighty-first birthday. Bill had to use a cane on his morning walks because he recently sprained his ankle on the stairs. He didn't feel as strong as he was twenty years ago. He could not walk around the block without taking numerous breaks.

Causal (exp 4 & 5)
Nevertheless, his age never prevented him from acting in emergencies because he always had boosts of adrenaline. The adrenaline always gave him immediate boosts in strength and energy. In fact, last month he was able to get his neighbor out of her house when there was a fire.

Filler
Today, Bill stopped to talk with Mrs. Jones. They had been friends for quite some time. They were talking about how hot it had been. For the past three months there had been record breaking high temperatures and no rain. Soon there would be mandatory water rationing. As Bill was talking to Mrs. Jones, he saw a young boy who was lying in the street hurt.

As Bill was talking to Mrs. Jones, he saw a young boy who was lying unconscious and hurt in the street.

Target
He quickly ran and picked the boy up.
Bill carried the boy over to the curb.

Closing
While Bill helped the boy, Mrs. Jones ran into her house to call the boy's mother and an ambulance. He kept the boy calm and still until help arrived.

Did Bill hate walking in the morning?

Introduction
Owen had just completed graduate school and now had begun looking for a job. Most jobs he looked at were academic positions which required both teaching and research.

Consistent
The part of graduate school that Owen liked most was teaching. He hoped his new job would only consist of teaching responsibilities. His students all had favorable things to say about him and he was proud of his accomplishments. He was not interested in research.

Inconsistent
Owen particularly liked the research that he performed while in graduate school. To him, there was nothing more enjoyable than discovering something that had not been known before. He was a successful researcher and wanted to continue along this line. He was not interested in teaching.

Inconsistent Causal: (exp3)
Owen particularly liked the research that he performed in graduate school. He was not interested in teaching because he was terrified of talking in front of the classroom with everyone looking at him. He was a successful researcher and wanted to continue along this line.

Causal (exp 4 & 5)
Because there were no research positions currently available, his mentor told him to find a decent teaching program.
Because the job market was so bad, teaching positions were his only option. He agreed with his mentor that this was a wise decision.

Filler
An additional constraint that Owen faced was geographical location. He grew up in New England and did not want to leave. Owen enjoyed the changing seasons and the cold weather. In fact, his favorite sports were hockey and skiing. With all of this in mind, Owen searched through the paper for jobs that would suit him. Finally, he found one he liked.

Owen searched through the paper for jobs that would suit him. It took days but he finally found one he liked.

Target
Owen applied for a teaching position.
This university discouraged research.

Closing
Owen hoped that he would be hired for the job. He knew many new doctorates who could not find positions that suited them and he did not want to be in that position.

Was Owen an auto mechanic?

Introduction
Steven recently graduated from college and was going to graduate school. As an undergraduate, he was involved in numerous organizations. This helped Steven to narrow his interests for graduate school.

Consistent
He was most proud of being an officer of the mechanical and industrial clubs. Steven felt that natural resources should be exploited. It didn't matter if it destroyed the environment. He believed any effect would be temporary and the environment would take care of itself.

Inconsistent
He was most proud of being an officer in the numerous clean up and recycling clubs. Steven was an active environmentalist on campus and in the surrounding community. Once, he was involved in leading a protest against companies dumping waste products into a local river.

Inconsistent Causal: (exp3)
He was proud of being an officer in the numerous clean up and recycling clubs. Steven was an active environmentalist because his little brother got seriously ill from drinking contaminated water. He was involved in leading a protest against companies dumping waste products into a local river.

Causal (exp 4 & 5)
Still, he never recycled trash outside of school because he only presented himself that way to build his resume.
Because he didn't really care about recycling, he often dumped trash anywhere. But it was important to Steven to look good because graduate schools look for students with volunteer work.

Filler
Last Saturday, Steven had to work on his car. Steven kept it in perfect working condition. It was time for its monthly grease job, filter replacement, and oil change. He took out all of the tools that he would need. Then he jacked the car up and drained the oil into an old container. Steven took the container around to the side of his house.

Last Saturday, Steven had to work on his car. He jacked the car up and drained the oil into an old container.

Target
He dumped the oil out in his backyard.
Steven figured that it would be okay.

Closing
He returned to the garage and finished working on his car. After he was satisfied with the engine work, Steven waxed the finish, polished the chrome, and cleaned the interior.

