DOMAIN-SPECIFIC EPISTEMOLOGICAL BELIEFS AND READING COMPREHENSION OF EXPOSITORY TEXTS ON PSYCHOLOGY AND PHYSICS

By

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To humanity’s ability to deal with the confusion we create every day

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The relations between domain-specific epistemological beliefs and reading comprehension of expository texts on the subjects of psychology and physics were investigated. Thirty-six undergraduate students typed their comments on a computer while they read. Participants had more sophisticated epistemological beliefs in psychology than physics. When reading the psychology text, participants evaluated more information, acknowledged more often their lack of a certain stance in regards to the information, and had better comprehension scores. Having naive epistemological beliefs in psychology was positively related to making predictive comments while reading. Making comments that reflected an epistemological evaluation of the text were positively related to metacognitively monitoring the information while reading the psychology and the physics text. Participants who epistemically evaluated the information had better comprehension scores and made more elaborations while reading the psychology text. This study found that epistemological beliefs are related to reading measures of reading comprehension at a domain-specific level.

CHAPTER 1
INTRODUCTION

People's views about the nature of knowledge and the knowing process are studied under the name of epistemological beliefs or personal epistemology (Schommer-Aikins, 2002; Schommer, 1990). According to Schommer-Aikins (2002), people are said to have sophisticated epistemological beliefs when they are able to use various ways to justify knowledge, integrate knowledge, and see the knowing process as something that takes time and is in constant development. Research shows epistemological beliefs are related to readers' ability to comprehend texts (Schommer, 1994), which is a critical academic skill. Indeed, it is becoming well documented that personal epistemology predicts different aspects of this intellectual activity, such as the types of strategies readers use to comprehend a text (Ryan, 1984), the types of conclusions written after reading a text (Schommer, 1990), the accuracy of monitoring how much information has been understood (Schommer, 1990), the kinds of cognitive processes used while reading (Kardash & Howell, 2000), and reading comprehension of multiple texts (Bråten & Strømsø, 2006). The general purpose of the study is to further explore the relation personal epistemology has with different aspects of reading comprehension. Given the important findings present in the literature tying reading comprehension to the beliefs people have about knowledge, it appears important to investigate whether some of the relations already observed are in fact happening while someone reads texts in different knowledge domains. The goal is to understand more accurately this dynamic, and to what extent personal epistemology is an important factor that educators need to address if they are to aid students to successfully comprehend scientific texts in multiple subjects.

It has become a recent area of research to determine whether epistemological beliefs should be understood as a cognitive construct that affects multiple areas of intellectual activity (domain-general) or if should be understood as a construct that is specific to a particular content domain (domain-specific), which is an important question to explore when studying its relation to reading if a clear relation between epistemological beliefs and reading is to be understood. According to Hofer (2000), first-year college students hold epistemological beliefs relative to the disciplines of science and psychology. She found that students generally had more sophisticated beliefs in psychology than in science. For instance, when it came to knowledge in psychology, students believed that personal knowledge and experience had a higher epistemic status than an external source of authority and expertise. When it came to science, students believed knowledge in science to be more certain and static, and viewed the role of experts as more important than firsthand experience when determining truthfulness. Since epistemological beliefs have been found to operate within specific domains, and epistemological beliefs are related to reading comprehension (Bråten & Strømsø, 2006; Kardash & Howell, 2000; Ryan, 1984; Schommer, 1994; Strømsø, Bråten, & Samuelstuen, 2008), I believe it important to study whether epistemological beliefs operate at a domain specific level even when people read texts that differ in topic. The specific purpose of this study is to unveil possible ways in which domain-specific epistemological beliefs are related to reading comprehension. In more explicit terms, the study attempts to answer how readers' epistemological beliefs specific to a domain of physics and psychology influence cognitive processing and comprehension of physics and psychology texts.

Epistemological Beliefs and Reading

To date, research about epistemological beliefs has been conceptualized in two broad ways. The first research tradition conceives personal epistemology as a construct of stages that develop as the person interacts with knowledge. On the basis of a yearly analysis of interviews of mostly male college students, including 67 complete four-year reports of the college experience, Perry (1970) proposed nine positions by which students look at themselves, the world, and knowledge. From his initial research several developmental models of personal epistemology have been developed (Baxter Magolda, 1992; Belenky, Clinchy, Goldberg, & Tarule, 1986; Hallett, Chandler, & Krettenauer, 2002; King & Kitchener, 2004), but they retain a core developmental structure. In the first stage (dualism or absolutism) the person thinks that knowledge is the product of directly observing reality and there are true and false observations of reality. In the second stage (relativistic, multiplist, or skepticism) the person realizes that knowledge is a matter of interpretation. In other words, the person realizes that people interpret the same reality differently and that humans construct knowledge based on those interpretations. Therefore, there are no truths or falsehoods. Knowledge is opinion and is relative to the individual. In the last stage (commitment within relativism, evaluativist, or rationalism) the person believes that given certain criteria or grounds, people make better or worse assertions about reality. Knowledge, at this stage, is the product of careful reflection and evaluation, and there is perceived value in the rational process of attaining knowledge. However, few studies attempting to understand the relationship between personal epistemology and reading comprehension have stemmed from this line of research.

Ryan (1984) conducted one of the only studies investigating the relationship of personal epistemology and reading comprehension using a conceptualization that fairly resembles Perry's (1970) developmental scheme. In this study participants' personal epistemology was classified using Perry's (1970) scale as either having dualistic (right or wrong, true or false) or relativistic epistemological positions. Ryan asked college students to read an introductory textbook chapter in psychology with the purpose of assessing their reading comprehension strategies. He found that those students with a dualistic epistemological position were more likely to identify and memorize isolated facts, and students with a relativistic epistemological position were more likely to abstract relationships and inferences present in the text. There was no assessment of final comprehension, however. This study collected some of the first data correlating a person's understanding about the nature of knowledge and the use of different reading comprehension strategies.

The second research tradition conceives of personal epistemology as a set of beliefs that can operate independently from each other. For example, someone might believe knowledge to be composed of simple facts but believe that learning about a subject takes time and effort. Schommer (1990) conducted the first major study that attempted to conceptualize personal epistemology as five beliefs expressed along a continuum from naïve to sophisticated. On the basis of a factor analysis of the scores of 266 college students on her 63-item questionnaire Schommer found evidence for a construct of personal epistemology as composed of four beliefs: S*imple Knowledge, Certain Knowledge, Quick Learning,* and *Omniscient Authority*. According to Schommer (1994), the *Source of Knowledge* dimension (omniscient authority) ranges from the view

that knowledge comes from authoritative external sources (experts or textbooks) to knowledge is actively constructed by the knower. The *Certain Knowledge* factor is characterized by the naïve belief that knowledge is absolute or the sophisticated belief that knowledge is tentative and is constantly evolving. The *Simple Knowledge* (Organization of Knowledge) belief can vary from a person believing that knowledge is composed of isolated facts to the idea that knowledge is composed of complex networks of associations and interrelationships. The *Quick Learning* (Speed of Learning) dimension fluctuates from the belief that knowledge can be gathered quickly and surely to the belief that acquiring knowledge is progressive.

In addition to administering the questionnaire that assessed the aforementioned dimensions of epistemological beliefs, Schommer (1990) asked participants to read one text on aggression and one on nutrition where contrasting viewpoints about each subject were presented. She found that when participants believed that learning happens in a quick way, they were more likely to write conclusions where only one point of view was stated or avoided writing a conclusion altogether. When participants believed knowledge to be certain, they were more likely to state in their conclusions that there was a definitive answer to the contrasting viewpoints or that there was an answer at hand in the future. Another important finding in her study was the lack of interaction between epistemological beliefs and the domain of the text, which was interpreted by the author as the presumption that the effect epistemological beliefs had on reading comprehension is generalizable across domains. In her study, Schommer also found that when reading the text on aggression, believing learning happens in a quick way predicted poor performance on the reading comprehension test and overconfidence

about the amount of information understood. The importance of this study is that it gave statistical evidence for a construct of personal epistemology as a set of beliefs that correlated with specific types of cognitive processes people use during reading. It also provided data supporting the notion that epistemological beliefs are related to reading comprehension in a general way, and that monitoring one's level of comprehension is related to the level of sophistication people have in regards to their beliefs about knowledge. Hence, the purpose of this study is to further investigate some of the findings of Schommer's (1990) study. It is important to research whether epistemological beliefs do indeed operate in a general way, or if they operate specific to a knowledge domain, and if epistemological beliefs predict accurate comprehension monitoring, that is, metacomprehension.

