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BENJAMIN ROBERT FORSYTH

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THE INFLUENCE OF WORLDVIEWS ON SELECTIVE RECALL FROM TEXTS
ABOUT HISTORY AND PHYSICS

By

Benjamin Robert Forsyth

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ABSTRACT

THE INFLUENCE OF WORLDVIEWS ON SELECTIVE RECALL FROM TEXTS ABOUT HISTORY AND PHYSICS

By

Benjamin Robert Forsyth

This dissertation tests the psychological reality of two philosophically developed worldview schemas, called *mechanism* and *organicism*, via a selective recall paradigm. It was hypothesized that portions of text that coincide with a person's preferred worldview will be selectively recalled at a greater rate than portions of text that do not reflect this preferred worldview. Furthermore, this bias in recall was hypothesized to occur with some degree of predictability across texts about different knowledge domains. Participants were asked to complete a psychological instrument which measured preference for mechanism and organicism. Next, they read two texts about the French Revolution and quantum mechanics containing items of text that varied across the mechanist and organicist worldviews. Then they wrote down what they could recall from the texts. Evidence that consisted of significant interactions between participants' worldview preferences and the types of items that they recall from the text was found and was interpreted as support for the hypothesis that worldviews are psychologically real high-level schemas. These results suggest the psychological reality of Pepper's mechanism and organicism worldviews. The implications surrounding these findings are also discussed.

I dedicate this dissertation to Emily.

The journey would have had little worth to me without you.

ACKNOWLEDGMENTS

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CHAPTER 1: INTRODUCTION

Central to this dissertation is the evaluation of two philosophically developed systems for conceptualizing, organizing and evaluating knowledge called *mechanism* and *organicism*. The author of these two systems, Stephen Pepper (1942), hypothesized that mechanism and organicism should have the ability to affect how knowledge from ANY domain is represented. Due in part to this hypothesized capability, Peppers' ideas have had a small but consistent presence in research across a wide variety of domains such as education (Kilbourne, 1974; Proper, 1982), counseling and therapy (Fontana, Dowds, & Bethel, 1976; Lyddon, 1989), scientific inquiry (Overton, 1984) and historical analysis (White, 1973). The researchers who employ Pepper's ideas often refer to these systems as "worldviews."

As purported knowledge structures capable of applying across a wide range of knowledge domains, mechanism and organicism seem to behave like a special kind of schema which Feltovich, Spiro and Coulson (1989; Spiro, Feltovich, & Coulson, 1996) called "prefigurative schemas." Furthermore, these two worldviews seem to fit the distinction of a kind of schema described by Bransford, Nitsch and Franks (Bransford, Nitsch, & Franks, 1977) that a person thinks *in terms of* as opposed to schemas a person thinks *about*.

Despite fitting the description of a particular kind of theorized schema as well as being used by researchers across various knowledge domains, Pepper's worldviews have not yet been evaluated empirically to determine if they possess basic psychological traits common to other kinds of schemas in the schema-theory paradigm (see, e.g., Anderson &

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Pearson, 1984; Anderson, Reynolds, Schallert, & Goetz, 1977; Gick & Holyoak, 1983; Rumelhart, 1980; Rumelhart & Ortony, 1977; Spiro, 1980). Furthermore, as purported high-level knowledge structures, a basic test of worldviews' psychological reality could evaluate whether they can be added to the catalogue of known schemas with demonstrated cognitive effects. If a demonstration of their psychological reality can be shown, worldviews could be subjected to further studies intended to fill out their operation in greater detail. This dissertation addresses this need by testing Pepper's mechanism and organicism worldviews for psychological reality.

Since testing the psychological reality of worldviews is the main goal of this dissertation, it is crucial that an established method for showing such a reality be used. One such method is the selective recall paradigm of Anderson and colleagues (Anderson & Pichert, 1978; Anderson, et al., 1977; Pichert & Anderson, 1977). This paradigm has had a large influence on and gained general acceptance as a method for demonstrating the psychological reality of purported knowledge structures used during the comprehension of a text. In this paradigm, a text is created with segments that differentially pertain to particular schema perspectives under study. The text is learned by participants who, after a period of time, must then recall whatever parts of the text they can. If the schemas under study are operative, patterns of selective recall indicating those schemas become evident in the memory data. For example, in Pichert and Anderson (1977), a text was created to possess features of interest to individuals who assumed either a homebuyer or burglar schema. Participants were asked to read the text from one perspective or the other and then asked after a period of time to recall whatever parts of the text they could. It was found that readers with a homebuyer schema

selectively recalled the text differently than what was recalled by readers with a burglar schema (e.g., homebuyers remembered water stains on the ceiling more often than burglars and burglars remembered the kinds of locks on the doors more often than the homebuyers). In other similar studies perspectives on how to read the text were not assigned out, but instead were previously determined (e.g., Anderson, et al., 1977). This latter design is closer to what will be proposed in this dissertation. However, the example described above is meant to demonstrate that the selective recall paradigm relies on recording an effect for how a text is recalled based on the preference for one perspective over another.

As purported knowledge structures, Pepper's worldviews can be studied along the same lines of Anderson and colleagues' selective recall paradigm. In this dissertation, texts were created that differentially pertained to two of Pepper's worldviews called mechanism and organicism (described in greater detail later). Participants were asked to read and recall these texts, and then these memory data were analyzed to see if participants' preferred worldview could predict which segments of text would be recalled more often (i.e. data was analyzed to see if mechanists recall more mechanist segments and if organicists recall more organicist segments). If a pattern of selective recall based on worldview preference could be shown in the form of a significant interaction between participants' worldview preference and the kinds of items that they recalled from the text, then the claim that worldviews are psychologically real high-level schemas are supported. Such results would also indicate a need to increase the amount of educational research on these worldviews.

Hypotheses

This dissertation approaches Pepper's mechanist and organicist worldviews with the hypothesis that they are psychologically real schemas that possess properties similar to prefigurative schemas described by Spiro and colleagues (Feltovich, et al., 1989; Spiro, et al., 1996). This hypothesis can be tested by seeing if Pepper's mechanism and organicism have the capability of affecting recall from a text in a manner similar to the studies of Anderson and colleagues (Anderson & Pichert, 1978; Anderson, et al., 1977; Pichert & Anderson, 1977) which helped to establish the psychological reality of schema-theory in general. If it can be shown that individuals' selectively recall items from a text embedded with Pepper's worldviews based on their preference for these two worldviews then I can claim support for the hypothesis that mechanism and organicism are psychologically real. This is because selective recall suggests that the embedded schemas are actively affecting the cognitive process of recall. To be even more specific, my hypothesis about mechanism and organicism would predict that individuals with a mechanist worldview will recall more mechanist items than organicist items from a text that possesses items from both worldviews, and that individuals with an organicist worldview will recall more organicist items than mechanist items. Furthermore, the pattern of recall of individuals who prefer organicism will be significantly different from mechanism preferring individuals (i.e., a significant interaction between participants' worldview preference and items recalled in a text). If I cannot show an interaction effect between the individuals' worldview preference and the types of items that they recall, I would need to reject the hypothesis that worldviews are psychologically real.

A second related hypothesis is that Pepper's worldviews should be able to show patterns of selective recall across texts describing different knowledge domains. This hypothesis is based on the assertion by Pepper that his worldviews are capable of applying across a wide variety of contexts "of any facts, whatever" (Pepper, 1942, p. 99). Therefore, in order to retain this hypothesis I would need to see interaction effects between participants' worldview preference and the types of items they recall across texts from at least two different knowledge domains. Finding selective recall in only some texts and not others (especially in texts that are specifically designed to find selective recall) would indicate a limit to the kinds of knowledge domains Pepper's worldviews apply to. However, the wider the variety of texts in which Pepper's worldviews can be shown to produce selective recall, the more confidently one can claim that worldviews are capable of applying across various contexts.

Finally, a third hypothesis concerning Pepper's mechanism and organicism has to do with the *kinds* of recall worldview preferences are capable of affecting. Although the previous two hypotheses are primarily concerned with what might be termed "accurate" recall of items from texts, similar hypotheses can be made about Pepper's worldviews' influence on inaccurate recall of a text which would include memory data that is distorted, ambiguous or imported.[1] More specifically, I hypothesize that participants' worldview preferences should affect inaccurate recall in a manner similar accurate recall. In other words, measurements of participants' distortions, ambiguities, and importations should significantly interact with their worldview preference in ways similar to accurate measures of recall.

Research Questions

  The first two hypotheses regarding the influence of mechanism and organicism on selective recall and the ability of mechanism and organicism to apply across multiple knowledge domains were combined into one research question since they both concern measures of accurate recall. The third hypothesis regarding the influence of mechanism and organicism on measures of inaccurate recall was made into a second research question. The research questions employed in this dissertation are formally stated as follows:

1) What patterns of selective recall from texts containing mechanist and organicist worldviews are present (a) based on individuals' pre-existing worldview schemas and (b) across texts from different knowledge domains?

2) In what ways do the kinds of recall that are present in selective recall tasks affect the kinds of interpretations that can be made about Pepper's worldviews' influence on text comprehension?

CHAPTER 2: LITERATURE REVIEW

In this chapter a description of worldviews is given followed by a discussion of worldviews' previous presence in educational and psychological literature. Also, a discussion of schema theory centering upon the work of Anderson and colleagues (Anderson, et al., 1977; Pichert & Anderson, 1977) will be given.

Description of Pepper's Worldviews

Stephen Pepper's (1942) conception of world hypotheses (written as worldviews in this paper) was originally put forth as a philosophical treatise on metaphysics. He described these worldviews as four viable deep-seated root metaphors that people use to reason about the nature of the world and events in it. Each different but legitimate worldview deeply affects how people approach making sense of different pieces of knowledge. Pepper called these four views formism, mechanism, organicism and contextualism. Each has specific strengths and weaknesses in being able to describe how the world works. However, despite their relative strengths and weaknesses, all four are equally capable, according to Pepper, of describing content in any domain of knowledge. In this sense, worldviews can be described as "content-free" structures. This is <u>not</u> meant to imply that worldviews themselves are devoid of any content. Rather, the description is intended to indicate that worldviews' are not externally bound to describe only a small set of knowledge domains. Instead they are "free" to organize knowledge across many domains which supports their appellation as "world"-views.

Mechanism. Pepper's mechanism is a reductionistic worldview that focuses on understanding things via the parts of a whole. Mechanism assumes a discrete and specific

set of relations for any problem and that each of these fundamental cause and effect relations should be able to be separated for examination. Pepper suggested that mechanism was espoused by scholars like Democritus, Galileo, Descartes, Hobbes, Hume and Locke. White (1973) suggests that Marx and Tocqueville were also mechanists. Prawat and Floden (1994) describe information processing theory (Shank & Abelson, 1977) as possessing a mechanist worldview and Tudge and Winterhoff (1993) argue that behaviorism approaches psychology from mechanistic worldview.

Rose (2004) suggests that a mechanist will often ask the question "How does it work?" This question is fitting since mechanism is rooted in the metaphor of a well put together machine like a lever, clock, combustion engine or electric generator. To illustrate, consider how a clock can be understood by looking at all of its individual parts. By separating out and examining each cause and effect relationship between each part (e.g., cogs, springs, gears), one can build up, and come to understand, how all parts work together to make the clock perform its proper function.

Johnson, Germer, Efran, and Overton (1988) in their work studied correlations between two of Pepper's worldviews (mechanism and organicism) and other personality characteristics (see Table 1). They suggest that mechanists approach understanding the world via a stable and elementaristic ontology. Furthermore, a mechanist typically prefers viewing the world objectively and passively; which, by extension, means that mechanists believe that a person's actions are determined externally by their environment rather than through internal purposeful intentions.