Did Steven graduate from college?

Introduction
Today, Mary was meeting a friend for lunch. She arrived early at the restaurant and decided to get a table. After she sat down, she started looking at the menu.

Consistent
This was Mary's favorite restaurant because it had fantastic junk food. Mary enjoyed eating anything that was quick and easy to fix. In fact, she ate at McDonalds at least three times a week. Mary never worried about her diet and saw no reason to eat nutritious foods.

Inconsistent
This was Mary's favorite restaurant because it had fantastic health food. Mary, a health nut, has been a strict vegetarian for ten years. Her favorite food was cauliflower. Mary was so serious about her diet that she refused to eat anything which was fried or cooked in grease.

Inconsistent Causal: (exp3)
This was Mary's favorite restaurant because it had fantastic health food. Mary had been a strict vegetarian for years because she was an animal rights activist and against animal cruelty. She was serious about her diet and refused to eat anything that was fried or cooked in grease.

Causal (exp 4 & 5)
 She wasn't getting enough vitamins because of her diet so her doctor said she had to start eating meat.
She agreed to begin eating meat because it would solve her health issues. He doctor assured her that her iron levels would soon return to normal.

Filler
After about ten minutes, Mary's friend arrived. It had been a few months since they had seen each other. Because of this they had a lot to talk about and chatted for over a half hour. Finally, Mary signaled the waiter to come take their orders. Mary checked the menu one more time. She had a hard time deciding what to have for lunch.

Mary checked the menu and specials one more time. She was having a hard time deciding what to have for lunch.

Target
Mary ordered a cheeseburger and fries.
She handed the menu back to the waiter.

Closing
Her friend didn't have as much trouble deciding what she wanted. She ordered and they began to chat again. They didn't realize there was so much for them to catch up on.

Was Mary meeting her husband for lunch?

Introduction:
Joe sat down by the window and looked outside. It was a beautiful evening. He wanted to spend some time enjoying it, so he changed into shorts and headed outside.

Consistent:
Joe was an avid jogger. He would run as many as six miles a day. In fact he began jogging ten years ago as an occupational hobby, but was now one of the best runners in that area. Joe could run five miles in under twenty five minutes.

Inconsistent:
Joe hated physical exertion. His idea of exercise was climbing up two flights of stairs. If he had a choice he would use the elevator. He was not exactly lazy, but he generally avoided unnecessary exercise, such as jogging. Joe thought that jogging was a waste of time.

Inconsistent Causal: (exp3)
Joe hated physical exertion. He especially hated jogging because he had weak ankles and he didn't want to injure them further. At work he would always use the elevator if he had a choice. He was not exactly lazy, but he generally avoided unnecessary exercise.

Causal: (exp 4 & 5)
However, because he was starting to put on some extra weight, Joe decided to make jogging a regular habit.
He made a schedule so he could get in as much exercise that he could during the day. He did not want to be out of shape.

Filler:
Joe had recently moved to a new area. His new apartment was in the country. There were miles and miles of country roads leading to and from the city. Joe really loved the area and enjoyed having all the open spaces around him. He moved from the city and did not miss the congestion that was its trademark. He would never live in that city again.

Joe had recently moved to a new area and vowed never to live in the city again because he loved the open space.

Target:
Joe decided he would go for a long run.
He ran five miles before heading home.

Closing:
Joe was outside for about an hour. He would have stayed out longer but it was getting late and he had to get up early for work the next morning.

Was it raining outside?

Introduction
George was a senior in high school and was in the process of applying to college. During this time, he realized he needed to participate in some extracurricular activities before he graduated.

Consistent
George had always been outgoing and loved to talk and perform in front of people. When a teacher would assign an oral report he would get excited. On the day of an oral report, he would be the first to volunteer to present his report.

Inconsistent
He had always been shy and detested speaking in front of strangers. When a teacher would assign an oral report he would become sick to his stomach. On the day of a report, George would often break out in hives and would have to leave school.

Inconsistent Causal: (exp3)
He had always been shy. He detested speaking in front of strangers because the last time he did he broke out in hives, everyone laughed, and he had to leave school. When a teacher would assign an oral report he would become sick to his stomach.

Causal (exp 4 & 5)
Because George wanted to act, he was determined to overcome his fear of speaking in front of people. So, he enrolled himself in a public speaking course. He enjoyed the course so much that he pursued more opportunities for public speaking.