Schommer's (1990) finding indicating a relationship between epistemological beliefs and metacomprehension appears to be an important piece of the puzzle when attempting to understand the role of epistemological beliefs in reading comprehension. Kuhn and Dean (2004) have stated that a person's epistemological understandings are a metacognitive process. According to the authors, metacognition can be thought of as having both procedural and declarative aspects. When it comes to reading, procedural metacognition would be associated with the monitoring of comprehension and the use of specific processes that takes place as a text is being read. The declarative aspect of metacognition would be associated with the awareness a reader has in regards to knowledge and the way knowledge is manufactured. Therefore, the relationship found by Schommer (1990) where epistemological beliefs, or declarative metacognition, predicted a measure of metacomprehension, procedural metacognition, needs to be

understood more thoroughly. It must be investigated whether this dynamic takes place at domain-specific levels. In other words, it is important to know whether the level of understanding a reader has about knowledge and its construction in a specific domain predicts the accuracy of metacognitive monitoring of comprehension in the specific domain of the text being read.

Given the findings provided by Schommer (1990), where epistemological beliefs were found to be related to reading comprehension and monitoring of comprehension, a more recent study was designed with the purpose of investigating the influence of epistemological beliefs on the kinds of cognitive processes used to comprehend and monitor information while reading texts presenting contrasting views about a subject (Kardash & Howell, 2000). In this study, participants' cognitive processes while reading were measured using a think-aloud methodology, where comments made during reading were correlated to their epistemological beliefs. The authors found that when readers had naïve epistemological beliefs about the speed of knowledge, they were less likely to use reading strategies to develop awareness about the text and establish intra-sentential ties among sentences. In other words, believing that knowledge does not require much effort or time to acquire was negatively correlated to the attempt to assess one's level of concentration and understanding, and the attempt to resolve ambiguity resulting from reading the text. That is, naïve epistemological beliefs lead to 'shallow' text processing. Thus, it appears clear that epistemological beliefs are related to the kinds of strategies students use while reading. However, the current study attempts to clarify this question by assessing epistemological beliefs in the areas of psychology and

physics and correlating them with reading processes while reading texts in psychology and physics.

Epistemological beliefs also have an important role when information is presented from multiple perspectives, which often expose the reader to contradictory claims about the same issue. In a study by Bråten and Strømsø (2006), participants read either a series of texts discussing different perspectives on attention-deficit hyperactivity disorder (ADHD) or a text with the same information but coherently put together as in a textbook-like chapter. The participants in their study were 39 pre-service teachers, who were classified as having either sophisticated or naïve epistemological beliefs using the Schommer Epistemological Questionnaire (Schommer, 1990). However, in their study, participants' general epistemological beliefs were categorized as either naïve or sophisticated rather than in Schommer's original dimensions. The study found that those students who had sophisticated epistemological beliefs had higher inference verification scores in the multiple-text task than students holding naïve beliefs, and those students with naïve epistemological beliefs had higher inference verification scores in the textbook-chapter task than those students holding sophisticated beliefs. These results point to the importance of sophisticated epistemological beliefs for integrating information from multiple texts. In a more recent study investigating the role of epistemological beliefs in reading comprehension, Strømsø, Bråten, and Samuelstuen (2008) asked 157 college students to read seven texts discussing different perspectives about climate change. Participants' epistemological beliefs were assessed using a Topic-Specific Epistemic Belief Questionnaire developed by the authors of the study. The intention of this inventory was to assess the participants' beliefs about the

certainty, simplicity, source, and justification of knowledge on climate change only. Students who believed that knowledge is complex as opposed to simple were more likely to recognize inferential statements across texts and within texts and had better surface-level representation of text, which was measured by the recognition of sentences that were exactly or similar to those read in the texts. Believing that knowledge was uncertain also predicted the recognition of inferential sentences across texts. Unexpectedly, it was found that believing authorities and experts is a more important source of knowledge than personal interpretations predicted recognizing inferences made within the text. In other words, a naïve belief about the source of knowledge was related to a measure of reading comprehension. The authors claim this finding was not hypothesized and was contrary to what Schraw (2000) found, which was that beliefs emphasizing the importance of the reader in generating meaning from a text was found a predictor of reading comprehension. Finally, the epistemological belief of justification of knowledge did not correlate with any of the reading comprehension measures in the study. Strømsø et al.'s (2008) study gives support to the belief that topic-specific epistemological beliefs, specifically about the simplicity of knowledge, are an important predictor of comprehension of multiple texts.

Cognitive Psychology of Reading

To further understand the role of epistemological beliefs in reading comprehension, it is relevant to consult psychological models of reading. In fact, when understanding reading comprehension, one must look at those characteristics that are brought by the reader, sometimes referred as top-down reading processes. Epistemological beliefs are one of such top-down variables which have been found to influence reading comprehension according to constructionist views. Graesser, Singer,

and Trabasso (1994), proposed that readers make meaning of narrative texts depending on the goals for reading the text, the relationships found within information pieces of the text, and the naïve theories readers hold about science. More recent studies have shown that top-down cognitive processes, like the ones identified by Graesser et al., also influence on-line reading processes when reading expository and scientific texts. For instance, van den Broek, Lorch, and Linderholm (2001) found that students who read with the goal of studying for an exam were more likely to make inferences while reading, which allowed them to create a more coherent meaning of the text, and students who read just because they were interested in the topic were more likely to reflect on their understanding of the text, make associations, and evaluate the information being read. Prior knowledge has also been found to influence the kinds of strategies readers use while reading scientific texts. Kendeou and van den Broek (2007) separated students in regards to their prior knowledge and misconceptions about a scientific topic. They found that only those students with incorrect prior knowledge (misconceptions) about the subject they were reading were more likely to respond to the conflict presented in the text by changing their concepts about what they read, expressed their cognitive conflict in regards to the information, or contrasted information presented on the text than. It was also found that readers without misconceptions were more likely to make correct inferences and less likely to make incorrect inferences than readers with misconceptions. In view of this, and the research reviewed here on epistemological beliefs, it seems reasonable to expect epistemological beliefs, a top-down cognitive process, to influence on-line reading measures of scientific texts.

Furthermore, the kinds of processes readers use to successfully integrate text information with what is already stored in long-term memory might be related to the level of sophistication readers have in regard to their beliefs about the nature of knowledge and the process of knowing. According to the literature on text representation, there are at least two ways in which a reader mentally represents a text in their episodic memory (Graesser, Mills, & Zwaan, 1997; Kintsch, 1998). The first one is the textbase model, which is a basic level representation of a text, often impoverished, and does not include any added information, such as personal experience or prior knowledge from the reader. The text base model is a representation of the text built from relationships and elements directly resulting from reading the text and linked into a seemingly coherent model. A situation model is a more developed construction, which would include the already mentioned textbase model plus an attempt to interpret and integrate the information presented in the text with already existing knowledge. Thus, the mental representation of a situation model requires the use of cognitive processes complex enough to allow for a coherent comprehension of a text in relation to information stored in long-term memory. For instance, according to Zwaan (1994), a strong situation model is dependent on the monitoring of irrelevant or unimportant information presented in the text. In a study done by Schroeder, Richter, and Hoever (2008), efforts to integrate and interpret the text, with the purpose of creating a situation model, necessitate operation of further processes, like checking whether information presented in the text is consistent with already stored information and whether such information will be acknowledged as being valid or invalid. In addition, a situation model must be constructed if information from multiple sources, like the

television or a newspaper, from multiple languages, and multiple texts is to be incorporated into a coherent representation (Zwaan & Radvansky, 1998).

From the reviewed literature on the psychology of text comprehension, it is expected that when readers read a text in psychology they will be more likely to display reading processes associated with a situation model than when they read a text in physics. This is considered only if readers have more sophisticated epistemological beliefs in psychology than physics, which would allow readers to review their current understanding of the topic in psychology, integrate plausible information with an already established understanding of the text, and understand the fluid process of getting to know about a subject. I expect readers with sophisticated epistemological beliefs in psychology to be more likely to use processes like inferences, paraphrases, judgments, epistemic evaluations, and elaborations while reading. Conversely, it appears less likely that readers will use such processes than when they read a text in physics since their epistemological beliefs in physics are expected to be more naïve. In regards to the comprehension of the physics text, it is expected that readers will display cognitive reading processes associated with text base models while reading a text in physics, such as inferences, paraphrases, and association.