Organicism. In organicism basic parts cannot be understood independently of one another because they work in concert simultaneously as a system. In other words,

organicists reject the simple linear cause and effect analyses of mechanists for a more synthetic, interactional approach for understanding how the world works. Super and Harkness (2003) explain that an organicist, "believes that every event in the world is the result of an organic process and that its apparent structure is best viewed as an 'ideal, aimed at by the progressive steps of progress' (Pepper, 1942, p. 281)" (p. 6). Pepper attributed the philosophical work of Schelling, Hegel and Royce to organicist perspectives. Other suggested organicists are Ranke, a French historian, Hegel (White, 1973), and the developmental psychologist Piaget (Tudge & Winterhoff, 1993).

Rather than asking the mechanist question "How does it work?" an organicist would prefer to ask, "How does it develop?" (Rose, 2003). In fact, Lyddon (1989) suggests that many theories of human development have philosophical underpinnings from the organicist worldview which is fitting considering that the organicist worldview, as described by Pepper, is rooted in the metaphor of a growing plant or animal.

Pepper recommended that organicists prefer viewing events in the world as the result of a purposeful process toward an idealized state and Johnson et al. (1988) found this same pattern in their own study of organicist personalities. As is shown in Table 1, organicists approach the world from an ontology that favors change over stability and holism over elementarism. Whereas mechanists view the world as objective and passive, organicists prefer to view the world, and persons in it, as constructed, purposive and active.

Contextualism. Rather than attempting to show how all parts of the whole cohere together as in mechanism or to explain how processes are driven by internalized purposes as in organicism, contextualism focuses on understanding the world via subjectively

interpreted particular moments. In other words, contextualist seek to understand "act[s] in the moment" (Pepper, 1942, p. 231), and, according to Rose (2003) attempt to answer the question "How is it happening?" To a contextualist, the only meaning that can be discerned in this world comes from two sources: from the history of the act, and from the context and the perspective of the observer. This means that objective mechanist descriptions or idealized organicist constructions that extend beyond "the moment" are given less credence. Pepper included Protagoras, Peirce, James, Dewey and Mead as contextualist philosophers and White (1973) suggested that Croce and Burckhardt were also contextualists.

In contextualism change and novelty are considered inherent to any moment and meanings are often relative to the observer. Therefore multiple interpretations abound as the number of observers increases. However, multiple interpretations are not looked down upon by contextualist, but are rather preferred. Super and Harkness (2003) the contextualist perspective this way: "In this view, it is impossible to arrive at a single or simple explanation of the 'cause' for anything…[M]ultiple perspectives are appreciated, even required" (p. 6). To a contextualist, "the whole universe…is such as [the] event is, whatever it is" (Pepper, 1942, p. 235).

Although Pepper viewed contextualism as a worldview apart from the other three worldviews, some scholars (see, e.g., Overton, 1984; Prawat & Floden, 1994) believe that contextualism does not adequately represent a true worldview. This is, they argue, because of its tendency to form "hybrid" (Prawat & Floden, 1994) worldviews with mechanism and organicism or because of its difficulty to find a place in "scientific research methods" (Overton, 1984).

Formism. The worldview of formism is based on the assumption that objects (or concepts) can be categorized with discrete boundaries based on their assigned definition or similarity to a prototype. Pepper suggested that this worldview was espoused by philosophers like Plato and Aristotle as well as many of the medieval Scholastics. Hayden White (1973) in his book *Metahistory* describes both the philosopher Nietzsche and the French historian Michelet as formists. Rose (2003) suggests that the formist worldview seeks to answer the question "What is it like?" and to answer this question, formists make sense of the world by deriving meanings and definitions via classifying and categorizing. Furthermore, Super and Harkness (2003) describe that the primary cognitive task for a formist is to analytically "discern diagnostic similaristics" (p. 5).

Pepper explains that the formist worldview seems "the least adequate of the four [worldviews]" (p. 144). However justifies not dropping it from the list of other viable worldviews because of how powerful yet simplistic the formists' root metaphor of similarity of types is for describing the world. Nevertheless, Pepper's lack of confidence in formism as a worldview seems to be supported by the fact it is the most neglected when researchers choose to use only a subset of Peppers' four worldviews (see, e.g., Altman & Rogoff, 1987; Babbage & Ronan, 2000; J. A. Johnson, 1987; Overton, 1984; Prawat & Floden, 1994; Spiro, et al., 1996; Tudge & Winterhoff, 1993).

Symmetry across the four worldviews. Pepper explained that the four worldviews (formism, mechanism, organicism, and contextualism) contain a "certain symmetry…which may itself possess a cognitive significance" (Pepper, 1942, p. 141). Furthermore, he explained that "[t]hese four worldviews arrange themselves in two groups of two each" and that "there is a polarity between these two pairs…and between

the members of each pair" (Pepper, 1942, p. 142). These two groups, depicted in Figure 1, concern the principle procedures whereby Pepper believes knowledge is investigated. Pepper described these two groups of worldviews as "Analytic" and "Synthetic." Furthermore, the "polarity" between the members of each group is based on two tendencies for interpreting knowledge which Pepper described as "Dispersive" and "Integrative." Descriptions of these groupings are presented below followed by individual descriptions of each worldview.

Analytic and Synthetic worldviews. Pepper uses the terms *analysis* (i.e. to break an idea down to its essential parts) and *synthesis* (i.e. to bring together the parts of a system to make one consistent whole) to describe the two processes by which the four worldviews investigate knowledge. Formism and mechanism are considered analytic worldviews and contextualism and organicism are considered synthetic worldviews. All four worldviews use both kinds of investigations, but the two groups emphasize the need for one kind of investigation over the other. Therefore, for formism and mechanism, analysis is employed as the primary means of reasoning about knowledge whereas any kind of synthesis is a secondary process. Contextualists and organicists, on the other hand, conduct their reasoning about the world principally via synthesis whereas analysis becomes derivative.

Dispersive and Integrative worldviews. Each of the two members of Analytic worldviews (Formism and Mechanism) and the Synthetic worldviews (Contextualism and Organicism) vary according to interpretive tendencies which Pepper described as Dispersive or Integrative. The Dispersive worldviews (Formism and Contextualism) interpret knowledge about the world individually and resist systematizing this knowledge

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with other events. Dispersive worldviews take facts "one by one from whatever source they come and are interpreted as they come and so are left" (Pepper, 1942, p. 142). On the other hand, Integrative worldviews (Mechanism and Organicism) interpret knowledge as capable of being placed into one grand structure. For the Integrative worldviews, "the world appears literally as a cosmos where facts appear in a determinate order" (p. 142).

Worldviews in Educational and Psychological Literature

Since its original publication Pepper's ideas have had a small but consistent presence in the educational and psychological literature. However, their use has often been descriptive or comparative, and they have never been tested for their influence on basic cognitive processes. Educationally they have been used to describe the content in a science textbook (Kilbourne, 1974), as well as in an analysis of science teachers' dialogue (Proper, 1982). They have also been used to describe different views of constructivism (Prawat & Floden, 1994). Psychologically they have been utilized to describe major paradigms like behavioral analysis (Hayes, Hayes, & Reese, 1988), empiricism (Overton, 1984), environmental psychology (Altman & Rogoff, 1987), and the developmental perspectives of Bandura, Vygotsky and Piaget (Tudge & Winterhoff, 1993). They have also been used to assist in counseling (Fontana, et al., 1976; Lyddon, 1989) and understanding research on adolescent behavior (Cooper, 1987). Even more recently they have been used to analyze changes in human development (Lewis, 2000; Super & Harkness, 2003) and differences in personality (Babbage & Ronan, 2000).

Along with these studies, various psychological instruments have been developed to measure and analyze the use of these worldviews (Germer, Efran, & Overton, 1982;

Harris, Fontana, & Dowds, 1977; J. A. Johnson, et al., 1988; Kramer, Kahlbaugh, & Goldston, 1992; Spiro, et al., 1996; Super & Harkness, 2003). A description of these different instruments is explained below.

Harris, et al. (1977) developed an instrument called the *World Hypotheses Scale* (WHS) which is a 12 item test given to measure individual preferences for all four worldviews discussed by Pepper. Germer, et al. (1982) subsequently created an instrument to compete with the WHS called the *Organicism Mechanism Paradigm Inventory* (OMPI) and which was further developed by J. A. Johnson and colleagues (1987; J. A. Johnson, et al., 1988). The OMPI measured only two of the four worldviews (organicism and mechanism) but was reported to be more psychometrically valid than the WHS due to reducing the redundancy in the items. This redundancy likely existed due to the fact that Peppers four worldviews share characteristics across investigative procedures (Analysis, Synthesis) and interpretive tendencies (Dispersive, Integrative). In contrast to the two-worldview OMPI, both Kramer and colleagues (Kramer, et al., 1992) and Super and Harkness (2003) developed scales that measure all four worldviews called the *Social Paradigm Belief Inventory* (SPBI) and *Child Behavior Questionnaire* (CBQ). However, the items on these scales were written to measure an individual's worldview preference specific to social situations and parenting styles, respectively, whereas the OMPI was designed with items that covered a variety of topics like education, relationships and business. Finally, Spiro and colleagues developed an instrument titled the *Cognitive Flexibility Inventory* (CFI) that utilized two worldviews (mechanism and contextualism) to measure students' learning preferences.

Worldviews as Schemas

In this section, the similarities between schemas and worldviews are described along with their ability to apply to a diverse set of knowledge domains. These descriptions are intended to show that worldviews should be considered special high-level schemas that are structured in such a way that allows them to apply more flexibly across knowledge domains compared to other schemas.

Much of the comparison between schemas and worldviews that follows comes from The work of R. C. Anderson and colleagues (Anderson, et al., 1977; Pichert & Anderson, 1977). These two studies also provide for this dissertation the methodological point of departure. For this reason, a more detailed description of these studies is provided in Appendix B.

Similarities between schemas and worldviews. Originally discussed by philosophers like Immanuel Kant and John Locke, schemas came to be discussed in psychological and educational circles by psychologists like Bartlett (1932) and Piaget (1936). The definition of high-level schemas used by R. C. Anderson and colleagues (Anderson, et al., 1977; Pichert & Anderson, 1977) along with researchers like Rumelhart and Ortony (Rumelhart, 1980; Rumelhart & Ortony, 1977) concerns an organized method for storing mental representations. For example, Anderson, et al., (1977) define schemas as abstract knowledge structures that contain placeholders for "represent[ing] the generic concepts underlying objects, events and actions" (p. 369). This kind of description also fits for worldviews since they abstractly organize the way that content should be represented. Anderson and colleagues also argue that schemas in general (not limited to just "high-level" schemas) can be even more important than the

structural details of text when considering one's ability to comprehend a text since these schemas alter how the content is perceived. Worldviews can also be said to be more important when considering one's ability to comprehend a text based on their ability to influence perceptions.

As further evidence for interpreting Pepper's worldviews as a series of four interconnected schemas is the claim that Anderson and colleagues make about high-level schemas' ability to predispose people to comprehend texts in specific ways. They say, "...at a very early stage in processing, high-level schemas can cause a person to give one interpretation to a passage without even considering other possible interpretations" (Anderson et al., 1977, p. 370-371). This is also a claim put upon the capability of worldviews and it is specifically discussed by Spiro and colleagues (Feltovich, et al., 1989) wherein they say that worldviews are "a kind of 'lens' that one sees with and at the same time determines what is excluded from view" (p. 123).

Worldviews as schemas unrestricted by content. The most important feature that sets worldviews apart from other high-level schemas is their ability to organize knowledge across diverse knowledge domains. This is unique because the general body of research on schemas is typically tied to specific knowledge domains. To illustrate this point consider the schemas chosen by Anderson and colleagues in their studies. They worked with specific schemas that were specifically chosen to represent the following knowledge domains: (1) wrestling, (2) prison escapes, (3) card games, (4) music rehearsals, (5) shipwrecks, (6) botany, (7) burglary and (8) real estate. Each of these schemas are quite content-laden in that there would be few insights to be gained by applying the schema of one knowledge domain (e.g., a wrestling schema) to content from

a different knowledge domain (e.g., botany). On the other hand, Pepper claims that his worldviews should be able to validly apply to any one of these aforementioned knowledge domains.