Filler
His high school offered many different after school activities. He decided to join the band as one of his activities. He also became a member of the yearbook staff. He decided to check the activities bulletin board for a couple more ideas. He first noticed an announcement for wrestling tryouts and then he noticed a colorful poster. It was announcing auditions for the spring play.

His high school offered many different after school activities. He saw a large flier announcing open auditions for the spring play.

Target
He auditioned for the part of male lead.
He was cast in the male lead of Romeo.

Closing
The rehearsals were to begin the next day. George picked up his script and began to study that night. He wanted to be the best Romeo anyone had ever seen.

Was George applying to college?

Introduction
Jess had always been fascinated by different cultures. Her family had decided to take a trip to Germany last summer. She was glad her parents had chosen Germany as a vacation spot.

Consistent
Jess was able to use the language she had been studying for seven years. She had always gotten A's in her German classes and had also received the outstanding German student award in high school. This award included a scholarship for each year of college.

Inconsistent
It was the first time Jess had left her small midwestern town. She had no idea what Germany would be like. None of the schools in her town offered foreign culture or language classes. Her only exposure to German culture was a television documentary.

Inconsistent Causal: (exp3)
It was the first time Jess had left her small midwestern town. She could not speak German at all because none of the schools in her town offered foreign culture or language classes. Her only exposure to German culture was a television documentary.

Causal (exp 4 & 5)
Jess was able to learn German because she borrowed library cds of a complete course in the language.
She carefully listened to cd's for several weeks. Soon, she could understand quite a bit of German and she could speak the language fairly well.

Filler
While in Germany the family went to Check Point Charlie and the Berlin Wall. After their trip through East Germany, they agreed it was a very depressing place. They also visited the Rhineland and many different castles. The family attended Oktoberfest and the Faschings festival. They had a wonderful time at both carnivals. At the festivals, the greatest experience was eating in the huge dining halls.

While traveling in Germany, the family saw many famous sights. The greatest experience for them was eating in the huge dining halls.

Target
Jess ordered all of her meals in German.
No one could believe how fluent she was.

Closing
Everyone agreed that German food was much better than American food. After dinner one night the family decided to visit the Berlin zoo. Jessica wanted to see the baby pandas.

Did Jessica and her family visit Cape Cod?

Introduction
As he got out of the shower, Tim was thinking about what needed to be done. He was going to have one shot at this and he wanted to get it right.

Consistent
He was going to tar his roof and then lay down shingles. Tim knew tarring was messy and sticky work. On hot days, the tar seemed to get everywhere. He knew by the end of the day he would be covered with the stuff.

Inconsistent
Tim was going to propose to his girlfriend. Their evening would begin at Chez Loui, an elegant French restaurant. Chez Loui was a very formal place and Tim wanted to look his best. After he proposed a toast, Tim would ask for her hand in marriage.

Inconsistent Causal: (exp3)
Tim was going to propose to his girlfriend. He needed to dress up in a suit and tie because they were going to Chez Loui, an elegant French restaurant. Tim wanted to look his best. After he proposed a toast, Tim would ask for her hand in marriage.

Causal (exp 4 & 5)
He needed to dress casual because he didn't want her to know this was a special night.
He knew if he put on dress pants and a tie she would be suspicious. So, he decided to throw her off and to wear casual clothes.

Filler
With a towel around his waist, Tim went about getting ready. He went into the bathroom and shaved. Then he returned to his bedroom and he searched for his shoes. Next, he looked through his dresser for some clothes but didn't find anything he liked. He opened his closet and turned on the light. Tim had a hard time choosing what to wear.

Tim had a hard time choosing what to wear. He looked through his dresser for some clothes but didn't find anything he liked.

Target
At last he grabbed some old faded jeans.
Tim pulled them on and zipped them up.

Closing
Tim searched his drawers for a pair of socks. He finished getting ready and grabbed his keys and wallet. Tim locked the door behind him and was on his way.

Was Tim getting ready to go to bed?

Introduction
Jennifer enjoyed walking everyday in the park near her house. During the summer months, she would often stop and watch the ducks swimming in the small pond.

Consistent
Jennifer was a healthy, twenty-two year old woman. She had just graduated from college and was in top physical condition. She could not imagine herself being in better shape. In fact, her health was the one thing she was most proud of.