In addition to the hypothesis that epistemological beliefs are related to cognitive processes readers use while reading, on-line measures, it appears reasonable to expect that they will predict readers' performance in reading tasks after reading a text, off-line measures. In fact, research already reviewed here provides evidence that epistemological beliefs have predicted the kinds of conclusions (Schommer, 1990) and the ability to recognize inferences (Bråten & Strømsø, 2006; Strømsø et al., 2008) by

readers after reading expository texts. Top-down cognitive processes, such as the goals readers have (van den Broek, Lorch Jr, Linderholm, & Gustafson, 2001), prior-knowledge about the subject (Recht & Leslie, 1988), and misconceptions about the information being read (Kendeou & van den Broek, 2005) also have a role in the amount of information retained or recalled after reading. Additionally, Schommer and colleagues (1990, 1992) reported in their studies that having naïve epistemological beliefs predicts stating too much confidence after reading in regards to the amount of information understood. Thus, it seems likely that domain-specific epistemological beliefs, another example of top-down processing, will be related to information remembered after reading.

In summary, expecting to find a relationship between domain-specific epistemological beliefs and reading comprehension of psychology and physics texts is a reasonable hypothesis given the following findings. College students think differently about knowledge on the social sciences than knowledge in the natural sciences (Hallett, Chandler, & Krettenauer, 2002; Hofer, 2000). The amount of knowledge someone has on a specific subject is related to reading comprehension of that same subject (Recht & Leslie, 1988), giving support to the importance of cognitive processes relative to reading a text in a specific domain. In addition, the beliefs, including beliefs about the nature of knowledge, readers have specific to a subject are related to the kinds of cognitive processes used while people read in that specific subject, including the extent to which comprehension is monitored (Kardash & Howell, 2000), and to off-line measures of reading comprehension (Strømsø, Bråten, & Samuelstuen, 2008). As already mentioned, Schommer (1990) studied the relation between epistemological beliefs and

reading comprehension of aggression and nutrition texts. Yet, in her study epistemological beliefs were assessed not specific to the subjects of aggression and nutrition, but about knowledge in a broad way. Thus, college students think about knowledge differently in different domains, and cognitive processes specific to a domain are important factors when it comes to reading comprehension; however, there is no evidence that epistemological beliefs specific to a domain are related to reading comprehension measures in various domains. The question still remains whether there is clear evidence that domain-specific epistemological beliefs relate to reading comprehension in different domains, which puts emphasis on the importance of epistemological beliefs specific to a given knowledge domain as an important and perhaps more accurate predictor than domain-general epistemological beliefs of reading comprehension. I consider it important to investigate whether domain-specific epistemological beliefs are related to reading comprehension of psychology and physics texts because of the evidence pointing to the importance of epistemological beliefs on reading comprehension, the importance of domain-specific cognitive processes on reading comprehension, and the lack of evidence suggesting that this relationship exists even when people read subjects in various knowledge domains.

Hypotheses

The first purpose of this study is to investigate whether college students' epistemological beliefs in the fields of psychology and physics differ. On the basis of previous studies (Hallett, Chandler, & Krettenauer, 2002; Hofer, 2000; Kuhn, Cheney, & Weinstock, 2000), I expect the beliefs about the nature of knowledge and the process of gathering knowledge to be more sophisticated when students think about psychology than when they think about physics. The second and main goal of the study is to

investigate if college students read texts in psychology and physics differently, and to what extent this difference is related to their domain-specific epistemological beliefs. I expect that students with more sophisticated epistemological beliefs in psychology engage cognitive processes needed to gain an in-depth and integrated understanding of the psychology text, and use cognitive processes associated to constructing a situation model. Moreover, comprehension scores in regards to the psychology text are also expected to be higher, reflecting better recall of the psychology text than the physics text. Finally, since epistemological beliefs, or personal epistemology, have been conceived as a metacognitive process (Hofer, 2004; Kuhn & Dean, 2004), and have been related to the amount of confidence readers have after reading a text (Schommer, 1990; Schommer, Crouse, & Rhodes, 1992), I expect readers' ability to accurately monitor and judge their understanding of the texts, metacomprehension, to be related to having sophisticated epistemological beliefs.

CHAPTER 2
METHODS

Participants

The participants of this study were 43 undergraduate students enrolled in introductory classes in educational psychology and human development at the University of Florida's College of Education. They were recruited from the human participants research pool from the Department of Educational Psychology at the University of Florida and participated as part of a course requirement.

A participant's data was not used when the task was not completed or when thoughts were not reported by the participant in at least 75% of the sentences read in the verbal protocol task (Linderholm & van den Broek, 2002). One participant's data also was discarded as a result of not getting any question right in the comprehension measure of the physics text, which created doubt in the credibility of the participant's data. A total of 36 participants resulted from using this elimination criterion. Of the remaining 36, eleven were males and twenty-five were females. Participants' ages ranged from 18 to 26 years, and the average age was 20.26 (*SD* = 1.70).

Materials

Prior Knowledge

Participants were asked how many classes they had taken in psychology, physics and chemistry with the purpose of assessing their prior exposure with the subjects. The reason participants were also asked about the classes they had taken in chemistry was because the sample of the study was composed mainly of students in the liberal arts college, and who were not expected to have a lot of exposure to physics only. Also, Hofer's (2000) study in the dimensionality of epistemological beliefs divided

the domains in psychology and science. Thus, asking participants about their exposure to chemistry was an attempt to have a more balanced subject pool in regards to their prior knowledge in the different domains. The question assessing prior knowledge was open-ended so that participants could enter any number..

Texts

The purpose of choosing the texts used in this study was not to expose the reader to the latest and most accurate state of research in any specific topic on psychology and physics. Rather, the purpose was to have two texts in the social and physics sciences that elicited reading processes related to reading a text where knowledge was presented as changing, where multiple views about the same problem were stated, and where an answer to the problem presented was not specified.

The text in the area of psychology was derived from the textbook Developmental Psychology: An Advanced Textbook (Lutz & Sternberg, 1999). This text defined object permanence and presented different research methodologies in the study of object permanence and the results emerging from the diverse methodologies. This text contained 582 words, 27 sentences, and was around the12th-grade level according to the Flesch-Kincaid Grade Level Index (Flesch, 1973). The text started by giving a brief definition of object permanence and by introducing Piaget's research on the subject. The text's author then posed a question regarding the validity of Piaget's research methodology. Different tasks in studying object permanence were described, including the A-not-B task, where an object is hidden under a blanket and then moved to a second blanket while the infant participant is looking. Infants are usually said to not have developed object permanence when they are unable to first look for the object

underneath the second blanket. The text ends by stating that there is no certain answer to when Object Permanence develops, or why the search error occurs in the A-not-B task (see Appendix A).

The second text was a text in the area of astrophysics downloaded from an educational website[1]. This text was structured in the same way the psychology text was. It was composed of 557 words, 30 sentences, and was around the 11th-grade level according to the Flesch-Kincaid Grade Level Index. The text started by describing Kant's theory of planet formation and a later revision of it. It then described a modern and more detailed theory of how planets are formed with the indication that there are still phenomena that remain unexplained. The text concluded with the idea that our knowledge of planet formation is still incomplete (see Appendix B).

Epistemological Beliefs Survey

Two equivalent epistemological beliefs questionnaires, one in physics and one in psychology, were used in this study, each containing 27 items (Hofer, 2000). All items in the survey were the same ones used by Hofer, which were designed to measure beliefs about the certainty of knowledge (psychology $\alpha = .74$; physics $\alpha = .81$), source of knowledge (psychology $\alpha = .56$; physics $\alpha = .61$), justification for knowing (psychology $\alpha = .51$; physics $\alpha = .64$), and attainability of truth (psychology $\alpha = .60$; physics $\alpha = .75$). Participants responded to each item on a 5-point Likert-type continuum (1 = strongly agree, 5 = strongly disagree). The psychometric test scores reported are the ones attained by Hofer (2000).

[1] http://library.thinkquest.org/27930/planet_formation.htm

Verbal Protocol Task

For the verbal protocol task, participants read a text one sentence at a time, and then typed their thoughts regarding the sentence after each sentence (Mills, Magliano, & Torado, 2006; Muñoz, Magliano, Sheridan, & McNamara, 2006). Microsoft Power point was used for this task. With the purpose of creating a criterion for the amount of comments made by readers, a participant's data was discarded when their comments were reported less than 75% of the time (Linderholm & van den Broek, 2002)..