To take the difference between Pepper's worldviews and other lower-level schemas one step further consider what happens if the schema of wrestling was replaced by a more general schema like "fighting" or by a less general schema like "headlocks." Although the levels of generality of these schemas are different, they are still more or less dependent upon content because each of these schemas was originally constructed with a specific knowledge domain in mind. On the other hand, worldviews like those described by Pepper are philosophically reasoned to be content-free which make them categorically different from other schemas. Rather than being constructed to represent a specific object, event or action, like most schemas, worldviews are constructed to determine more generally what form any representation or explanation of knowledge should take. Pepper's worldviews should be able to be applied to fighting or wrestling or headlocks or botany or music rehearsals or whatever the content may be.

The question can be raised about whether each worldview is completely content-free in the sense that they are "free" to be applied to any knowledge domain. Aside from being described philosophically as possessing such a trait, they have yet to fail to be applied to any of the knowledge domains for which they have been used in the sixty plus years that they have been around.[3] The difference is admittedly conceptual, but the conceptual difference between a category described as content-laden versus a category described as content-free seems to be quite a clear conceptual distinction. Nevertheless,

the second part of the first research question of this dissertation is written to investigate this issue in a more empirical way via the selective recall paradigm.

For this dissertation the need to investigate worldviews' content-free nature is secondary to the need to establish their psychological reality since evidence of worldviews' content-free characteristics exists whereas <u>none</u> is as yet available concerning their psychological reality. Nevertheless, worldviews' purported capability of applying across so many knowledge domains is a main reason why a test for psychological reality is so important to complete. If Peppers worldviews can be shown to be psychologically real, research that specifically investigates the limits to their "content-free" nature could commence.

CHAPTER 3: METHOD

Participants

The participants were 60 undergraduate and graduate students (33 females, 27 males, $M = 23$, $SD = 4.5$) who responded to advertisements put up in buildings across campus. Advertising across a diverse cross-section of the campus was intended to help ensure that a wide variety of backgrounds and interests would be present in the study to help ensure a broad sampling of worldview preferences. Participants received $20 as an incentive to take part in the study. Six participants did not complete the entire study.

Design

Restricting the analysis down to mechanism and organicism. Rather than investigating all four of Pepper's worldviews for psychological reality I decided to only focus upon mechanism and organicism. I made this decision for a two reasons. The first reason was that including all four worldviews in a first test of psychological reality greatly increased the amount of complexity in the design and sophistication in the types of analyses. As a first test I felt that the simpler I could make the design, the greater chance I would have to present compelling findings.

The second reason for including only two worldviews was based having only a limited number of instruments to choose from that were readily available for measuring participants' worldview preferences. As mentioned in the literature review, only a handful of instruments have been developed that measure an individual's worldview preference based on Pepper's ideas (i.e., Germer, et al., 1982; Harris, et al., 1977; Kramer, et al., 1992; Spiro, et al., 1996; Super & Harkness, 2003). Of the five described

in this dissertation the OMPI designed by Germer, et al. (1982) seemed the most appropriate for use in establishing psychological reality. First, it was psychometrically more reliable than the WHS (Harris, et al., 1977). Second, it covered more knowledge domains in the individual items than the SPBI (Kramer, et al., 1992) and CBQ (Super & Harkness, 2003). And lastly, it was more widely used than the CFI (Spiro, et al., 1996). For these reasons the OMPI was selected to be used in this dissertation and since the OMPI only measures participants' preference for mechanism and organicism and neglects Pepper's other two worldviews, it was necessary for me to reduce my investigation to only these two worldviews.

Despite my reasoning for choosing to measure only two of Pepper's four worldviews, the question remains whether one can validly measure only two worldviews at a time. This can be answered in several ways. First, Pepper himself suggested that his worldviews "arrange themselves in groups of two…[with] a polarity between the members" (1942, p. 142). Mechanism and organicism form an "integrative" group of worldviews with mechanism at the analysis pole and organicism at the synthesis pole (see Figure 1). Since these two worldviews have a bipolar relationship, it suggests that they can be measured in a bipolar fashion.

The second reason which suggests that Pepper's worldviews can be analyzed two at a time is based on the success of the OMPI for distinguishing between individuals' preference for only two of Pepper's worldviews. The developers of the OMPI (Germer, et. al, 1982) were aware of Pepper's commentary about the relationships between pairs of worldviews used this commentary to justify including only mechanism and organicism in the instrument. Furthermore, the superiority of the OMPI over the WHS (an instrument

that measures all four worldviews) prompted one of the developers of the OMPI (J. A. Johnson, 1987) to write that "certain world hypotheses [mechanism and organicism] might be better operationalized as ends of a bipolar continuum" (p. 4).

A third, admittedly softer, reason that suggests mechanism and organicism can be measured independent from contextualism and formism concerns following the precedent established by other researchers for making claims using only a subset of Pepper's four worldviews. As was stated in the literature review, formism seems the most neglected of the four worldviews by scholars who utilize Pepper's worldviews, and, although contextualism shows up more often in the literature, it is also under-represented. Since this dissertation is an initial test of worldviews' psychological reality it seems justifiable to follow in the footsteps of more experienced scholars and avoid the more problematic set of Pepper's four worldviews until the basic cognitive properties of their stronger counterparts are better established.

Main analyses to answer the research questions. To answer part (a) of the first research question (i.e., What patterns of selective recall from texts containing mechanist and organicist worldviews are present based on individuals' pre-existing worldview schemas,) data were collected to run two-way mixed design analyses of variance (ANOVAs) which consisted of a between-subjects factor of worldview preference (Mechanists and Organicists) and a within-subjects factor of items recalled from a text (Mechanist Items and Organicist Items). After collecting data to evaluate the first part of research question 1a, another within-subjects factor called text type (History and Physics) was added to make a three-way mixed design ANOVA in order to better evaluate part (b) of the first research question (i.e., What patterns of selective recall...are present...across

texts from different knowledge domains?). This three-way mixed design ANOVA was also used to investigate research question 2 (i.e., In what ways do the kinds of recall that are present in selective recall tasks affect the kinds of interpretations that can be made about Pepper's worldviews' influence on text comprehension?) by changing the dependent variables to measures of different kinds of recall (e.g., accurate recall, distortions, ambiguities, importations). The effect of a number of potential covariates upon these models were also investigated.

Materials

The main materials used in this dissertation included an inventory for measuring participants' worldview preference and two texts; one about the French Revolution and the other about quantum mechanics. Also, six other materials were designed to measure potential covariates in the study. These materials were a factor referenced vocabulary test, two background knowledge tests about the French Revolution and quantum mechanics, a short demographic survey for obtaining participants' age and gender, and two inventories intended to measure participants' worldview beliefs about how history and physics should be learned. What follows is a more in depth description of each of these materials.

Organicism Mechanism Paradigm Inventory. In order to measure participants' preference for mechanism and organicism an instrument titled the *Organicism Mechanism Paradigm Inventory* (OMPI) was used. This instrument, designed by Germer, Efran and Overton (1982) and further developed by Johnson and colleagues (J. A. Johnson, 1987; J. A. Johnson, et al., 1988) is a peer reviewed, 26 item, forced choice instrument for measuring an individual's preference for organicism or mechanism. The

OMPI includes items that discuss philosophical issues regarding mechanism and organicism (such as the causes of change and development) as well as items that address practical situations about topics like education, relationships, and business. A full copy of the OMPI has been provided in Appendix B.

Germer et al. (1982) reported that the OMPI showed good internal consistency with a Guttman split-half coefficient of .86 and a Cronbach's alpha coefficient of .76. Also, a three week test-retest interval showed a stability coefficient of .77. Every item wherein an organicist statement is chosen gains one point and every item wherein a mechanist item is chosen gains zero points. Therefore, lower scores indicate a greater preference for mechanism and higher scores indicate a greater preference for organicism. Scores can range from 0 to 26. Research conducted by Babbage and Ronan (2000), as well as Johnson et al. (1988), suggest that although the minimum range of scores can reach down to zero, scores below 9 are very uncommon amongst college aged students in the United States.

Texts. Two texts of about 1300 words in length were written to contain alternating mechanist and organicist paragraphs. The content of the first text was about the French Revolution and the content of the second text was about quantum mechanics. These texts will hereafter be called the "History text" and the "Physics text," respectively. Both texts can be viewed in Appendix C. The content of each text was purposely made to be very different from the other so that the influence of participants' worldview preferences could be evaluated across texts with different knowledge domains.

Although the content across the History and Physics text is very different, the way in which mechanism and organicism are embedded into each text is very similar. Each text is seventeen paragraphs long beginning and begins with an introductory paragraph that outlines the content of the text. After this introductory paragraph the next sixteen paragraphs alternate between portraying content in either a mechanist or organicist worldview. Therefore each text contains eight "mechanist" paragraphs of content and eight "organicist" paragraphs of content. When discussing these 16 mechanist and organicist paragraphs collectively they are referred to as "target paragraphs," and the worldview that each target paragraph is meant to portray is referred to as the "intended worldview." The worldview that a target paragraph was not purposely meant to portray is called the "alternative worldview."

Vocabulary test. An Extended Range Vocabulary Test from a kit of factor referenced tests (French, Ekstrom, & Price, 1976) was used to identify and control for verbal intelligence. This test has two 24-item sections in which participants have six minutes to complete each part.

The Extended Range Vocabulary Test was included in the dissertation for two reasons. First, as a good proxy for verbal intelligence (Neisser et al., 1996), as well as for reading comprehension (Nagy & Herman, 1987; Nelson-Herber, 1986) vocabulary scores could potentially co-vary with the amount of text recalled by participants. By having these data, some extraneous variability may be able to be controlled for if necessary. Second, it is possible that worldviews may be more effective with participants who have higher verbal intelligence/reading comprehension. Therefore, vocabulary test can provide me with data to investigate this possibility.

Background knowledge tests. As a control for background knowledge, two 10-item multiple choice tests about the French Revolution and quantum mechanics were written. None of the answers to these questions could be directly answered by content found in the History or Physics texts. Both tests can be found under Appendix C.

Basic demographics questions. Participants were asked to give their age and gender so that these variables could be checked as potential covariates with worldview preference.

Revised Cognitive Flexibility Inventories. Out of concern that participants might exhibit subject specific worldview biases when reading text about history versus text about physics, I sought out an instrument that could help to measure this potential covariate. I wanted to find an instrument that would ask OMPI-like questions for determining worldview preference, but would ask these questions as they related to one specific knowledge domain. I could not find an instrument designed specifically for this purpose. However I still felt it was important to make an attempt to measure participants' worldview preferences specific to learning history and physics. Therefore, I took the instrument developed by Spiro, Feltovich, and Coulson (1996) called the *Cognitive Flexibility Inventory* (CFI) and revised a number of the items to create an instrument that could potentially capture participants' perceptions about whether physics and history should be learned from a mechanist perspective or from an organicist perspective.

The original CFI is a 15- paired item instrument which asks participants to evaluate statements regarding thoughts, attitudes and reasons about how people learn. The statements vary according to assumptions held by two worldviews called the "reductive" worldview and the "expansive" worldview. Though labeled with different

names, the reductive and expansive worldviews are based in part off of Pepper's

mechanism and contextualism worldviews, respectively. The CFI was developed in

connection with research aimed at showing differences in medical students' capability to

learn and flexibly apply ill-structured medical concepts (Feltovich, et al., 1989; Spiro, et

al., 1996) wherein it was found that students with a more expansive worldview were

better able to make correct diagnoses regarding congestive heart failure than students

with reductive worldviews.

Revisions made to the original CFI for use in this dissertation are as follows.

First, all contextualist statements were replaced with organicist statements. Second, the

wording and vocabulary of most items was stripped down to appeal to a younger more

undergraduate audience. Third, six of the original 15 paired items were deleted due their

contributing the most to a poor Spearman Brown split-half coefficient (.48) when this

test was administered to 12 students in a pilot study. Fourth, the CFI was made into a

forced choice instrument instead of a Likert scale test. The decision for this revision was

made based on suggestions by Johnson et al. (1988) that forced choice items are a better

format for tracking worldviews. Lastly, and most importantly, the items in the revised

CFI address domain specific learning in history and physics. In other words, participants

evaluate each item on the revised CFI according to how they think it applies to learning

from one subject at a time. Because of this, participants take the revised CFI twice; once

as it applies to learning history and once more as it applies to learning physics.