Inconsistent
Jennifer was quite old and was having problems with her hearing. She was legally deaf and could not hear anything at all. She had tried to use a hearing aid, but it had stopped helping years ago. She was in her own silent world.

Inconsistent Causal: (exp3)
Jennifer was old and was having problems with her hearing. She was legally deaf and could not hear anything because of a serious infection that damaged her ears. She tried to use a hearing aid, but it stopped helping years ago. She was in her own silent world.

Causal (exp 4 & 5)
However, now she is able to hear loud noises because her doctor gave her a newer model hearing device.
The new model worked much better than any she had used in the past. She was able to hear loud noises even those far away

Filler
One day, while Jennifer was walking in the park, a mugging took place. A young man approached an elderly woman. He demanded her money. The man was dressed in black and wore a mask over his face. Jennifer was about thirty feet from where the event was taking place. The woman screamed as the young man stole her purse and ran away.

One day, while Jennifer was walking, a mugging took place. Jennifer was about thirty feet from where the event was taking place.

Target
Jennifer heard the woman yell for help.
She looked up to see what was happening.

Closing
The police asked Jennifer to give them all of the information that she could. There had been a string of muggings in the park and the police were interested in finding the culprit.

Did Jennifer enjoy swimming in the pond?

Introduction
Carl and Sarah had only been dating for about two weeks. However, Carl wanted to plan a special night for their next date. A friend suggested that they attend a baseball game.

Consistent
Carl loved baseball and thought that this was a great idea. He had been a huge fan of the Red Sox ever since he could remember. As a child, his whole life revolved around the sport. He thought going to a game would be the perfect date.

Inconsistent
Carl thought that this was a terrible idea. When he was younger his father had dragged him to baseball games. He hated them and vowed that he would never go again. He was sure that he would think of something better to do on their date.

Inconsistent Causal: (exp3)
Carl thought a game was terrible idea. Carl hated baseball because he got hit in the head by a fly ball when he was younger. He vowed that he would never go again. He was sure that he would think of something better to do on their date.

Causal (exp 4 & 5)
He knew, however, that Sarah would love to go to the game on their date because she loved baseball.
So, he decided to ignore his own hatred for the game. On his date he was going to do what she wanted to do.

Filler
He called Sarah to set a time for their next date. After he finished talking to her, he thought about their relationship. Although they had only been dating for a short while, he really liked her. Carl enjoyed her great sense of humor. He was particularly fond of her laugh. Carl decided that this was the night to tell Sarah how he felt about her.

He called Sarah to tell her about the plan for their next date, and then he confirmed the day and time.

Target
He called the ballpark to order tickets.
He hoped that they would get good seats.

Closing
Carl sat back and thought about where he and Sarah would go to eat before the game. He was certain that they would have a great time together.

Were Carl and Sarah married?

Introduction
Fred always wanted to go to college. He studied really hard in high school so he would be able to achieve his goal. He graduated with high honors.

Consistent
Fred's favorite subject in school was math. He could not think of a bigger challenge in school which matched the one posed by understanding math. He spent his free time performing complicated mathematical equations on his new computer. The intellectual challenge of math excited him.

Inconsistent
Fred had done well in all his classes except math. He had to struggle though each math course with the help of a tutor. He just did not understand the concepts behind the operations. He only took the minimum number of math courses required to graduate.

Inconsistent Causal: (exp3)
Fred had done well in all his classes except math. He avoided math courses because in the past he was made fun of for failing the same course twice. He struggled through each math course with the help of a tutor. He just didn't understand the concepts.

Causal (exp 4 & 5)
Because he wouldn't let his high school experience influence him, he took summer math courses and improved his skills.
He now completely understood many of the basic concepts of math. He even began to really enjoy learning about the more challenging math topics.

Filler
Because of Fred's hard work, he had been accepted to Stanford University. He knew that the school had an excellent reputation. He would have little problem finding a job when he finished college. Fred decided it was time to look through the college catalogue. He looked for some classes for the fall. He wanted to pick classes he knew he would do well in.

Fred had been accepted at Stanford University. He decided to look through the college catalogue for classes he knew he would do well in.

Target
He decided to take three math courses.
He thought they would be interesting.

Closing
College would be hard, but Fred was confident that he would do well. His hard work had always paid off and he was certain it would this time as well.

Did Fred want to go to college?

Introduction
Ken had been looking for a hobby for quite some time. With his new job, he had four days a week free which would give him plenty of time to devote to a hobby.