Comprehension and Metacomprehension Measure

Confidence estimates were assessed by asking participants the following questions: "Please indicate what percentage of the text you think you were able to comprehend", "Please indicate how many of the questions you think you got right" (before answering the reading comprehension questionnaire), and "Please indicate how many of the questions you think you will get right" (after answering the reading comprehension questionnaire). The following scale was used: 0%, 20%, 40%, 60%, 80%, and 100% (Maki, Shields, Wheeler, & Zacchilli, 2005). Participants answered a 6-item multiple-choice questionnaire for the text in psychology and the text in physics to demonstrate recall of information. For each questionnaire three questions were about simple facts read in the text and the other three questions required the understanding of a relationship, a conclusion that could be derived from the reading, or a possible implication of the content. Each question had four choices with only one correct answer (see Appendix C).

Procedure

Participants came to a small room for the experiment, which lasted about one hour. They sat in front of a computer. First, participants answered a demographics

questionnaire where they answered questions about themselves including how many classes they had taken in psychology and science. They continued by completing two questionnaires regarding their epistemological beliefs in physics and psychology. Flipping a coin was used to control for any effect that resulted from thinking and reading about one of the subjects first. They completed the verbal protocol task using one of the texts, and then performed a reading comprehension and metacomprehension task. After they finished the first text, they completed the second verbal protocol task and also answered questions assessing their comprehension. The order by which participants read the texts, psychology or physics, was randomly ordered and determined by flipping a coin.

Scoring

Verbal Protocol Task

The text processing categories (connections, elaborations, predictions, reinstatements, metacomprehensive comments, associations, paraphrases, repetitions) used in this study were based on those used by Linderholm and van den Broek (2002). The categories of *Judgment* and *Dealing with Ambiguity* were similar to those used by Kardash & Howell (2000). The epistemological evaluative comment categories (*Process of Knowing Evaluations and Nature of Knowledge Evaluation*s) were derived from a list of metacognitive judgments and monitoring processes offered by Hofer (2004). Each comment typed by the reader was categorized into one out of 16 categories, which are subcategorized into *evaluations, inferences*, *metacognitive comments* and *other reading processes* (see Appendix D for examples of each category). Precise definitions are included in the next section.

Evaluations

Process of Knowing Evaluations are evaluative comments or questions about the source and justification of the assertions presented in the text. *Nature of Knowledge Evaluations* are evaluative comments or questions about the certainty and complexity of the assertions presented in the text. *Personal Opinions a*re simple comments expressing a personal opinion or emotional response to the material being read. *Judgments* are comments where the information presented is evaluated and a reason or justification is provided for such judgment. *Dealing with Ambiguity* are comments where the reader expresses a lack of ability to make a judgment about the text because there is not enough information or by unstated reasons.

Inferences

Elaborations are comments where prior knowledge is brought by the reader with the purpose of developing a better understanding of the text. *Predictions* are comments where the possible outcomes of an experiment of theory being described by the text are made by the reader. *Reinstatements* are *c*omments where information read in the text is paraphrased by the reader. *Connections* refer to *c*omments that attempt to relate the present sentence with the prior sentence. *Associations* are comments by the readers which were elicited by the content in the text and did not have the intention of comprehending or evaluating the material.

Metacognitive Processes

Simple Metacognitive Comments are *s*imple questions or comments referring to the comprehension (or lack of comprehension) of the material. *Metacomprehensive Comments* are reflective statements about the comprehension or lack there of regarding what is being read.

Other Reading Processes

Repetitions are typing part or the entire sentence being read. *Inaccuracy of text processing* are comments where the reader appeared not to have understood the current sentence. *Paraphrases* refer to typing the current sentence in more familiar words. *Other comments* are statements that did not fall in any of the previous categories.

A volunteer rater (a Master's degree student in Educational Psychology) and I scored 15% of the verbal protocol's comments into one of the previously presented categories and achieved a 79% inter-rater reliability. Whenever there was disagreement in rating a comment, the volunteer and I discussed the comment's category until we reached agreement. I then scored the rest of the protocol data.

Epistemological Beliefs Survey

Hofer (2000) designed the questionnaire with the intention of assessing four dimensions of epistemological beliefs. However, I created a composite score using Hofer's instrument where epistemological beliefs were assessed in a general fashion. All 27 items in the questionnaire were used to create this score. The composite scores were used to classify whether a person had either sophisticated or naïve epistemological beliefs in the subjects of psychology and physics. Cronbach's alpha reliability estimates for the composite score were .64 for the psychology questionnaire and .83 for the physics one.

CHAPTER 3
RESULTS

Differences in Reading Processes between Psychology and Physics Texts

An analysis of variance (ANOVA) was used to test if students had statistically significant differences in their epistemological beliefs in the domains of psychology and physics. A higher score on the composite scale indicates less sophisticated beliefs. According to the ANOVA, students had a more sophisticated outlook on psychology (M = 2.28, SD = .37) than in physics (M = 3.29, SD = .55), F (1, 70) = 82.70, $p < .001$. This finding was in accordance with Hofer's (2000) findings where she found that college students tend to understand knowledge in psychology in more sophisticated ways than in science in general.

A multivariate analysis of covariance (MANCOVA) was used to investigate whether there were differences in participants' reading processes while reading a psychology versus a physics text, while controlling for prior knowledge. The dependent variables in this study were the reading processes described on the methods section (see verbal protocol task categories) and the comprehension and metacomprehension results for each text.

Evaluations: The results of the MANCOVA showed that students made more judgments while reading the psychology text (M = .11, SD = .14), than the physics text (M = .04, SD = .07), F (1, 69) = 6.62, $p < .05$, and made more comments indicating the suspension of a clear judgment regarding the information (*Dealing with ambiguity)* when reading the psychology text (M = .03, SD = .03), than the physics text (M = .01, SD = .01), F (1, 69) = 9.81, $p < .01$.

Inferences: There were no significant effects of text topic, Fs< 1.

Metacognitive processes: There were no significant effects of text topic, Fs< 1.

Other reading processes: There were no significant effects of text topic, Fs< 1.

Comprehension and confidence estimates: In regards to comprehension, students answered more questions right in the reading comprehension measure of the psychology text (*M* = .58, *SD* = .19), than the physics text (*M* = .44, *SD* = .19), *F* (1, 69) = 8.13, *p* < .05. There were also significant differences in measures of metacomprehension; students predicted that they would understand more of the psychology text (*M* = .76, *SD* = .22), than the physics text (*M* = .61, *SD* = .27), *F* (1, 69) = 4.58, *p* < .05; students predicted getting more questions right in the psychology text reading comprehension questionnaire (*M* = .67, *SD* = .18), than the physics text reading comprehension questionnaire (*M* = .53, *SD* = .21), *F* (1, 69) = 5.65, *p* < .05, and were more confident of getting more questions right in the psychology text's reading comprehension questionnaire after taking the test (*M* = .62, *SD* = .16), than the physics text's reading comprehension questionnaire (*M* = .46, *SD* = .=22), *F* (1, 69) = 7.59, *p* < .01. In order to test for a difference in the accuracy of the confidence estimates when readers read a psychology versus a physics text, the confidence estimate scores before and after taking answering the comprehension questionnaires were subtracted from the actual reading comprehension score. There were no significant differences in the accuracy of the estimates before and after taking the reading comprehension questionnaire, F_s< 1.

The way prior knowledge in the subjects of physics and psychology was assessed in this study did not provide an entirely valid way of measuring it. For instance, I did not know what grades students got in the classes they took in psychology

and physics. Also, one of the texts was in astrophysics, and the question that assessed prior knowledge only asked how many classes the student took in physics and chemistry. Because of this potential lack of validity on the way prior knowledge was measured, a multivariate analysis of variance (MANOVA) was conducted, where prior knowledge was not controlled for.

Evaluations: The results of the MANOVA in reference to different types of evaluations made by the readers showed that students made more evaluations about the justification and the source of knowledge while reading the psychology text (M = .04, SD = .05), than the physics text (M = .20, SD = .04), F (1, 70) = 4.01, p < .05, made more judgments while reading the psychology text (M = .11, SD = .14), than the physics text (M = .04, SD = .07), F (1, 70) = 7.97, p < .01, and made more comments that recognized their ambiguity when reading the psychology text (M = .03, SD = .03), than the physics text (M = .01, SD = .01), F (1, 70) = 12.80, p < .01.