Therefore, these tests are respectively referred to in this dissertation as the "Revised CFI

for Learning History," and the "Revised CFI for Learning Physics." When referring to

both tests collectively, they are referred to as "Revised CFIs." The items and instructions for completing the Revised CFI for Learning Physics can be viewed under Appendix E.

The final revised CFIs include nine items of paired organicist and mechanist statements about how one should learn *history* or *physics*. Every item wherein a participant chooses an organicist statement gains one point and every item wherein a participant chooses a mechanist item gains zero points. Therefore lower scores indicate a greater preference for learning the targeted knowledge domain in a mechanistic fashion and higher scores indicate a greater preference learning the targeted knowledge domain in an organicistic fashion. Scores can range from 0 to 9.

It should be stressed that the revised CFIs used in this dissertation were not fully tested regarding their psychometric properties. Therefore any data obtained by its use must be interpreted cautiously. Despite not being fully tested, it has been included in this dissertation because of the potential for participants' worldview preference to vary according to the knowledge domain that they read in. With no other readily available instruments for measuring subject specific worldview preference and because measuring this variable is not the central focus of the dissertation, I felt it was justifiable not to take the extra steps necessary to properly test the psychometric properties of the revised CFI (especially since constructing a new psychological instrument can be a dissertation all by itself!)

Procedure

Participants completed the research activities in two phases. The first phase was completed online through a survey software website called Qualtrics (http://www.qualtrics.com). The main research activities completed during this online

phase were to answer items from the OMPI and revised CFIs. The main activities in the second phase, which was completed face-to-face, were to read the History and Physics texts and then to write down as much of the texts that they could remember in a free recall task. A description of these two phases will now be described in greater detail.

First phase—completed online. A potential participant would email or call me expressing interest in participating in the study after seeing an advertisement on campus. I would then send them via email a link to my research materials at the Qualtrics website along with a four-digit ID number which they would use to accept a consent page and gain access to complete the rest of the online research activities. ID-numbers were sequential so that there would be an equal number of participants whose ID-numbers were even and odd were then used to counterbalance the order in which research activities were completed.

After consenting to be a part of the study participants were asked to provide their age and gender. Next, they completed an online version of the OMPI. Lastly, they completed the Revised CFI for Learning History and then for Learning Physics. The average time to complete all online research activities was roughly 14.5 minutes (SD=7.6).

Giving consent, answering the basic demographics questions, and completing both the OMPI and Revised CFIs online were intended reduce the mental fatigue from completing all research activities in the same session. It was also intended to reduce potential interference between being measured for worldview preference and reading texts with embedded worldviews.

Second phase—completed face-to-face. After completing all online activities, participants were prompted to re-contact me and schedule a time to complete the rest of the research activities in person. Most participants met with me within a week of completing the online activities though the range across all participants varied from two days to five weeks.

All research activities for the second phase were conducted in a quiet office on campus where distractions could be held to a minimum. The range of time to complete all research activities in this second phase varied from 45-minutes to one and a half hours. Most participants completed the second phase just under an hour. After finishing the second phase of the study, the participants were told the general purpose of the study (to investigate patterns of recall based on worldview preference) and were compensated for their time with $20.

Reading the first text. To start the second phase of the study participants reviewed the consent form which they signed electronically during the online phase. Next each participant was instructed to first read either the History text or the Physics text depending on the last digit of their ID-number so that the order for reading each text would be counterbalanced. If the last digit of the participant's ID-number was odd, they were given only the History text first. If their ID-number was even they were given the Physics text first. The instructions for reading the text were included at the beginning of the text handout and were read out loud to the participant. These instructions can be found in Appendix A along with the rest of the History and Physics texts. In short, the instructions cautioned the participant to read the text carefully, to take as much time as needed to read through the text, and that the participant would be asked about the text

later. A common question asked by the participants was whether they could write on the text and permission was given to all who asked.

Reading the second text. After reading the first text, participants were immediately shown the second text, read the instructions for completing the task, and then allowed to read the text. Participants knew they would be required to read a second text after completing the first text since this procedure was outlined in the consent form, but they did not know the exact topic they would be required to read. Despite being informed that they would be asked to read two texts, there were a surprising number of participants who seemed surprised to see a second text presented to them.

Vocabulary test. After reading both texts and before being asked to recall the contents of those texts, participants completed the Extended Range Vocabulary Test (French, et al., 1976). They were first shown a sample item from the test and then were read out loud the following instructions before completing the task:

> Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong. You will have <u>6 minutes</u> for each of the two parts of this test. Each part has one page. When you have finished part 1, STOP. Please do not go to Part 2 until you are asked to do so.

Recall tasks. After completing the vocabulary test the next task was for the participant to compete two recall tasks; one for each text in the same order that they read the texts. In other words, if a participant read the Physics text first and the History text

second, she would first recall items from the Physics text, and then, afterwards, to perform the same recall task for the History text.

To perform these recall tasks, each participant was handed a blank sheet of paper with the exception of a few lines of instruction at the very top of the page that revealed to them nature of the task. Assuming a participant who was asked to first recall items from the History text, the following instructions would have been read out loud before beginning the task:

Please write down as much as you can remember about what was written in the French Revolution text. Be as detailed and as accurate as possible. Write down what you remember in the order that it comes to your mind. Feel free to continue on the back of this paper. When you are finished tell the researcher and he will tell you what to do next.

Immediately after completing the first recall task, each participant was given a second sheet of paper with the same instructions to record all they could recall from the second text. In contrast to the surprise that many participants showed when handed the second text, most participants were very expectant to receive the second recall task and several even began writing down what they could remember before I could read through all the instructions to them.

It was expected that a within-subjects designing for completing the recall tasks would add in serial effects which meant that whatever text a participant read first will likely be recalled less accurately and with less detail compared to his or her recall for the second text. This serial effect also increases the total error variance found across participants. However, it was felt that this drawback could be adequately made up by the

power gained through keeping the task a within-subjects design. The order of presenting texts and recall tasks could have been alternatively arranged so that each participant was administered a recall task immediately after reading the corresponding text. Ordering the recall tasks in this manner might have mitigated some of the serial effects, but would have also introduced a priming effect for reading and recalling the second text. With the desire to retain a within-subjects design of the recall tasks it was felt that the error variance introduced due to a serial effect would be more acceptable than introducing error variance due to a priming effect.

Background knowledge tests. The final tasks completed by each participant were the two multiple choice background knowledge tests about the French Revolution and quantum mechanics (see Appendix D). The instructions at the top of each test were first read out loud to the participant and then the participant was allowed to complete the task. The tests were presented in the same order that the texts and recall tasks were presented to the participant. Also these tests were the last tasks to be completed by the participant so they could not interact with the memory data recorded by participants in the recall tasks. None of the answers, correct or incorrect, found on the background knowledge tests were mentioned in the corresponding texts. This was done to help reduce any interactions between reading the texts and answering items in the background knowledge tests.

Scoring

In the following section a number of new terms are introduced that operationalize the ways in which the History and Physics texts as well as memory data from the recall tasks were parsed for scoring. These terms are defined at the time that they are initially

introduced. However, since many are frequently used after being initially introduced, a glossary has been provided in Appendix F which lists many of these terms in alphabetical order for quicker reference.

Parsing the texts into idea units. Both The History and Physics texts were parsed into what are known as "idea units" based on the general method outlined by Pichert and Anderson (1977). Although Pichert and Anderson give a good outline for how to break up a text into idea units, they do not explicitly define what comprises an idea unit. Fortunately, the term "idea unit" seems to have been in common use by other contemporary educational psychologists who studied memory via textual analyses (Brown & Smiley, 1977; R. E. Johnson, 1970; Kintsch & Flammer, 1982). These other researchers often describe idea units in terms of clauses (or phrases) with "self contained ideas" (Hidi, Baird, & Hildyard, 1982, p. 66).

After determining from other researchers that idea units were generally described as clause-sized units of text, I wanted to make sure Pichert and Anderson (1977) were using the term in the same way. To do this, I analyzed a passage of text called the "House Passage" provided on page 310 of Pichert and Anderson (1977) that they reported was parsed into 72 "idea units." I reasoned that if I could parse the House passage into the same number of idea units based on the general descriptions of idea units by other contemporary researchers then I would have a much better grasp of Pichert and Anderson's particular characterization of the term.

On my third attempt I was able to successfully parse the House passage into 72 idea units. I found that each idea unit was roughly one clause in length with no more than one subject and one predicate to each clause. Therefore, I proceeded to parse the History

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and Physics texts in the same manner; with the operational definition of an idea unit as a portion of text one clause in length reduced down in most cases to contain one subject and one predicate.

Establishing inter-rater reliability. To establish inter-rater reliability scores for parsing the History and Physics texts into idea units I recruited an Industrial and Organizational Psychology doctoral student familiar with Pepper's ideas and basic psychological research on semantic memory. This rater was first trained to parse the History and Physics text into idea units by being taught the operational definition of an idea unit and then giving him the task of parsing the House passage from Pichert and Anderson (1977, p. 310) into 72 idea units. His training was considered complete when he was able to parse this passage into between 70 and 75 idea units. On his second attempt he was able to meet this criterion.

Four paragraphs from the History text and four paragraphs from the Physics text (roughly one fourth of the total text) were selected to be parsed into idea units by myself and the other rater. This was an amount of text slightly longer than the texts originally used by Pichert and Anderson (1977) to establish inter-rater reliability. We were in agreement on 86% of the idea unit parsings on the History text and 83% of the idea unit parsings on the Physics text. This level of agreement was similar to the level of agreement reported by Pichert and Anderson on their texts. Disagreements were resolved in conference.

After establishing an acceptable level of agreement for parsing text into idea units I parsed the rest of the content from both texts into similarly defined idea units. The

History text divided into 212 idea units and the Physics text divided into 220 idea units. A sample of idea unit parsings from one paragraph of text can be seen in Figure 3.

Worldview ratings. Every idea unit was given two independent ratings according to how well it reflected characteristics of a mechanist and organicist worldview. Each rating was on a scale of one to five. The higher the rating, the more strongly that worldview (mechanism or organicism) is reflected in the content of the idea unit. For example, if an idea unit were given a mechanist rating of "five" (the highest rating), it would indicate that the idea unit was judged to very strongly reflect a mechanist worldview. On the other hand, if the idea unit were given a mechanist rating of "one" (the lowest rating), it would indicate that the idea unit was judged to not reflect a mechanist worldview at all.[4]

The aforementioned rater and I assigned mechanist and organicist ratings to every idea unit in both texts. In order to keep the mechanist and organicist ratings as independent as possible all idea units from both texts were initially rated from only one of the two worldviews. Then, after a short break (at least an hour), the same process was repeated for rating all the idea units according to the other worldview. If either rater was unsure of how to rate a particular idea unit they were encouraged to consult an adapted table (see Table 1) from Germer, et al. (1982, p. 55) to help make a decision. This table succinctly presents 12 characteristics about both worldviews and was also consulted very early in the process of writing the History and Physics texts.

Idea units from the History and Physics texts were reliably rated between me and the other rater for their mechanist and organicist properties based on good Cronbach's alpha coefficients (all above .87) and percentage of agreement scores that ranged

between 81% and 90%. These reliability data are summarized in Table 2. If a worldview rating differed by only one point (e.g., I gave an idea unit an organicist rating of 3 and the other rater gave an organicist rating of 4) my rating was retained. All worldview ratings that differed by more than one point were resolved in conference. A sample of worldview ratings assigned to a group of idea units from the Physics text can be found in Table 3.