Consistent
Ken was a big man and always tried to keep in shape by jogging and lifting weights. His 250 pound body was solid muscle. Ken loved tough physical contact sports which allowed him to match his strength against another person.

Inconsistent
Ken was a small man and didn't worry about staying in shape. His small 120 pound body was all skin and bones. Ken hated contact sports, but enjoyed non-contact sports, such as golf and bowling which he could practice alone.

Inconsistent Causal: (exp3)
Ken was a small man and didn't worry about staying in shape. He avoided contact sports because he already broke his arm and leg. His small 120 pound body was all skin and bones. Ken enjoyed non-contact sports, such as golf and bowling which he could practice alone.

Causal (exp 4 & 5)
Because his friends often teased him about his weight, he wanted to do a more physical sport. Ken decided he really needed to build some muscle to stop the teasing. So, he was looking for an appropriate class to help him do just that.

Filler
While walking downtown, Ken passed a new gymnasium. He noticed the display in the window. It was an advertisement for their summer sports program. Ken started looking at the advertisement and was impressed with the long list of activities that the gym sponsored. As he continued to look over the list, he became very excited. It seemed interesting so Ken went inside.

While walking downtown, Ken passed a new gymnasium. He noticed the advertisement for their sports program. It seemed interesting so Ken went inside.

Target
Ken decided to enroll in boxing classes.
He felt this would be the perfect hobby.

Closing
Ken signed-up for the class and paid the registration fees. He couldn't wait for the class to begin. Ken exited the gym and continued his walk downtown.

Was Ken looking for a hobby?

Introduction
Elizabeth's daughter, Kim, had just started kindergarten. Elizabeth was happy that Kim had made a lot of friends. Kim would often tell her mom about her friends at school.

Consistent
In addition, little Kim loved animals. In fact, she refused to leave a room that had any type of pet in it. Every time she saw an animal she wanted to pet it and take it home. Elizabeth didn't know why Kim loved animals so much.

Inconsistent
Unfortunately, Kim hated animals and was terribly frightened of them. In fact, she refused to go in the same room with a cat. Every time an animal approached her, she ran away and began to cry. Elizabeth didn't know why Kim was so frightened of animals.

Inconsistent Causal: (exp3)
Unfortunately, Kim hated animals. She was terribly frightened of them because she was attacked by her neighbor's cat. She refused to go in the same room with a cat. Every time an animal approached her, she ran away and began to cry.

Causal (exp 4 & 5)
However, Kim wasn't afraid of animals when her mother was in the room because her mother always protected her.
In fact, as long as her mother was there, Kim seemed to enjoy animals. She was not afraid to play with them at all.

Filler
Elizabeth always dropped Kim off at school. Today, however, Kim wanted Elizabeth to come into school with her. She wanted Elizabeth to see her art work and meet some of her friends. When they arrived, Kim ran up to the school doors. As Elizabeth and Kim entered the classroom, Kim looked around. Someone had brought in their pet and all the children were gathered around it.

As Elizabeth and Kim entered the classroom, Kim looked around. Someone had brought in their pet and all the children were gathered around it.

Target
Kim ran across the room to pet the dog.
She smiled as she brushed the dog's fur.

Closing
Kim waved to her mom and asked her to come see the dog. Elizabeth walked to the other side of the room and knelt down beside Kim and petted the dog.

Was Elizabeth's daughter in high school?

Introduction
Todd woke up and hopped out of bed. This was his favorite time of the day and he did not want to waste it lying in bed.

Consistent
Todd ran over to the wood stove and lit a fire to warm up. During the winter months, his house usually got very cold. He enjoyed lighting a fire and watching it burn while he had breakfast and warmed up.

Inconsistent
It had been the warmest winter in the past fifty years. Todd could not believe it had gotten so warm. In fact, it was so warm that people were spending most of the day outdoors. Todd decided he would go outside after he finished breakfast.

Inconsistent Causal: (exp3)
It was the warmest winter in the past fifty years. Todd kept hearing on the news that the area was getting abnormal weather because of global warming. It was so warm that people were spending most of the day outdoors. Todd decided he would go outside after breakfast.

Causal (exp 4 & 5)
There were icicles in the windowsill because Todd left the windows open and it was still freezing at night.
Because the window was wide open all night, the house lost all the heat. He needed to turn the thermostat up higher to make the house more comfortable.