Inferences: Participants elaborated more on the psychology text (M = .12, SD = .13), than the physics text (M = .52, SD = .07), F (1, 70) = 6.54, p < .05

Metacognitive processes: Participants made less simple questions in the psychology text (M = .30, SD = .20), than the physics text (M = .40, SD = .20), F (1, 70) = 4.51, p < .05.

Other reading processes: Participants made less comments that did not follow any of the categories and did not appear to aid in the understanding of the text or evaluated the information while reading psychology text (M = .04, SD = .05), than the physics text (M = .08, SD = .09), F (1, 70) = 5.03, p < .05.

Comprehension and confidence estimates: Concerning reading comprehension, readers answered more questions right in the reading comprehension measure of the psychology text (*M* = .58, *SD* = .19), than the physics text (*M* = .44, *SD* = .19), *F* (1, 70) = 9.41, *p* < .01. Confidence estimates were also found to be significantly different; readers predicted that they would understand more the psychology text (*M* = .76, *SD* = .22), than the physics text (*M* = .61, *SD* = .27), *F* (1, 70) = 6.61, *p* < .05, predicted getting more questions right in the psychology text reading comprehension questionnaire (*M* = .67, *SD* = .18), than the physics text reading comprehension questionnaire (*M* = .53, *SD* = .21), *F* (1, 70) = 8.55, *p* < .01, and were more confident of getting more questions right in the psychology text reading comprehension questionnaire (*M* = .62, *SD* = .16), than the physics text reading comprehension questionnaire (*M* = .46, *SD* = .=22), *F* (1, 70) = 11.28, *p* < .01..

Partial Relations among Processes within Psychology and Physics

The relationship between epistemological beliefs and on-line and off-line reading comprehension processes was investigated by correlating epistemological beliefs with the use of specific cognitive processes, comprehension, and confidence estimates. In addition, the number of *epistemological evaluations* performed by the participants was used as a supplementary measure of epistemological beliefs. Using the number of *epistemological evaluations* by the reader was done with the purpose of getting a clearer picture of the relation between people's understandings about the nature of knowledge in a specific topic and reading comprehension. E*pistemological evaluations* give a more realistic measure of the actual beliefs students have about knowledge in a specific domain. Moreover, the questionnaire relies on often biased self-reported

statements, and reflects beliefs about the broad knowledge domains of physics and psychology and not about the specific subject being read.

Psychology

Partial intercorrelations, where prior knowledge was partialled out, between epistemological beliefs measures in psychology, all reading processes, comprehension, confidence estimates, and prior knowledge, yielded the following results:

Epistemological beliefs: Naïve epistemological beliefs were positively related to making predictions about the text ($r = .45$, $p < .01$). This means that the more naïve a person's psychology-specific epistemological beliefs are, the more likely they are to predict what the outcomes of an experiment or theory presented on the text would be.

Evaluations: Participants who made statements evaluating the nature of the assertions made in the psychology text were more likely to make comments monitoring their understanding of the text ($r = .41$, $p < .05$), and less likely to make simple questions regarding the information ($r = -.37$, $p < .05$).

Physics

Partial intercorrelations, where prior knowledge was partialled out, between all reading processes, comprehension, metacomprehension, prior knowledge, and epistemological beliefs measures in the physics text yielded the following results:

Epistemological beliefs: No relationship between epistemological beliefs and any of the categories was found.

Evaluations: Participants who evaluated the source of the knowledge were more likely to monitor their comprehension ($r = .58$, $p < .01$). Participants who evaluated the nature of the assertions were also more likely to monitor their comprehension ($r =.40$, $p < .05$). Evaluating the source of the assertions was negatively related to making

personal comments about the information (r = -.34, p < .05). Participants who suspended their judgments in view of the assertions in the text were less likely to ask simple questions about the information (r = -.41, p < .05). Making confident predictions about the number of questions right before answering the comprehension questionnaire was positively related to making evaluations about the justification of the assertions (r = .34, p < .05), and negatively related to making personal comments (r = -.37, p < .05). Making justified judgments about the information was related to stating high confidence about the understanding of the text (r = .39, p < .05).

Relations among Processes within Psychology and Physics

Since there was a potential for lack of validity in the way prior knowledge was measured, the effects of prior knowledge were removed in this section of the analyses.

Psychology

Interrcorrelations between all reading processes, comprehension, metacomprehension, and prior knowledge yielded the following results while participants read the psychology text :

Epistemological Beliefs: Naïve epistemological beliefs were positively related to making predictions about the text (r = .42, p < .05).

Evaluations: Participants who made statements evaluating the complexity of the assertions made in the psychology text were more likely to make comments monitoring their understanding of the text (r = .35, p < .05). Making evaluative comments about the source and justification of knowledge was positively related to elaborating on the text (r = .37, p < .05), comprehension scores (r = .34, p < .05), having taken more classes in psychology (r = .37, p < .05), and negatively associated with making comments that were not related to any of the categories established (r = -.34, p

< .05). Making personal comments without any apparent justification was negatively related to making elaborations (r = -.40, p < .05 and dealing with the ambiguity that the text elicited (r = -.33, p < .05). Making justified judgments about the information presented in the text was negatively associated with making simple comprehension questions (r = -.35, p < .05).

Physics

. Interrcorrelations between all reading processes, comprehension, metacomprehension, and prior knowledge yielded the following results while participants read the physics text:

Epistemological beliefs: Physics-specific epistemological beliefs were not related to any of the reading processing categories.

Evaluations: The more a reader evaluated the source and justification of the knowledge presented on the text, the more metacomprehensive type comments they made (r = .58, p < .01, and the less they made evaluations without any apparent justification (personal comments) (r = -.34, p < .05). Making comments about the complexity of the text was positively related to making metacomprehensive comments (r = .41, p < .05). Making justified evaluations about the information was positively related to elaborating on the information on the text (r = .46, p < .01), to reporting a higher level of confidence regarding the amount of the text understood (r = .41, p < .05), and negatively associated to making simple questions (r = -.50, p < .01 Making personal comments was negatively associated with making metacomprehensive comments (r = -.44, p < .01 and making simple questions (r = -.33, p < .05). Making comments where the reader dealt with the ambiguity elicited from reading the text was negatively related

to asking simple questions (r = -.40, p < .05), and positively related to inaccurately processing the information presented (r = .40, p < .05).

CHAPTER 4
DISCUSSION

The goal of the study was to uncover differences in reading processes when reading a text in psychology versus physics and to discover whether these differences would be related to domain-specific epistemological beliefs. In this study, participants had more sophisticated beliefs in the area of psychology than physics participants, and read psychology and physics texts using different cognitive processes. While reading a psychology text about object permanence, participants made more evaluations about the source and justification of the information presented in the text, made more judgments with justification, elaborated more, and recognized more their inability to make a judgment about some claims in the text. Readers also had better comprehension scores and were more confident about having understood the text when they read the psychology text. When readers read a physics text about theories of planet formation, they asked more simple questions regarding words or concepts presented in the text, and made more comments that were not related to comprehending, evaluating, or associating the information with prior knowledge. Even when controlling for prior knowledge, participants had more sophisticated epistemological beliefs in psychology than physics, made more justified judgments, dealt with the ambiguity elicited by the text, displayed better reading comprehension scores, and were more confident about their understanding of the text when reading the text in psychology.

In regard to the relation between epistemological beliefs and reading processes, naive epistemological beliefs, as measured by the questionnaire (Hofer, 2000), were only associated with making predictions about the possible outcomes of implementing a

task in the object permanence text. Still, when participants made more epistemological evaluations about the information presented in the psychology text, they were more likely to elaborate on the information using prior knowledge, metacognitively monitor their understanding of the text (metacomprehension), had better scores in the comprehension text, and claimed to have taken more classes in psychology. Also, when readers read the physics text, making epistemological evaluations was positively associated with metacomprehension and negatively associated with making unfounded judgments.