Difference Ratings. Although each idea unit was given an independent mechanist and organicist rating, it was also desirable to have a score that indicated an idea unit's combined worldview characteristic. In other words, I wanted to have a measure of how strongly each idea unit portrayed mechanism or organism when taking both worldviews into account. This was accomplished by assigning a "difference rating" to each idea unit which was calculated by subtracting the mechanist idea unit rating (ranging from one to five) from the organicist idea unit rating (also ranging one to five). This meant that an idea unit's difference rating could range between negative four and positive four. Therefore, the more negative the difference rating of an idea unit, the more "mechanist" it is without any interference from organicist characteristics. The more positive the rating, the more "organicist" an idea unit is without interference from mechanist characteristics. This difference rating was, amongst other things, used to evaluate "target idea units" which are discussed below.

Target Idea Units. Although the History and Physics texts were written to contain target paragraphs that emphasized one worldview over the other, the idea units that make up each target paragraph are still subject to vary in their worldview ratings. In other words, some idea units in a target paragraph do not reflect the intended worldview

as strongly as other idea units in the same target paragraph. For example, in Table 3 most of the idea units in this mechanist paragraph from the Physics text have higher mechanist ratings than organicist rating, which is logical since its intended worldview is mechanism. However, not every idea unit in this paragraph follows this pattern (see, for example, the last idea unit in Table 3), and not every mechanist rating is particularly high (see, for example, the third to last idea unit in Table 3). Therefore, six idea units were identified in each target paragraph that most strongly reflected each target paragraph's intended worldview. As an example of how target idea units typically compare to other idea units in a target paragraph, see the six bolded idea units found in Table 3.

Target idea units from each target paragraph were determined by identifying the six idea units of a target paragraph with the strongest difference ratings in the direction of the intended worldview (i.e., the six most negative difference ratings for mechanist paragraphs, or the six most positive difference ratings for organicist paragraphs). Ties were decided by keeping the idea unit with the higher intended worldview rating. For example, consider two idea units from an organicist paragraph that tied for being included as a "target" idea unit because both had a difference rating of two. One idea unit had a mechanist rating of one and an organicist rating of three. The other unit had a mechanist rating of two and an organicist rating of four. Therefore, the second idea unit would be chosen to be included as a target idea unit because its target worldview rating (i.e., organicism) was a four compared to the other idea unit's organicist rating of three. If a tie still existed, the idea unit was chosen in conference with the other rater.

No organicist target idea unit had a difference rating lower than two and no mechanist target idea unit had a difference rating higher than negative two. Almost all

target units (more than 93 percent) had intended worldview ratings that were either a four or five.

Memory data coding scheme. The central purpose of parsing the History and Physics texts into idea units was to create a standard format for which participants' memory data from the recall tasks could be similarly parsed and compared to the texts. Therefore, the procedure for parsing participants' memory data followed the same pattern in which the texts were parsed into idea units with the exception that memory data parsings are called "recall units" instead of idea units. Both idea units and recall units are structurally similar in that both are defined as a portion of writing (e.g., from text or memory data) that is one clause in length and reduced down to contain one subject and one predicate. Furthermore recall units are subject to being assigned a mechanist and organicist worldview rating as well as a difference rating in the same way that idea units are assigned these ratings.

Prior to viewing any data indicating participants' worldview preference, each recall task was divided into recall units by underlining and numbering each individual parsing so that these data could be entered into a spreadsheet. Subsequently, every recall unit was assigned a mechanist and organicist worldview similar to the process of assigning worldview ratings to idea units with the exception that more breaks were taken during the process of rating recall units. The reason for these extra breaks are given below.

The memory data from 54 participants produced nearly 3500 recall units which made the process of assigning worldview ratings to so many recall units very tedious. Therefore, the risk of compromising the consistency of rating the recall units over time

due to mental fatigue needed to be taken into consideration. This was accomplished by spending no more than one hour at a time assigning worldview ratings to recall units and taking at least a one hour "break" from the task before beginning once again. A break could include any activity that did not involve sitting in front of the computer.

After parsing each participant's memory data into recall units and giving each recall unit a mechanist, organicist and difference rating, the next task was to determine how each recall unit corresponded to the original texts. This was essentially a matching process wherein the recall unit was compared to each idea unit in a text. This comparison of recall units to idea units was aided by using a spreadsheet software program that contained all the idea units from both texts and could be easily searched using a "Find" function.

Four kinds of recall. Each recall unit was categorized according to four kinds of recall, based on how it compared to the idea units in the original text. These four categories are called (1) accurate recall, (2) distorted recall, (3) ambiguous recall, and (4) imported recall. A description of each of these categories as well as the criteria for assigning a recall unit to each category is described below.

Accurate recall: A recall units is considered "accurate" when the content of the recall unit is only capable of corresponding to one and only one idea unit from the text. However, this criterion is not so strict that the recall unit and idea unit cannot have minor semantic differences. The allowance for recall units to remain categorized as accurate recall despite minor semantic differences is called by Anderson, Reynolds, Schallert, and Goetz (1977) a "gist" criterion. Table 4 provides a sample of recall units that were categorized as accurate recall in this study.

In addition to corresponding to one and only one idea unit in a text, a recall unit must also possess a similar worldview rating as the corresponding idea unit to be considered accurate recall. This is operationally defined as a recall unit whose difference rating differs less than three points from the corresponding idea unit.

If a recall unit is accurate it assumes the corresponding idea unit's worldview ratings.

Distorted Recall (Distortions): A recall unit is categorized as a "distortion" when it corresponds to a specific idea unit according to the gist criterion but not according to the corresponding idea unit's worldview ratings. In other words, the wording of the recall unit has been transformed into language that no longer suits the idea unit's intended worldview.

A distortion is operationally defined as a recall unit whose difference rating is greater than or equal to three points different than the difference rating of the corresponding idea unit. Furthermore there are two types of distortions based on the direction that it skews the original worldview ratings of the idea unit. An "organicist distortion" is when the distortion's difference rating is greater than or equal to three points higher than the difference rating of the corresponding idea unit, and a "mechanist distortion" is when the distortion's difference rating is less than or equal to three points lower than the difference rating of the corresponding idea unit. Put another way, an organicist distortion is a recall unit that is "more organicist" than its corresponding idea unit and a mechanist distortion is a recall unit that is "more mechanist" than its corresponding idea unit.

Ambiguous Recall (Ambiguities): A recall unit is categorized as "ambiguous" when the content of the recall unit corresponds to content written in the text at the target paragraph level, but not at the idea unit level. In other words, the recall unit has so little detail, or is so generalized, that a specific idea unit cannot be identified. For example, consider the following recall unit that was categorized as ambiguous: "...talked about relativity's relation to quantum mechanics." It is clear that this recall unit corresponds to the 10th paragraph in the Physics text since it is the only paragraph that discusses relativity's relation to quantum mechanics. However, it is not detailed enough to correspond any specific idea unit covered in that paragraph. For this reason it is coded as an ambiguity.

All ambiguities are assigned a mechanist and organicist rating. Also, the paragraph that the ambiguity refers to is recorded along with its worldview ratings. Ambiguities are considered "mechanist recall units" if their difference rating is less than or equal to negative two. If their difference rating is greater than or equal to two, they are considered "organicist recall units." Finally, an ambiguity is considered a "neutral recall unit" if its difference rating is less than two and greater than negative two.

In the case that a recall unit is so vague that it cannot be determined which paragraph the recall unit is referring to, it categorized as an importation (see below).

Imported Recall (Importations): A recall unit is categorized as an "importation" when the content of the recall unit does not correspond to any of the idea units contained in the text. For example, one participant wrote in reference to the French Revolution leader Robespierre, "He was originally a financial officer under King Louis." This recall unit is both incorrect, and, more importantly for this study, not in the History text and

was, therefore, categorized as an importation. Although a recall unit does not have to be factually incorrect to be categorized as an importation it does need to satisfy the condition that its content cannot be found anywhere in the original text. Recall units with misspellings of important people or topics in the text were not grounds for categorizing a recall unit as an importation.

Each importation is given a mechanist and organicist rating as well as a difference rating just like all other recall units. Importations are considered "mechanist recall units" if their difference rating is less than or equal to negative two. If their difference rating is greater than or equal to two, they are considered "organicist recall units." Finally, an importation is considered a "neutral recall unit" if its difference rating is less than two and greater than negative two.

Establishing inter-rater reliability for categorizing recall units. It was assumed that parsing memory data into recall units could be reliably conducted across raters since the process of parsing the memory data into recall units was similar to the process of parsing the History and Physics texts into idea units, and since idea units and recall units have a similar structure (i.e. both are one unit of writing one clause in length with no more than one subject and one predicate). However, a reliability score for categorizing recall units according to the four kinds of recall previously discussed was still necessary. To establish an inter-rater reliability score, myself and the aforementioned rater categorized the memory data of ten randomly chosen participants recall units according to the four kinds of recall. Out of 262 total recall units evaluated, we agreed 232 times (89%) on our categorization. A Cohen's Kappa coefficient of .80 was calculated which indicates a very good strength of agreement for categorizing recall units across all four

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categories. Cohen's Kappa coefficient was also calculated to measure our strength of agreement for categorizing recall units into each individually category. These coefficients equaled .83, .87, .76, and .81 for assigning recall units to accurate recall, distortions, ambiguities and importations, respectively, which suggest good to very good strength of agreement for categorizing recall units.

Accurate Recall of target paragraphs and target idea units. If a recall unit was categorized as accurate, it was also recorded whether the corresponding idea unit was a *target* idea unit. It was important to have a count of recalled target idea units since they reflect mechanism and organicism better than any other idea units based on their worldview ratings. Analyses involving participants' recall of target idea units are used as a principal means for evaluating both parts of research question one.

Since both texts were written to alternate between mechanist and organist paragraphs there was an opportunity to evaluate participants' patterns of selective recall based on worldview preference at both the target paragraph level in addition to the idea unit level. A target paragraph was counted as "recalled" if the participant recalled two or more of the six target idea units from the paragraph. This criterion for counting sufficiently recalled target paragraphs is quite restrictive (i.e., participants seldom recall two or more target idea units per paragraph). However, since each target paragraph is meant to portray one worldview over the other, and since a participant could potentially recall only the least indicative idea units of the paragraph's intended worldview, it was important to make sure that my protocol for counting paragraphs was limited exclusively to patterns of recall that reflected the paragraph's intended worldview.

CHAPTER 4: RESULTS

Before reporting the analyses that were intended to directly evaluate the research questions a number of descriptive statistics will first be reported. This first section includes details regarding participants' OMPI scores, the Revised CFI's, results from the vocabulary test and background knowledge tests, and worldview ratings from the idea units of the History and Physics texts. Also, descriptive statistics regarding participants' memory data from both texts will be reported in this section. To conclude this first section, a number of correlations between variables are reported.

The next several sections report on the results intended to answer the research questions. First, two 2 x 2 mixed design analyses of variance (ANOVAs) are reported. These ANOVAs were calculated for the purpose of answering research question 1a. This section also reports the effect that a set of covariates had on the original results of these ANOVAs.

After reporting results intended to evaluate research question 1a, the results of a 2 x 2 x 2 mixed design ANOVAs will be reported which was intended to investigate research question 1b. This section also reports the effect of adding vocabulary score as a covariate to the original ANOVA results.

In the final section three 2 x 2 x 2 mixed design ANOVAs are reported which were intended to evaluate research question two. As is the case with the previous section, this section also reports the effect of adding vocabulary score as a covariate to the original results of these three ANOVAs.

Robustness of the Findings

To demonstrate the robustness of the effect of worldview preference on participants' recall, I measured participants' recall patterns of both target idea units and target paragraphs. In general, statistically significant selective recall effects were found using both analyses. Therefore, one could argue that these results are fairly robust. However, in order to make the report of these results more cohesive, only the analyses that used target idea units as a dependent variable are reported below. All analyses demonstrating selective recall effects at the target paragraph level are available in Appendix G.