Filler
Todd lived in a house which he had designed and built himself. He was proud of it and enjoyed showing it off. He had not been a great student and people believed he wouldn't amount to much. However, he became a successful architect and builder. He was proud of his accomplishments, but believed he was capable of more. His dream was to design and build skyscrapers.

Todd really enjoyed winter activities like skiing and ice fishing. Hockey had been his favorite sport since he was a child.

Target
Todd thought that his house was cold.
He grabbed a sweater from his closet.

Closing
Todd walked back into the kitchen. He finished eating his breakfast and went into the living room. Todd thought it was going to be a great day.

Did Todd like the morning?

Introduction
As Linda was driving to her job interview, her car overheated and stopped running. The car was very old and she knew she needed to buy a new one.

Consistent
Fortunately, this wasn't a problem for Linda. Her parents were very rich and would give her the money for a new car. Linda's parents always gave her money and whatever else she wanted. They had continued to do so even after she graduated from college.

Inconsistent
Unfortunately, Linda didn't have the money to buy a new car. She had just graduated from college and was unable to find a job. She owed thousands of dollars in loans and barely had enough money to survive. Linda knew she couldn't get a loan.

Inconsistent Causal: (exp3)
Linda didn't have the money to buy a new car. The bank turned her down for a loan because she already owed thousands of dollars and had very bad credit. She just graduated from college and couldn't find a job. She barely had enough money to survive.

Causal (exp 4 & 5)
Because her parents wanted her to have a reliable vehicle, they co-signed a loan for buying a car. Linda would not have been able to get a car on her own. Because her parents were helping, she could get any car that she wanted, regardless of price.

Filler
Right now, though, Linda had to call a tow truck and find a way to get to her interview. Luckily, there was a pay phone just up the road. She called to have her car towed. Next, she called to reschedule her interview. As Linda waited for the tow truck, she thought about what she was going to do. Linda had to find a new form of transportation.

Linda called a tow truck to come pick her up. She knew she had to find a new form of transportation.

Target
Linda decided to buy a brand new car.
She could easily afford to buy a car.

Closing
Finally, the tow truck arrived. Linda was happy to see the truck because she wanted to go home. Linda was frustrated and thought the day was a complete disaster.

Was Linda on her way to a job interview?

Introduction
Al and Sue were on their way to a friend's house for a party. This was the first time in quite awhile that Al and Sue had visited their friends.

Consistent
They were speeding along the highway at about 85 mph. Al described to Sue the perfect condition of his new, sleek sports car. He loved the power, control and speed of the car, which could cruise at speeds well over 95 mph.

Inconsistent
They were crawling along the highway at about 30 mph. Al described to Sue the terrible condition of his old, beat up car. He complained about how the car would only sputter up to 35 mph then stall and over-heat.

Inconsistent Causal: (exp3)
They were crawling along the highway at about 30 mph. They could only go 30 mph because if they went faster the car would sputter then over-heat and break down. Al described to Sue the terrible condition of his old, beat up car.

Causal (exp 4 & 5)
Because Sue often enjoyed driving fast, she told Al to test the limits of his car and drive faster. Al let Sue influence him and he pushed down on the gas. He was nervous but got the car up to a speed well over the limit.

Filler
Al and Sue always enjoyed the road-side scenery on the long drive to their friend's home. Their friends lived in the mountains. The road was lined with large oaks and maples. The scenery was especially beautiful in the fall. As they were driving along the highway, Al suddenly noticed a police car in his rearview mirror. Al pulled over to the side of the road.

As they were driving, Al suddenly noticed a police car in his rearview mirror. Al pulled over to the side of the road.

Target
The officer handed Al a speeding ticket.
He told Al it would cost fifty dollars.

Closing
Al took the ticket and put it in his wallet. Quite upset, Al started up the car. For the remainder of their trip, Al did not say a word.

Were Al and Sue going to visit their parents?

Introduction
Karen called her friend Ralph at his dormitory. She had just returned from spring vacation and asked if he could arrange for someone to pick her up at Logan airport.

Consistent
Ralph enjoyed driving to the airport in Boston. Because he grew up in the city, he had a lot of practice driving in heavy traffic. Ralph was proud of his city driving skills and often offered to take his friends into the city and to the airport.

Inconsistent
Even though Ralph had had his license for years, he was petrified of driving in Boston. Ever since he was in a terrible accident two years ago, he refused to drive in the city. If he needed to go anywhere near the city, Ralph took public transportation.