From the results above, as a whole, participants reported having more sophisticated epistemological beliefs in psychology, and they used more processes that allowed for a deeper comprehension of the text and for an integration of text-information with prior knowledge when they read the psychology text versus the physics text. In other words, readers were more likely to construct a situation model of the text when their epistemological beliefs were more sophisticated in the subject of the text they read. The question becomes whether epistemological beliefs had any responsibility in helping readers create a situation model of the psychology text, or if there is something about the topic of the text that is eliciting the differences found. The interpretation that epistemological beliefs are related to building a situation model is sound since participants had better comprehension scores in the psychology text even while controlling for prior knowledge. Moreover, claims made by Schroeder et al. (2008), who purports that situation models are dependent on the monitoring and elaborating on the validity of the information presented in a text, also support the notion that epistemological beliefs are related to building a situation model. In their study, they

found that readers epistemically judge the validity of the information they read and are more likely to integrate plausible than implausible information into the situation model. My findings indicate that when readers read the text in psychology, they used processes that would allow them to integrate the information with prior knowledge, like elaborating on the information. They also used processes that enabled them to construct a representation of the text that either adjusted the accuracy of their already stored information or evaluated the accuracy of the information being read by evaluating the justification and source of the information, making justified judgments of the information, and recognizing their ambiguity in regard to making a judgment about the information in the text. An important finding that also supports the claim that epistemological beliefs are related to text representation is that when readers epistemologically evaluated the assertions from the psychology text they were also more likely to metacognitively monitor their understanding, elaborate on the information, and attain better comprehension scores. Hence, readers were found to have more sophisticated beliefs in psychology than physics, they had better comprehension scores when reading the psychology text, epistemological evaluations were found to be related to comprehension, metacognitive monitoring, and elaboration, and readers used reading processes that would enable them to build a situation model in psychology but not in physics.

Thus, if epistemological beliefs are indeed an aid in the creation of a situation model, there needs to be an explanation for there being only one process that correlated (i.e., *predictions*) with the epistemological beliefs questionnaire during the verbal protocol task. One possible explanation is the difficulty in assessing

epistemological beliefs. For instance, it is an issue of debate whether personal epistemology can be conceptualized as the set of five beliefs proposed by Schommer (Hofer & Pintrich, 1997); specifically the dimensions in question are omniscient authority and innate ability. The main problem with the line of research stemming from Schommer's conceptualization of personal epistemology is that more recent studies have not given the same results as those obtained by her. Other authors have attempted to develop a more reliable personal epistemology questionnaire and have apparently reached higher levels of reliability in their efforts (Schraw, Bendixen, & Dunkle, 2002).

Another possible explanation for the low number of cognitive processes that correlated with the epistemological beliefs questionnaire (Hofer, 2000) is whether beliefs or opinions about knowledge and epistemology have the capacity of altering the amounts of resources used while people read, and if it would be more appropriate to use an inventory that reflects the developmental structures of personal epistemology like the ones used in other studies (Hallett, Chandler, & Krettenauer, 2002; Kuhn, Cheney, & Weinstock, 2000). One reason for proposing the use of an assessment inventory that takes into account the stages of epistemological understanding is that a belief might not reflect a genuine cognitive understanding about the process of justifying knowledge. For instance, a student may believe that truths in psychology change, or that it is difficult to determine what is the true answer in psychology because they have heard this in their educational environment, and not necessarily because they have direct experience with the subjective and dynamic nature of coming up with theories in psychology.

Another reason for using a developmental psychometric tool is the inability of the questionnaire used in this study, which stems from Schommer's work, to assess whether a participant has any understanding about the specific process of justifying assertions made in a given scientific field. For instance, a participant might answer the questionnaire and give the impression that they understand that there can be many answers to a given problem in psychology, that experts do not always hold the truth, that knowledge is not necessarily based on objective reality, that knowledge in psychology is complex, that it is good to questions ideas in psychology, that facts are not that important when coming up with knowledge, and that there is no way to determine what is the right answer (all these statements are from the questionnaire used in this study). However, none of these statements give insight into the participant's awareness of how knowledge in psychology is justified, created, transformed, or evaluated. Put more simply, the highest amount of sophistication that this questionnaire assesses is having a relativistic epistemological understanding, and not an evaluativistic one (Perry, 1970). Thus, students can be in the multiplist or relativistic stage of cognitive development and give the impression, with their scores in an epistemological beliefs questionnaire, that their understanding about knowledge and epistemology in a given field is sophisticated. Since the evaluations readers made about knowledge when they read were more useful than the questionnaire, future researchers might find it helpful to assess a reader's sophistication in their capacity to evaluate knowledge claims while reading by using actual cognitive behavior, as was done in this study. In the future, it might even be more accurate to categorize reader comments using the absolutist, multiplistic, and evaluativistic categories derived from research on personal

epistemology by Perry (1970) and Kuhn (Kuhn, Cheney, & Weinstock, 2000). Indeed, there is also an apparent need for a reliable epistemological beliefs questionnaire that reflects the developmental nature of personal epistemology.

An additional reason that might explain why epistemological beliefs, as assessed in the questionnaire, did not predict many cognitive processes was the evident lack of consistency in how the questionnaire reliably assesses epistemological beliefs in psychology and physics. The amount of variability in the responses was less when participants thought about knowledge in physics than in psychology. Cronbach's alpha reliability estimates for the epistemological beliefs composite score was .64 for the psychology questionnaire and .83 for the physics one. This can also be evidence that college students may have, in general, more established and reliable ideas about epistemological matters when it comes to physics than psychology. This might be further evidence about the notion that college students have more absolutistic or naïve epistemological understandings about knowledge in a field like physics.

It is important to discuss the role of prior knowledge when it comes to reading comprehension as well. Prior knowledge was assessed by asking participants to state the amount of classes taken in psychology and physics and chemistry. As mentioned, there are important considerations to be made in regard to the level or reliability present in the way prior knowledge was assessed, including, but not limited to the fact that prior-knowledge was measured using self-reported accounts of the number of classes taken in psychology, physics and chemistry, which might have compromised the reliability of the correlations. However, the following interpretations are made with the inclination that, even with this limitation, some interpretations about prior knowledge appear

valuable from the results in this study. When comparing the results from the MANOVA and the MANCOVA, it can be seen that students who knew more about psychology than physics made more elaborations on the psychology text, asked more simple questions on the physics text, and made more comments unrelated to reading comprehension or evaluation of the information in the physics text. Controlling for prior knowledge did not abstract the differences found in epistemological beliefs about psychology and physics, making justified judgments, recognizing one's ambiguity in regards to the information presented, comprehension scores and confidence estimates. From this analysis, it can be concluded that prior knowledge did not appear to have a major role in the kinds of cognitive processes used when readers made comments in psychology and physics. It only affected those processes that were directly related to knowing about the subject, such as making elaborations when there was prior knowledge and asking for more information when there was no prior knowledge. However, when students read the psychology text, the more classes students took in psychology, the more evaluations they made about the justification and source of knowledge, and the more elaborations they made. In addition, when students read the physics text, the more familiar students were with the field, the more confident they were about the amount of questions they would get right in the comprehension questionnaire. From these results, it can be concluded that the role of prior knowledge was not significantly related to making inferential reading processes like connections, reinstatements, predictions, or metacognitive monitoring. When it comes to evaluating the information presented, it appeared that prior knowledge was related to epistemological evaluations when readers made comments in psychology but not in

physics. This last result may point to an apparent discordance between the epistemological beliefs questionnaire's ability to assess personal epistemology and the way epistemological evaluations were rated. As mentioned previously, there needs to be more reliable ways to assess epistemological beliefs and also more research to understand its relationship with prior knowledge.

An important connection in understanding the relationship of epistemological beliefs and metacomprehension is whether sophisticated epistemological beliefs have any type of responsibility to the extent people accurately monitor the information they read. According to Schommer's (1990) findings, having a naive epistemological belief about the speed of learning, which is the notion that learning does not take much time, predicted being overconfident about the amount of information understood when reading a text in psychology (aggression). My findings did not show that topic-specific epistemological beliefs, as assessed by the questionnaire, were related to the level of accuracy people display when they metacognitively monitor the understanding of the text. However, when reading the psychology texts, making comments about the complexity of knowledge was related to metacognitively monitoring the information read. Furthermore, when reading the physics text, evaluating the source and the complexity of knowledge predicted metacognitively monitoring the information read. This shows that readers' understandings about the nature of knowledge in a specific subject are related to the extent that readers use their cognitive resources to monitor their understanding of the text. Epistemological beliefs have already been proposed as a metacognitive process by Kuhn (2004) and Hofer (2002), indeed. Further research

needs to clarify the nature of the relationship between metacomprehension and epistemological beliefs.