Initial Descriptive and Inferential Statistics

OMPI. Participants' (N = 60) OMPI scores ranged from 9 to 23 ($M = 16.25$, median = 16.5, $SD = 3.32$). The distribution was mildly platykurtic (-.685, $SE = .608$). Figure 3 provides a histogram of these scores. Participants' OMPI scores were subjected to a median split in order to categorize their worldview preference. Participants with scores of 16 or lower were categorized as "Mechanists," and participants with scores above 16 were categorized as "Organicists."

Revised CFI's. Out of a maximum score of nine, participants' (N =60) Revised CFI for Learning History ranged from one to seven ($M = 4.52$, $SD = 1.44$), and scores from the Revised CFI for Learning Physics ranged from zero to eight ($M = 3.82$, $SD = 1.58$). Higher scores indicate a preference for learning the targeted knowledge domain organicistically and lower scores indicate a preference for learning the targeted knowledge domain mechanistically. A paired samples t-test indicates that the mean scores across the two Revised CFIs were significantly different, $t(59) = 2.59$, $p = .012$

which suggests that participants view learning physics as a slightly more mechanistic process (or less organicistic) than learning history.

Vocabulary test. Participants' (N = 54) scores on the Extended Range Vocabulary test (French, et al., 1976) ranged from 1.25 to 35.75 ($M = 20.1$, $SD = 8.63$). Mean vocabulary score from this study was not significantly different, $t(53) = .031$, $p = .975$ from the mean vocabulary score ($M = 20.2$, $SD = 6.4$) of over 600 11th and 12th grade students who also took this test (Ekstrom, French, Harman, & Dermen, 1976).

Background knowledge tests. Out of a maximum score of 10, participants' scores on the French Revolution Background Knowledge Test ranged from 0.33 to 9.67 ($M = 3.89$, $SD = 2.10$). The range of scores on the Quantum Mechanics Background Knowledge Test ranged from 0.67 to 9.33 ($M = 4.58$, $SD = 2.59$). Test scores were fractional due to using a "corrected-for-guessing" technique (Frary, 1982; Rowley & Traub, 1977) wherein participants received one point for a correct response, no points for an omitted response and negative one third of a point for an incorrect response.

History and Physics texts. One of the main questions investigated by this dissertation asks, "What selective recall patterns are present across texts from different knowledge domains based on participants' worldview preferences?" In order to answer this question I needed to know how the worldview ratings of idea units in the History and Physics texts compared with each other. Therefore, independent samples t-tests were calculated to compare organicist and mechanist ratings of the idea units across texts in three ways. The first comparison checked the overall average mechanist rating and the overall average organicist rating of all idea units in each text (212 idea units in the History text and 220 idea units in the Physics text). The next comparison of means

evaluated the average worldview ratings for idea units in mechanist paragraphs across both texts as well as the average worldview ratings for idea units in organicist paragraphs across both texts (eight paragraphs for each worldview in each text). The final set of comparisons evaluated average worldview ratings for idea units in mechanist target idea units across texts as well as the average worldview ratings for idea units in organicist target idea units across texts (48 target idea units for each worldview in each text).

Since the structures of the History and Physics texts were written to be similar according to how Pepper's worldviews were embedded I expected that there would be little to no significant differences in the average worldview ratings across the texts. Of the 10 comparison of means tests conducted across the two texts, nine failed to reject the hypothesis that there was a significant difference in mean ratings. However, the one significant difference found was at $p = .05$, which could be interpreted as only marginally significant. The fact that nine out 10 comparisons of idea unit ratings across texts suggests that the structure of these texts possess a high degree of similarity. A high degree of structural similarity across texts means that any differences in selective recall patterns across texts are likely not attributable to structural differences. The results of these comparisons of means are reported below.

Overall worldview ratings. An independent samples t-test was performed to test whether the average organicist rating of History text idea units (N = 212), $M = 2.45$, $SD = 1.32$, was significantly different from the average organicist rating of Physics text idea units (N = 220), $M = 2.42$, $SD = 1.32$. The t-test concluded that there is no significant difference [t(430) = .272, $p = .79$]. An independent samples t-test was also performed to test whether the average mechanist rating of History text idea units (N = 212), $M = 2.50$,

SD = 1.32, was significantly different from the average mechanist rating of Physics text idea units (N = 220), *M* = 2.49, *SD* = 1.31. The t-test concluded that there is no significant difference [t(430) = .145, *p* = .89].

Target idea units.

Organicist Ratings. An independent samples t-test was performed to test whether the average organicist ratings of History text *organicist* target idea units (N = 48), *M* = 4.33, *SD* = .595, was significantly different from the average organicist rating of Physics text *organicist* idea units (N = 48), *M* = 4.23, *SD* = .660. The t-test concluded that there is no significant difference [t(94) = .812, *p* = .42]. An independent samples t-test was also performed to test whether the average organicist rating of History text *mechanist* idea units (N = 48), *M* = 1.17, *SD* = .377, was significantly different from the average organicist rating of Physics text *mechanist* idea units (N = 48), *M* = 1.20, *SD* = .410. The t-test concluded that there is no significant difference [t(94) = .518, *p* = .61].

Mechanist Ratings. An independent samples t-test was performed to test whether the average mechanist ratings of History text *organicist* target idea units (N = 48), *M* = 1.29, *SD* = .459, was significantly different from the average mechanist rating of Physics text *organicist* idea units (N = 48), *M* = 1.23, *SD* = .425. The t-test concluded that there is no significant difference [t(94) = .692, *p* = .49]. An independent samples t-test was also performed to test whether the average mechanist rating of History text *mechanist* idea units (N = 48), *M* = 4.25, *SD* = .636, was significantly different from the average mechanist rating of Physics text *mechanist* idea units (N = 48), *M* = 4.29, *SD* = .713. The t-test concluded that there is no significant difference [t(94) = .302, *p* = .76].

Target Paragraphs. The remaining four independent samples t-tests comparing the structural similarity across the History and Physics texts were performed at the target paragraph level. Three of these four tests concluded that there were no statistically significant structural differences. These results can be found in Appendix G.

Memory data. Table 6 contains a summary of the descriptive statistics for the kinds of items that were recalled by participants from both texts. It is from these data that many of the dependent variables were drawn to address this dissertation's research questions. Included in this table is a breakdown of the four kinds of recall units recorded by participants (i.e., accurate recall, distortions, ambiguities and importations), recalled target idea units and recalled target paragraphs.

Three excluded participants. It should be noted in this table that three Participants' memory data from the Physics text were excluded because they recorded less than 10 total recall units. Of these three excluded participants, one wrote down only two words, one stated that she was "too tired" to continue the study, and the third participant, whose first language was not English, said that his unfamiliarity with science terms in English affected his amount of recall from the Physics text. Excluding these three participants, the average number of recall units ($M = 36.2$) recorded from the History text was significantly more than the average number of recall units ($M = 30.0$) recorded from the Physics text, $t(103) = 2.16, p = .03$.

Ratio of target idea unit recall to total recall. It should also be noted that the ratio of mean recalled target idea units ($M = 12.9$) to total recall units ($M = 36.3$) from the Physics text was .36 and the ratio of mean recalled target idea units ($M = 11.8$) to total recall units ($M = 30.1$) from the Physics text was .39. This means that on average a

little over one-third of participants' recall units originated from the accurate recall of target idea units across both texts.

Ratios of accurate and inaccurate recall. The ratio of accurate recall to total number of recall units from both texts was .86. In other words, the most prevalent kind of recall measured in this dissertation was accurate recall. All the other kinds of inaccurate recall (distortions, ambiguities, and importations) accounted for the remaining portion of the memory data. This ratio of accurate recall compared to other kinds of inaccurate recall is similar to the ratios reported by Anderson et al. (1977, see p. 375).

Anthropomorphisms. A post-hoc analysis was conducted to measure the presence of anthropomorphisms in the Physics text and amongst the organicist distortions from the Physics text. This was done to see whether any relationship existed between the Organicism worldview and anthropomorphic descriptions that can sometimes lead to misinterpretations about concepts in physics (see, e.g., Gilbert & Watts, 1983; Sokal & Bricmont, 1998). In summary, the presence of anthropomorphisms in the texts and memory data were not overwhelming and did not significantly alter any of the main interpretations about this dissertation's research questions. However, the findings do hint at a potential relationship that could be more properly investigated in the future. These data are reported below.

Anthropomorphic idea units. Out of 220 idea units from the Physics text, five were identified as possessing anthropomorphic traits. Of these five idea units, two described entangled particles "communicating" with each other; two others described tunneling particles as "jumping" over barriers and the last described a light particle "manifesting itself" as if it had a will of its own. This means that the ratio of

anthropomorphic idea units to all other idea units in the Physics text was .023. These five idea units were recalled 48 times out of 1531 total recall units from the physics texts which yielded a similar ratio of .031.

Anthropomorphic distortions. Each of the 40 mechanist- and 44 organicist distortions from the Physics text were reviewed to look for indications of anthropomorphizing the original idea units. Of these 84 total distortions four were considered to be anthropomorphic and all of them were categorized as organicist distortions. This means that one out of eleven organicist distortions were anthropomorphic. However, the fact that all four anthropomorphisms were organicist distortions is mitigated by the fact that three of them originated from one paragraph about neutrinos. For example, one participant described a neutrino as having a "will" and another described neutrinos as capable of "altering" themselves internally. The third, and only slightly anthropomorphic distortion, came from a participant who described neutrinos as being "created" by radioactivity. The fourth distortion came from a paragraph about tunneling.

Correlations. In Table 7 the correlations between participants' OMPI score, gender, age, vocabulary score, background knowledge tests and Revised CFIs are provided. One of the largest of these correlations was between vocabulary test score and age ($r = .422, p = .001$) as well as between vocabulary score and both the Quantum mechanics background knowledge test ($r = .372, p = .005$) and the French Revolution background knowledge test ($r = .426, p = .001$).

The correlations between participants' vocabulary scores and background knowledge tests scores was expected, but the correlation between age and vocabulary

score did cause some concern. The significant correlation between age and vocabulary score can be explained by the fact that nearly half of the older participants (based on a median split) were graduate students (N = 13). Graduate students are typically older than undergraduates, and likely have higher verbal intelligence since most graduate programs select students based on high verbal reasoning scores on the *Graduate Record Examination* (GRE). However, although this correlation should be expected based on the presence of graduate students, it could also indicate that participants grouped into high and low ages or high and low vocabulary scores (based on median splits) might exhibit significantly different correlations across OMPI scores and/or background knowledge test scores. If significantly different correlations across these groups were found, it would suggest the need to independently investigate the influence of worldview preferences on selective recall for each group.

To investigate whether participants grouped by high or low age and high or low vocabulary scores exhibited significantly different correlation coefficients when correlated with OMPI scores and background knowledge scores, Fisher's *r*-to-*z* transformations were performed and a summary of these transformations can be found in Table 8. The results indicate that there were no significant differences between the correlation coefficients. Furthermore, these data were interpreted to mean that although there was a significant correlation between participants' ages and vocabulary scores, it did not differentially effect their distribution across OMPI scores or background knowledge scores. Therefore, participants' patterns of selective recall were not independently analyzed across groups characterized by high and low ages or high and low vocabulary scores.

Another notable correlation that is not included in Table 7 or Table 8 is that vocabulary scores were moderately correlated with the total recall units recorded from the History text ($r = .411$, $p = .002$) as well as with the total recall units recorded from the Physics text ($r = .595$, $p < .001$). Put another way, participants with high vocabulary scores are more likely to record more recall units from a text than participants with lower vocabulary scores. These results suggest that vocabulary could be used as a covariate in analyses that investigate this dissertation's research questions since all of the main analyses involve measuring and comparing differences in amounts of recall units across participants with different worldview preferences.