Inconsistent Causal: (exp3)
Even though Ralph had had his license for years, he was petrified of driving in Boston. He refused to drive in the city because he was in a terrible accident five years ago. If he needed to go anywhere near the city, Ralph took public transportation.

Causal (exp 4 & 5)
He had to get her because he couldn't find anyone else and she would be stranded if he didn't. Ralph was determined not to let his friend get stuck in the city. He printed directions so he would not get lost and walked over to his car.

Filler
Ralph and Karen were both sophomores in college. Ralph had known Karen for about a year. They had taken classes together. He thought she was a nice person and enjoyed her company. He was anxious to hear all about her vacation and he hoped that she had taken lots of pictures. Ralph had spent his vacation catching up on some overdue school work.

He was really anxious to hear all about Karen's vacation, and he hoped that she had taken a lot of pictures.

Target
Ralph drove into Boston to pick her up.
He recalled why he enjoyed city driving.

Closing
As he approached the airport, Ralph thought about how nice it would be to see Karen. He was anxious to hear about her vacation and tell her what had been happening at school.

Did Karen call Ralph at his dormitory?

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Introduction
Phil was watching television while his wife finished unpacking. They had gone away for the weekend and left the house a mess. His wife sat down and they began discussing cleaning up the house.

Consistent
Phil had a habit of throwing everything away, especially when it came to receipts and sales slips. He would read notes, letters, and bills once and then throw them away. In fact, Phil had not kept any kind of a record for over ten years.

Inconsistent
Phil was a true "packrat" and saved everything. In fact, he had been saving receipts, letters, and newspapers for over the past ten years. He had a large storage room in which he put important papers and other things he wanted to save.

Inconsistent Causal: (exp3)
Phil was a true "packrat." He saved everything because he had a medical disorder which caused extreme anxiety when he threw things away. He had been saving receipts, letters, and newspapers for over ten years. He had a large storage room in which he put important papers.

Causal (exp 4 & 5)
Because his storage room was becoming crowded, he stopped saving old documents after his wife demanded that he clean.
After she asked him, he spent one full day cleaning everything that he could. He got rid of all the unneeded old papers.

Filler
As Phil and his wife were talking, she remembered that she had to find the last bank statement. They had received a notice that their car payment was overdue. Phil's wife knew they had paid it but the notice said they hadn't. The confusion was probably a computer error. One of her friends had experienced a similar problem. Suddenly, Phil remembered what he had done with them.

As Phil and his wife talked, she remembered she had to find their latest bank statement. Phil remembered what he had done with them.

Target
He had thrown away the bank statements.
He had thrown them out a long time ago.

Closing
Frustrated, they sat down and started thinking about what they should do. Phil said he would call the bank in the morning to see if they had any record of the transaction.

Did Phil's wife unpack?

APPENDIX B
IRB APPROVAL PAGE

University of New Hampshire
Institutional Review Board for the Protection of Human Subjects in Research
Departmental Review Committee Exemption Classification Sheet

Name: _Emily Smith_   IRB #: _120905 A_

Dept: _Psychology_   Reviewer: _Lee_

Study: _Updates w/ Casal information_

Exempt Review

46.101(b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as:
(i) research on regular or special educational instructional strategies, or
(ii) research on the effectiveness of or comparison among instructional techniques, curricula, or classroom management methods.

46.101(b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and
(ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to subjects' financial standing, employability, reputation.

46.101(b)(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under category (b)(2) if:
(i) the human subjects are elected or appointed public officials or candidates for public office; or
(ii) federal statute(s) require(s) without exception that confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

46.101(b)(4) Research involving the collection or study of existing data, documents, records, pathological specimens or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked the subjects.

46.101(b)(5) Research and demonstration projects which are conducted by or subject to the approval of department agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) poss changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or lev of payment for benefits or services under those programs.

46.101(b)(6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods with additives are consumed or (ii) or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or be the level found to be safe, by the Food and Drug Administration, or approved by the Environme Protection Agency, or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

_____ Protocol is approved as presented in the category checked

_____ Protocol is approved with the following contingencies/comments (attach sheets if necessar

_____ Protocol is referred to the IRB for Expedited or Full Board review

_____ Protocol cannot be approved as presented (cite reasons on separate sheet)

DRC Reviewer: _____   Date: _____