The results of this study point to the necessity of further understanding how a person's epistemology in a given subject influences reading comprehension. Some of the limitations of this study point towards the need for better ways to assess the kinds of evaluations made by the readers during verbal protocols and the way epistemological beliefs are assessed. The verbal protocol categories used in this study included reading processes of epistemologically evaluating the information, which never have been used before in the literature. This caused some difficulties in achieving agreement concerning whether the comment was an actual evaluation of knowledge in psychology or physics or if it just was a belief about knowledge in general. Future research rating reading processes where epistemological evaluations are taken into account need to keep working at developing standards that will make it more reliable to assess these reading processes, including whether the comment appears to be in reference to knowledge in general or specific to the information being read, and also whether the comment reflects an absolutist, multiplistic, or evaluativistic epistemological outlook. In regards to the participants of the study, a more balanced sample would have provided the opportunity for gathering more significant findings. Most participants belonged to liberal arts majors, and it would have been fruitful to have students more familiar with the field of physics. As mentioned, there is a need for a more reliable way to measure epistemological beliefs using questionnaires. I suggest a questionnaire that considers the findings present in the literature portraying personal epistemology as a developmental construct. Finally, prior knowledge was not assessed in the most effective manner in this study,

thus, providing important limitations for the interpretability of the results. In this study prior knowledge was assessed using self-reported measures, thus, an alternative would be using a questionnaire specific to the subject people will read. This will ensure knowledge will be measured in a more reliable way, not depending on self-reports but on actual knowledge about the specific subject.

This study was the first study that I found in the literature on reading comprehension and personal epistemology that clearly assessed the role of epistemological beliefs and reading comprehension at domain-specific levels. The relevance of such investigation was to further inquire into the domain-specificity of epistemological beliefs and to see if the beliefs people have about knowledge in different domains have the ability of affecting how people read in different domains. Based on the results of the study, there appears to be a relationship. As a group, students that had a more sophisticated personal epistemology in psychology used more cognitive processes that would allow them to represent the information in the text at deeper and more integrated level. The implications of such findings point directly to the importance of epistemological beliefs and a reader's ability to successfully comprehend a text. Such implications can have direct consequences for high school and higher education settings where reading comprehension no longer entails understanding information superficially, but requires the recognition that knowledge is dependent on assumptions and perspectives, that knowledge is a process that keeps changing, and that knowledge does not stand independent of the broader informational context. If the teacher's goal is to prepare students to proficiently understand the information they are

reading, teacher’s need to provide ample opportunities for students to develop their personal epistemology.

APPENDIX A
OBJECT PERMANENCE TEXT

A child’s ability to know that objects exist even when they are not visible is called object permanence. A well-known psychologist, Piaget, asserted that object permanence develops from manipulating objects, a skill he believed emerges towards the end of the first stage of cognitive development. Yet, all the ways in which he tested whether the child had the ability involved children reaching for objects. Using reaching tests may underestimate infants' conceptual abilities because the infants' failure to respond correctly may be due simply to infants' immature motor systems. In Piaget's tests, the infant has the difficult task of removing a cover before grasping the object. Regardless, Piaget concluded from these tests that young infants are lacking the ability to represent objects mentally. More recently developed tests seem to show otherwise.

The habituation/dishabituation test is a way to study object permanence without requiring the infant to reach for an object. It requires the participants only to look at perceptual displays where objects appear and reappear. During this test researchers look at different observable responses that change as a result of the stimulus being displayed. In a collection of studies by Baillargeon that used this method, it was found that infants as young as 3 1/2 months old showed indications of object permanence. This finding, combined with those of other researchers, lends credence to the hypothesis that young infants fail Piaget's original tests because the tests require behaviors of which the infants are not yet capable. Research suggests that infants probably have some understanding that hidden objects continue to exist, and this understanding comes months earlier than Piaget had thought, and maybe even from birth.

Another task used for assessing the acquisition of object permanence is named the A-not-B task. Piaget assumed that an infant lacking the development of object permanence will erroneously look for an object in place A even when the object was moved from place A to place B while the infant was looking, also known as the AB search error. Piaget thought that infants experience pleasure from searching under cover A repeatedly. Studies have replicated the AB search error, but resultant explanations do not necessarily fit with Piaget's explanation of the phenomenon. For instance, it has been proposed that infants aren’t able to inhibit an established prepotent response, which in this case is to repeatedly look for the object under place A.

Additional research has proposed other variables not mentioned by Piaget, such as memory capacity, which may influence the development of object permanence. It has been shown that a time delay of a few seconds from when the object is hidden under B and when the infant can search for it is sufficient to cause the AB search error. This outcome could occur because infants' working memory is immature. Their memory for the object's appearance at A is much stronger than their memory for the object's disappearance at B. In contrast, Baillargeon has found that infants are able to remember the location of an object after a substantial time delay (up to 70 seconds) in tasks in which the infant does not have to search for the object actively. Baillargeon’s finding suggests that the role of memory in developing the object permanence skill is not yet clear.

In conclusion, research has shown that infants have a concept of object permanence earlier than Piaget had believed, but it has not been determined when it is developed. Also, there are several sound theories about what causes the AB search

error, but no one theory has been agreed on to explain the entire object permanence phenomenon.

APPENDIX B
PLANET FORMATION TEXT

The origin of the planets in our Solar System has been debated since 1755.

Kant proposed that a nebulae, which is a huge cloud of dust and gas, was pulled together by gravity so that it collapsed into a flat, rotating disk. The disk eventually coalesced into the Sun and planets. Kant also stated that because a similar process occurs around other stars, our Solar System is not alone in the universe. His theory was expanded on and later became known as the nebular hypothesis. It was further proposed that the planets were formed by rings of matter split off a rotating nebulae by centrifugal force. After the matter split off, it coalesced into a planet. The process repeated itself, resulting in a planet each time. The matter left over was the Sun.

The nebular hypothesis used a flat, rotating nebulae as the Solar System's origin to explain why all the planets orbit in nearly the same plane and in the same direction. The theory, however, contained a few problems. It contradicted the observation that the Sun contains most of the Solar System's mass but only a small fraction of its angular momentum. If the theory were correct, the Sun must have most of the Solar System's angular momentum. This is because the Sun's angular momentum would increase as it contracted, much like a spinning ice skater who rotates faster as he brings in his arms. Another problem with the nebular hypothesis was that if rings of matter were split off, as the nebular hypothesis predicted, they wouldn't be pulled together to form planets but would disperse into space.

A modern version of the nebular hypothesis is called the protoplanet hypothesis. The steps in planet formation theorized by the protoplanet hypothesis are: (A) The solar

system begins to form as a rotating cloud, or nebulae, collapses. (B) Instabilities in the nebulae cause dust particles to stick together. The dust particles accrete into billions of planetesimals with diameters of about 10 meters. The planetesimals then collide and form protoplanets. Meanwhile, the protosun in the center of the nebular disk becomes massive and hot enough to "turn on" by fusing hydrogen. (C) The Sun begins to radiate energy and vaporize dust in the inner part of the Solar System. The remaining gas is blown away by solar winds.

Despite the protoplanet theory's success in correcting problems with the nebular hypothesis, it did not provide an explanation for the distribution of angular momentum in the Solar System. To explain the transfer of angular momentum from the Sun to the planets, scientists proposed a braking action caused by the Sun's magnetic forces. The magnetic lines of force from the Sun transferred angular momentum from the spinning Sun to the planetary disk.

Our knowledge on planetary formation is still very incomplete. In fact, it was just April of 1999 when astronomers announced the first discovery of a multi-planet system other than our own. This discovery, which Kant predicted over two hundred years ago, shows that our planetary system is not as unique as it was once thought. Scientists continue to make discoveries that will increase our knowledge on the formation of our Solar System and shape the theories that explain planet formation throughout the universe.