Research Question 1a

Part "a" of research question one asks, "What patterns of selective recall from texts containing mechanist and organicist worldviews are present based on individuals' pre-existing worldview schemas?" I hypothesized that the pattern of recall of individuals who prefer organicism will be significantly different from individuals who prefer mechanism. Furthermore, participants with a mechanist worldview will recall more mechanist items than organicist items from a text that possess items from both worldviews and individuals with an organicist worldview will recall more organicist items than mechanist items. Therefore, to evaluate this hypothesis, and thereby provide an answer to research question 1a, a series of 4 two-way mixed design analyses of variance (ANOVAs) were evaluated with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor and type of recalled item (Mechanist Items, Organicist Items) as a within-subjects factor. Two ANOVAs (one for each text) evaluated the number of target idea units recalled as a

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dependent variable and the other two ANOVAs (again, one for each text) evaluated the number of target paragraphs recalled as a dependent variable. The results of the two ANOVAs that use target idea units as a dependent variable are reported below. The other two ANOVAs that use target paragraphs as a dependent variable are presented in Appendix G.

Recall of target idea units.

History text. A two-way mixed design ANOVA was conducted on the recall of target idea units from the History text with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor and type of recalled target idea unit (Mechanist, Organicist) as a within-subjects factor. Neither worldview preference, $F(1, 52) = .411, p = .50, \eta_p^2 = .01$, or type of recalled target idea unit, $F(1, 52) = 1.77, p = .19, \eta_p^2 = .03$, produced main effects. However, there was a significant interaction between worldview preference and type of recalled target idea unit, $F(1, 52) = 22.2, p < .001, \eta_p^2 = .30$, which supports the hypothesis proposed for research question 1a. A graph of this interaction effect is illustrated in Figure 4.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of recalled target idea unit. These tests revealed that *Mechanists* recall significantly more Mechanist Target Idea Units ($M = 8.44, SEM = 1.12$) than Organicist Target Idea Units ($M = 3.81, SEM = .693$), $t(26) = 4.06, p < .001$. Furthermore, *Organicists* recall significantly more Organicist Target Idea Units ($M = 8.04, SEM = .946$) than Mechanist Target Idea Units ($M = 5.44, SEM = .553$), $t(26) =$

2.53, $p = .02$. These results are consistent with the proposed hypothesis for research question 1a.

Physics text. A two-way mixed design ANOVA was conducted on the recall of target idea units from the Physics text with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor and type of recalled target idea unit (Mechanist, Organicist) as a within-subjects factor. Neither worldview preference, $F(1, 49) = 2.83$, $p = .10$, $\eta_p^2 = .06$, or type of recalled target idea unit, $F(1, 49) = .933$, $p = .34$, $\eta_p^2 = .02$, produced main effects. However, there was a significant interaction effect between worldview preference and type of recalled target idea unit, $F(1, 49) = 22.6$, $p < .001$, $\eta_p^2 = .32$, which supports the hypothesis proposed for research question 1a. A graph of this interaction is illustrated in Figure 5.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of recalled target idea unit. These tests revealed that *Mechanists* recall significantly more Mechanist Target Idea Units ($M = 6.42$, $SEM = 1.06$) than Organicist Target Idea Units ($M = 3.79$, $SEM = .625$), $t(23) = 2.32$, $p = .03$. Furthermore, *Organicists* recall significantly more Organicist Target Idea Units ($M = 8.59$, $SEM = .815$) than Mechanist Target Idea Units ($M = 4.63$, $SEM = .647$), $t(26) = 4.77$, $p < .001$. These results are consistent with the proposed hypothesis for research question 1a.

Covariates. The ANOVAS discussed above were re-evaluated as analyses of covariance (ANCOVAs) by including the following seven potential covariates one at a time: (1) age, (2) gender, (3) vocabulary score, (4) French Revolution background

knowledge score, (5) quantum mechanics background knowledge score, (6) revised CFI for learning history, (7) revised CFI for learning physics. The last two potential covariates (i.e., the revised CFIs) were rejected for use as covariates in future ANCOVAs because they failed to fulfill the assumption of homogeneity of regression. This means that these variables significantly interacted with the dependent variables (i.e., recall of target idea units and target paragraphs) at the $p < .05$ level. As for the remaining five potential covariates, none were able to effectively increase the statistical power from the previously reported ANOVAs. Furthermore, none of the previously reported effects of the ANOVAs associated with answering research question 1a changed as a result of including these potential covariates.

A reason for why these potential covariates were so ineffective could be that none of them, with the exception of vocabulary score, produced a significant main effect when included as a covariate in the preceding ANOVAs. Furthermore, the dependent variables involved in these analyses measured amounts of recall and the only potential covariate to significantly correlate with participants' total amount of recorded recall units was vocabulary score.

Measuring selective recall patterns across high and low background knowledge. Neither the French Revolution background knowledge score nor the quantum mechanics background knowledge score significantly affected the results from the ANOVA's used to investigate research question 1a. However, before abandoning these two variables as potential covariates, participants were split into four groups based on median splits of background knowledge scores. The first pair of these groups was based on high and low physics knowledge and the second pair of groups was based on high and

low French Revolution knowledge. From these two pairs of groups four new two-way mixed design ANOVA's measuring the recall of target idea units were calculated with the intention of investigating whether significant interactions between worldview preference and type of recalled target idea units would still occur across all four group. A summary of these ANOVA's are found in Table 9, which compares participants with high physics knowledge versus low physics knowledge, and in Table 10, which compares participants with high French Revolution knowledge versus low French Revolution knowledge.

In all four of these ANOVAs significant interactions were present between participants' worldview preference and types of recalled target idea unit. This suggests that the pattern of selective recall previously found across all participants is robust enough that it remains present regardless of high or low background knowledge. These data also support the finding that background knowledge failed to act as an effective covariate.

Future use of vocabulary score as a covariate. Although using vocabulary score as a covariate did not meaningfully account for any additional variance in the preceding 2 x 2 ANOVAs, it seemed to show the most promise as a covariate for future analyses intended to answer the remaining research questions. Therefore, it was the only covariate evaluated in any of the remaining analyses, and, as such, a report of its effect on these remaining analyses is included at the end of each section.

Research question 1b

Part "b" of research question one asks, "What patterns of selective recall...are present...across texts from different knowledge domains?" Pepper hypothesized that

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worldviews should be able to affect how one thinks about knowledge from any domain. Therefore, if worldviews are psychologically real and are capable of affecting recall in a text from one knowledge domain, they should, hypothetically, be able to show similar patterns of selective recall across texts from different knowledge domains. In order to retain this hypothesis I would expect to see interaction effects between participants' worldview preferences and the recall of similar text items across at least two different knowledge domains.

The results of the ANOVAs that were reported in connection with answering research question 1a do show similar patterns of selective recall based on participants' worldview preferences across a History and Physics text which suggests worldviews capability of applying across multiple knowledge domains. However, since these ANOVAs were calculated independent of one another, they are not capable of telling me whether or not an interaction effect exists between the types of items recalled and the types of texts these items were recalled from. If a text by recalled item interaction exists, it would qualify any interaction effect found to exist between worldview preference and recalled items and suggest constraints upon Pepper's worldviews' capability of applying to multiple knowledge domains.

In order to evaluate the hypothesis that mechanism and organism show similar patterns of selective recall across texts from different knowledge domains and to provide an answer to research question 1b, 2 three-way mixed design analyses of variance (ANOVAs) were evaluated with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, type of text (History, Physics) as a within subjects factor, and type of recalled item (Mechanist Items,

Organicist Items) as a within-subjects factor. The first of these two ANOVAs evaluated the number of target idea units recalled as a dependent variable. The results of this ANOVA is presented below, as well as the effect of including vocabulary score as a covariate. The results of the second ANOVA, which uses participants' recall of target paragraphs as a dependent variable, is provided in Appendix G.

Recall of target idea units. A three-way mixed design ANOVA (full factorial) was conducted on the recall of target idea units with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, text (History, Physics) as a within subjects factor, and type of recalled target idea unit (Mechanist, Organicist) as a within-subjects factor. As in the previously reported two-way ANOVAs for evaluating research question 1a, there were no significant main effects for worldview preference or type of recalled target idea unit. In addition, there was also no significant main effect for text although it approached significance, $F(1, 49) = 3.86$, $p = .06$, $\eta_p^2 = .07$. Also similar to the previous two-way ANOVAs was a significant interaction between worldview preference and type of recalled target idea unit, $F(1, 49) = 30.5$, $p < .001$, $\eta_p^2 = .38$. There was also another significant interaction between text and type of recalled target idea unit, $F(1, 49) = 4.28$, $p = .04$, $\eta_p^2 = .08$, which indicates that the pattern for recalling target idea units in the History text compared to the Physics text is different. All other effects in the ANOVA were insignificant.

Including vocabulary score as a covariate. The presence of a significant text by type of recalled target idea unit interaction is contrary to the proposed hypothesis for research question 1b. However, this interaction did not remain significant, $F(1, 48) =$

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2.68, $p = .11$, $\eta_p^2 = .05$, when vocabulary score was introduced as a covariate whereas

the interaction between worldview preference and type of recalled target idea unit, $F(1,$

$48) = 30.0$, $p < .001$, $\eta_p^2 = .38$, did remain significant (see Figure 6 for a graph depicting

this interaction). Besides introducing a vocabulary score main effect, $F(1, 48) = 12.8$, $p =$

$.001$, $\eta_p^2 = .21$, all other main effects and interactions remained insignificant as they

were in the original three-way ANOVA. These ANCOVA results qualify the original

text by type of recalled target idea unit interaction and lend support for retaining the

proposed hypothesis for research question 1b.

Paired samples t-tests were conducted to test the simple effects of the interaction

between worldview preference and type of recalled target idea unit interaction from the

ANCOVA using vocabulary score as a covariate. These tests revealed that *Mechanists*

recall significantly more Mechanist Target Idea Units ($M = 7.78$, $SEM = .799$) than

Organicist Target Idea Units ($M = 4.11$, $SEM = .684$), $t(23) = 4.78$, $p < .001$.

Furthermore, *Organicists* recall significantly more Organicist Target Idea Units ($M =$

8.26, $SEM = .754$) than Mechanist Target Idea Units ($M = 4.97$, $SEM = .645$), $t(26) =$

3.82, $p = .001$. These data suggest that Peppers' worldviews are capable of affecting

patterns of selective recall across two texts from different knowledge domains in similar

ways which is consistent with the proposed hypothesis for research question 1b.

Research Question Two

Research question two asks, "In what ways do the kinds of recall that are present

in selective recall tasks affect the kinds of interpretations that can be made about

Pepper's worldviews' influence on text comprehension?" The analyses associated with

research question one provide data for interpreting worldviews' influence on text comprehension according to accurate recall. However, answering research question two requires data that not only investigate patterns of selective recall via accurate recall, but also via distortions, ambiguities and importations.

Although the majority of recall units recorded by participants in this dissertation were of the accurate kind, and the general design of the dissertation is set up to capture accurate recall, it was still hypothesized that the remaining memory data consisting of distortions, ambiguities and importations would still exhibit patterns of selective recall similar to the patterns found amongst analyses of accurate recall.

In order to test this hypothesis and evaluate the second research question three more three-way mixed design ANOVAs were evaluated with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, type of text (History, Physics) as a within subjects factor, and type of recalled item (Mechanist Items, Organicist Items) as a within-subjects factor. The first of these three ANOVAs evaluated participants' distortions as a dependent variable. The second of these three ANOVAs evaluated participants' ambiguities as a dependent variable, and the last of these three ANOVAs evaluated participants' importations as a dependent variable. The results of these ANOVAs are reported below, as well as the effect of including vocabulary score as a covariate.