APPENDIX C
OBJECT PERMANENCE QUESTIONNAIRE

1. An infant's immature memory capacity may cause:
    a. The child to look for an object in the wrong place even after he has witnessed its movement to a new location
    b. The child not to be able to reach towards an object that is out of sight
    c. The cognitive processes in the mind to forget what is going on in the cognitive task
    d. The child to be habituated to an object that appears and disappears in front of his view

2. When do psychologists believe that the object permanence skill has developed?
    a. Towards the end of the sensorimotor stage of development
    b. There is not a consensus of when this skill develops
    c. This skill is innate
    d. When the child's sucking rate changes as soon as an object that was previously in sight disappears

3. According to Piaget, what is the needed evidence to confirm that object permanence ability has been reached?
    a. That the child passes a test claiming that the he or she is now in the second stage of cognitive development
    b. That the child looks surprised when his mother disappears
    c. That the child is able to reach for an object under a cover
    d. That the child is able to say that there is an object behind a cover

4. Little Maggie gets excited, that is, her facial expression changes every time her mother hides her face with a pillow. According to some psychologists this indicates:
    a. That the child has not acquired the object permanence skill
    b. Does not indicate much about the cognitive growth of a child
    c. This question should be answered by affective developmental psychologists
    d. that the child has passed a habituation/dishabituation test and has acquired the object permanence skill

5. Johnny saw an object being hidden under a blue cloth, and then the same object was moved to a red cloth. All this happened while Johnny was looking. However, he keeps looking for the object under the blue cloth where it was previously hidden by the researcher in previous occasions. An explanation for the child's behavior could be:
    a. Johnny is not yet able to inhibit a response which he had grown accustomed to perform
    b. He has not acquired the object permanence skill
    c. Psychologists don't have a reasonable explanation for Johnny's behavior
    d. Johnny's motor skills are not competent for the task at hand

6. What cognitive task/test described in the text leads to a final explanation of the development of object permanence in children?
    a. Piaget's reaching tasks
    b. Habituation/dishabituation task
    c. A-not-B task
    d. None of the above

APPENDIX D
PLANET FORMATION QUESTIONNAIRE

1. What aspect of Kant's original theory of planet formation still holds true today?
    a. Our Solar System was formed by a unique process not shared by others in the universe
    b. Our Solar System was formed by angular momentum
    c. Our Solar System is not alone in the universe
    d. Both a and b

2. What theory of planet formations appears to be the most realistic theory of how planets are formed?
    a. The nebular hypothesis
    b. Kant's hypothesis
    c. The protoplanet hypothesis
    d. The angular momentum hypothesis

3. What statement best summarizes the protoplanet hypothesis?
    a. Dust particles fuse together to form planets
    b. Rings of matter split off nebulae to form planets
    c. Planets are formed by a gravitational pull
    d. None of the above

4. The Sun's magnetic forces are an important addition to the protoplanet hypothesis because:
    a. They provide an explanation to why the angular velocity of the sun is not as high compared to the rest of the planets
    b. They turn matter that splits of nebulae form into planets
    c. They get rid of excess mass in the solar system
    d. They provide a heating mechanism which heats the Sun's corona

5. In a distant galaxy it was found that rings of matter do coalesce together when they are split off from a nebulae. What would this finding imply for the theories of planet formation?
    a. The nebular hypothesis would need to be reconsidered as a plausible explanation
    b. There would be no major implications
    c. The protoplanet hypothesis would fail to explain planet formation
    d. The nebular hypothesis would be the unquestionable solution to the problem of planet formation

6. If a scientist were to find that the Sun's magnetic forces do not affect the angular velocity of the planets in our solar system,
    a. The protoplanet hypothesis would be flawless
    b. The nebular hypothesis would be more adequate to explain planet formation
    c. the protoplanet hypothesis would need an alternative explanation for the angular velocity of the Sun relative to the planets
    d. The nebular hypothesis would need an alternative explanation for the angular velocity of the Sun

APPENDIX E
VERBAL PROTOCOL CATEGORIES

Category	Definition	Examples
Evaluations		
Process of Knowing	Refer to evaluations about the process of how an assertion in the text was gathered. • *Evaluations about the justification of knowledge*: statements that indicate whether the reader is evaluating the credibility of the knowledge or whether the evidence supports the claims in the text • *Evaluations about the source of knowledge*: statements that indicate that the reader is reflecting about the origins of the assertions in the text	• But how do they really know? It's not like a three and a half month old baby could just straight up tell you what's going on in their head. • How many things can babies really remember? And what if it differs from infant to infant? Then there's no good way of figuring out what is really happening in their mind.
Nature of Knowledge	Refer to evaluations about the nature of the assertions in the text. • *Evaluations about the certainty or the tentativeness of knowledge*: statements that reflect that the reader is thinking about the evolution of knowledge and its changing nature • *Evaluations about the simplicity or complexity of knowledge*: statements that reflect the reader's awareness about the complexity of knowledge	• All solar system development theories contain problems. • I think astronomers are wasting their time trying to come up with a theory of how the solar system formed. I don't think they'll ever really know.
Personal Opinions	Refer to comments where the reader expresses their opinion or position towards the information they are reading, and do not give any reason for it	• I do not believe this • I do not agree • I agree
Judgment	Readers make an evaluation of the information they are reading and provide an explanation or reason, usually accompanied by an elaboration or an inference	• Infants can't really reach for things that well so I agree this underestimates their conceptual ability • This is probably a better test for the infants because if does not involve reaching for an object because they aren't able to do so
Dealing with Ambiguity	Readers question and attempt to make sense of the ambiguity, uncertainty, and tentativeness of the information in the text. It involves: • Suspending a Judgment • Stating that they are not ready to make a judgment Stating that there need to be more information to make a judgment	• I want to look into more of his methodology, I'm not sure if I agree • I agree that it may be earlier, but I'm not sure if I agree with the findings as early as 3 1/2 months

Inferences		
Elaborations	Readers use previous knowledge about the subject in an attempt to understand the content of the current sentence.	• Thinking about what I know, I know this occurs around 1 year but no later than 2 years of age • We were talking about object permanence in my growth and development class a couple weeks ago. It's supposed to be quite a large step in cognitive development.
Predictions	Forward inferences that anticipate upcoming results in an experiment or theory.	• And the dust particles will clump, which will result in making planets. • The planets and stars will probably form the same way.
Reinstate-ments	Are when readers attempt to provide an explanation for the current sentence on the basis of prior text information that was not in the immediately preceding sentence	• This appears similar to what happens in the previous theory. • It may have been true for some, but, like the text previously stated, other children may have not had the motor skills but were able to represent the objects mentally.
Connections	Involve explaining the contents of the current sentence by connecting its meaning with the immediately preceding sentence.	• This shows their lack of memory (the comment was made after reading evidence for lack of memory which was introduced in the previous sentence)
Associations	Retrieval of information by the reader, which is not related to text comprehension.	• I've learned this in school, creation vs. big bang • I used to figure skate
Developing Awareness		
Simple Metacog-nitive comments	Occur when readers ask questions about words, ideas, and notions they do not know or understand. It also occurs then the reader states that they do not understand what is being said or when the reader needs clarification.	• What is angular momentum? Spinning? • What problems? • I am not sure what this means • I wonder what the problems are • I have learned about object permanence
Metacompreh ensive Comments	Occur when readers reflect on their level of comprehension of the text. These comments are also attempts to resolve their questions, meaning of words, or unclear concepts presented in the sentence being read.	• I'm unsure what problems were corrected by this theory • I don't understand how the ball of dust really turned into a planet • I also don't understand the concept of all the planets rotating and orbiting in the same plane and direction • So it's the sun's magnetic forces that keep all the planets from floating off into outer space

Other Reading Processes		
Inaccurate Text Processing	Readers unknowingly misinterpret information presented in the text.	• So the same problem as the last theory (the previous theory did not mention this problem).
Other	Comments that cannot be classified under any category	• Hey, I said that. • OK
Paraphrases	Occur when readers put the current sentence into their own words. Comments that capture the gist meaning of a sentence.	• So, this means that object permanence would develop before motor coordination. • In other words, the sun would just spin faster.

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BIOGRAPHICAL SKETCH

Part of Juan's interest in psychology started when he grew disappointed of the way he was being educated as a pre-medical student. As a result, he moved to a field where he would be able to have a profession where important dimensions of the human being, instead of being ignored, were attempted to be understood and acknowledged during the learning process. His studies in psychology began at a community college in South Florida, and continued at the University of Florida. When he ended a bachelor's in psychology at the University of Florida the only thing he knew for sure was that he had to keep studying, and out of luck, he was accepted into the Educational Psychology Department at UF. In truth, he did not really know what he was getting into, but thanks to the great team of professors in the department, he was able to explore and develop the craft of doing research in psychology. Presently, he looks forward to keep studying psychology, specifically mental health, from Buddhist and psychoanalytic frameworks.