Distortions. A three-way mixed design ANOVA (full factorial) was conducted on the amount of participants' distorted recall with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, text (History, Physics) as a within subjects factor, and type of distortion (Mechanist,

Organicist) as a within-subjects factor. The only significant effect was an interaction between worldview preference and type of distortion, $F(1, 49) = 26.1, p < .001, \eta_p^2 = .35$ (see Figure 7 for a graph depicting this interaction). Furthermore, introducing vocabulary score as a covariate via an ANCOVA using the same three factors did not change the significance of any of these effects which is exemplified by the fact that the introduced main effect of vocabulary score only approached significance, $F(1, 48) = 3.96, p = .052,$ $\eta_p^2 = .08$. These data suggest that the interaction between worldview preference and type of distortion is similar the interaction between worldview preference and measures of accurate recall which is consistent with the proposed hypothesis for research question two.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of distortion interaction from the original three-way ANOVA using participants' distorted recall as the dependent variable. These tests revealed that *Mechanists* recall significantly more Mechanist Distortions ($M = 1.44, SEM = .410$) than Organicist Distortions ($M = .396, SEM = .156$), $t(23) = 2.62, p = .015$. Furthermore, *Organicists* recall significantly more Organicist Distortions ($M = 1.30, SEM = .235$) than Mechanist Distortions ($M = .222, SEM = .105$), $t(26) = 5.89, p < .001$. These data suggest that participants' distortions exhibit patterns of selective recall similar to the patterns found amongst analyses of accurate recall which is consistent with the proposed hypothesis for research question two.

Ambiguities. As a reminder, recall units were identified as ambiguities when the content of the recall unit related to the text at the target paragraph level, but not at the idea unit level. Furthermore, although ambiguities could not be identified with a specific

idea unit from the text, they were still capable of being rated for their mechanist and organicist worldview properties. This is supported by the fact that there was a good strength of agreement for identifying recall units as ambiguous (Cohen's Kappa = .76) and the inter-rater reliability for worldview ratings was very good (see table 2 for these ratings). Therefore, although they are "ambiguous" according to content, ambiguities still possess analyzable worldview properties via their worldview ratings.

To analyze participants' ambiguities, a three-way mixed design ANOVA (full factorial) was conducted on the amount of participants' ambiguous recall with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, text (History, Physics) as a within subjects factor, and type of ambiguity (Mechanist, Organicist) as a within-subjects factor. There were no significant main effects or interactions although the interaction between worldview preference and type of ambiguity did approach significance, $F(1, 49) = 3.90, p = .054, \eta_p^2 = .07$.

Furthermore, introducing vocabulary score as a covariate via an ANCOVA using the same three factors did not change the significance of this worldview preference by type of ambiguity interaction, $F(1,48) = 3.77, p = .058, \eta_p^2 = .07$, nor were the significance levels of any of the other main effects or interactions changed by introducing vocabulary score as a covariate.

Since ambiguities were the least recalled kind of recall unit in this dissertation it is possible that these data are the result of not enough power to indicate a significant interaction between worldview preference and type of ambiguity. Nevertheless, the present data suggest that participants' ambiguities exhibit patterns of selective recall that

are dissimilar to the patterns found amongst analyses of accurate recall and distortion which suggests a limit to the proposed hypothesis for research question two.

Importations. A three-way mixed design ANOVA (full factorial) was conducted on the amount of participants' imported recall with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor, text (History, Physics) as a within subjects factor, and type of Importation (Mechanist, Organicist) as a within-subjects factor. The only significant effect was an interaction between worldview preference and type of importation, $F(1, 49) = 7.96$, $p = .007$, $\eta_p^2 = .14$ (see Figure 8 for a graph depicting this interaction). Furthermore, introducing vocabulary score as a covariate via an ANCOVA using the same three factors did not change the significance of any of the main effects or interactions. The main effect for vocabulary score was also not significant, $F(1, 48) = 3.14$, $p = .08$, $\eta_p^2 = .06$. These data suggest that the interaction between worldview preference and type of importation is similar the interaction between worldview preference and measures of accurate recall as well as measures of distortions which lends support for the proposed hypothesis for research question two.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of importation from the original three-way ANOVA using participants' imported recall as the dependent variable. These tests revealed that *Mechanists* <u>do not</u> recall significantly more Mechanist Importations ($M = .896$, *SEM* $= .211$) than Organicist Importations ($M = .542$, *SEM* $= .218$), $t(23) = 1.83$, $p = .08$ whereas *Organicists* do recall significantly more Organicist Importations ($M = .796$, *SEM* $= .245$) than Mechanist Importations ($M = .333$, *SEM* $= .107$), $t(26) = 2.19$, p

= .04. These data suggest that although participants' importations significantly interact with participants' worldview preferences, the pattern of this interaction is not the same as the patterns found amongst analyses involving accurate recall and distortions. Although this finding may be the result of a lack of power, as in the case of patterns of ambiguous recall, they nevertheless suggest a limit to the proposed hypothesis for research question two.

CHAPTER 5: DISCUSSION

This final chapter is divided up into four sections. The first section provides a general summary of the major hypotheses and main results that were intended to investigating these hypotheses. The next two sections report on the significance of these results (especially as they apply to the field of education) followed by their limitations. The final section is devoted to outlining a number of potential future studies involving Pepper's worldviews based on the assumption that they possess psychological reality.

General Summary of the Major Hypotheses and Main Results

Main hypothesis. This dissertation approached Pepper's worldviews with the main hypothesis that they are psychologically real schemas that possess properties similar to prefigurative schemas described by Spiro and colleagues (Feltovich, et al., 1989; Spiro, et al., 1996). This hypothesis was tested by seeing if Pepper's mechanism and organicism worldviews have the capability of affecting recall from two texts via the selective recall paradigm developed by Anderson and colleagues (Anderson & Pichert, 1978; Anderson, et al., 1977; Pichert & Anderson, 1977). This pattern of selective recall was hypothesized to consist of a significant interaction effect between participants' worldview preference and the types of items that they recall from a text (i.e., the pattern of recall of individuals who prefer organicism will be significantly different from mechanism preferring individuals) wherein individuals with a mechanist worldview were expected to recall more mechanist items than organicist items, and individuals with an organicist worldview were hypothesized to recall more organicist items than mechanist items. If I could not show an interaction effect between individuals' worldview

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preference and the types of items that they recall, I would need to reconsider the hypothesis that these worldviews possess psychologically reality.

Review of the research questions. The process for investigating worldviews' capability of affecting selective recall was guided by two research questions. These questions sought to investigate patterns of selective recall in three ways. The first way was to look at selective recall patterns within individual texts. The second was to investigate these patterns across texts from different knowledge domains and the third was to investigate patterns of "inaccurate" selective recall. As a reminder, these two research questions were as follows:

1) What patterns of selective recall from texts containing mechanist and organicist worldviews are present (a) based on individuals' pre-existing worldview schemas and (b) across texts from different knowledge domains?

2) In what ways do the kinds of recall that are present in selective recall tasks affect the kinds of interpretations that can be made about Pepper's worldviews' influence on text comprehension?

Answers to research question 1a. For research question 1a it was hypothesized that a significant interaction would exist between individuals' worldview preferences and the kinds of items that they recall. Moreover, it was hypothesized that the direction of this interaction would be that individuals will recall, on average, more items that align with their preferred worldview than items that do not align with their preferred worldview. The results from this dissertation support this hypothesis because these interactions were present in both texts centered upon the knowledge domains of history and physics based on two different measurements of accurate recall (i.e., at the idea unit

level and at the paragraph level). Participants who preferred mechanism, based on a median split of OMPI scores recalled on average more mechanist items from the texts than organicist items and participants who preferred organicism recalled on average more organicist items than mechanist items. Furthermore, these patterns of selective recall appeared to remain present across differences in age, verbal intelligence and background knowledge which attests to the robust nature of this effect across tested conditions. Effect sizes (measured via partial eta-squared) ranged between .25 and .32 which suggest a small to medium effect.

Answers to research question 1b. For research question 1b it was hypothesized that significant interactions between worldview preferences and recalled items should not only occur *within* a text (which was shown in connection with answering question 1a), but would also persist *across* texts from different knowledge domains. Results from this dissertation also supported this hypothesis. More specifically, by combining participants' recall of mechanist and organicist items across a History and Physics text (structured to possess similarly embedded worldviews) significant interactions between worldview preference and recalled items occurred based on measures of accurate recall at the target idea unit level and at the paragraph level. These significant interactions produced medium effect sizes (.37 and .38; measured via partial-eta squared) which were larger than the effects present in analyses aimed at answering research question 1a.

A marginally significant interaction between texts and types of recalled items also occurred, which suggests that the knowledge domain of the text also has an effect on patterns of selective recall in texts with embedded worldviews. However, this interaction proved insignificant by adding participants' vocabulary score as a covariate.

Answers to research question two. For research question two it was hypothesized that measurements of participants recall of distortions, ambiguities and importations would all produce significant interactions when crossed with worldview preference and that the patterns of these interactions would be similar to the interactions found in connection with answering research questions 1a and 1b. Results from this dissertation did not fully support this hypothesis because significant interaction effects were not found across all three kinds of inaccurate recall, although all measures intended to answer this research question did trend in the hypothesized direction.

The interaction between worldview preference and distortions was similar to the interactions found between worldview preference and accurate recall (with a partial eta-squared value of .37), but this same pattern did not exist for ambiguities and importations. More specifically, the interaction between worldview preferences and ambiguities was only marginally significant and its effect size was only .07 suggesting a much smaller effect compared measures of accurate selective recall. Furthermore, the interaction between worldview preferences and importations was significant, but the pattern of the interaction was not similar to interactions involving measurements of accurate recall (i.e., organicists recalled significantly more organicist importations than mechanist importations, but there was no significant difference in the types of importations recalled by mechanists).

Measurements of inaccurate recall patterns are typical in schema theory research (see, for example, Read & Rosson, 1982; Sulin & Dooling, 1974). This is because the presence of such patterns indicate schemas that likely already existed in the mind of a participant before reading the text. Therefore although the selective recall patterns

regarding participants' inaccurate recall (especially the distortion and importation data) were not as strong as the accurate selective recall patterns, they can still be interpreted as affirming the hypothesis that mechanism and organicism possess psychological reality.

Significance of the Results

During a personal communication regarding the results of this dissertation with Christopher Germer and John Johnson, two of the scholars associated with developing the OMPI (Germer, et al., 1982; J. A. Johnson, 1987; J. A. Johnson, et al., 1988), I was told that Stephen Pepper would have been gratified to know about my findings. This is because Pepper wrote about his four worldviews based on the premise that they have a real cognitive presence. He wrote about mechanism and organicism from the discipline of philosophy, but his ideas were intended to describe real psychological characteristics. The results of this dissertation appear to verify some of these characteristics. What follows below is a broader discussion regarding the significance of the results of this dissertation.

Generalizability of the findings. This study was able to show the presence of selective recall based on participants' worldview preference within two texts from very different knowledge domains. Although only two knowledge domains were used, the fact that similar patterns of selective recall were found in both texts despite differences in content suggests that these results could generalize across a broad field of knowledge.

The above assertion regarding the likelihood of Pepper's mechanism and organicism to generalize across multiple domains is not based solely on the presence of similar results across disparate texts. It is also based on the level of rigor and systematicity within the method employed to investigate these worldviews. Past studies

involving Pepper's worldviews, especially those linking worldviews to educational

implications (i.e., Kilbourne, 1974; Proper, 1982), have too often demonstrated

worldviews' presence without linking them to established theoretical frameworks. I have

avoided this shortcoming by using an established method (i.e., the selective recall

paradigm) and situating the use of Pepper's worldviews within the larger framework of

schema theory and cognitive processing. Therefore, one should take from this

dissertation that Pepper's worldviews are more than an interesting philosophical idea that

possess some degree of ability to correlate with what is observed in classrooms or

textbooks. Rather, they should begin to be seen as cognitively relevant structures that are

powerful enough to affect basic cognitive processes.

Identifying this pattern of selective recall empirically and according to a rigorous

methodology was no trivial matter. Had it been a trivial matter their psychological reality

would have been established much earlier by the small, yet persistent community of

scholars who employ Pepper's worldviews in their research (e.g., Babbage & Ronan,

2000; J. A. Johnson, et al., 1988; Kilbourne, 1974; Lyddon, 1989; Proper, 1982; Rose,

2003; Super & Harkness, 2003; White, 1973). However, the difficulty in showing the

effect of worldviews preference on patterns of selective recall was not because of

inherently small effect sizes. The effect sizes of interactions in this study (via η_p^2)

ranged between 0.14 and 0.38, which suggests that never less than a moderate portion of

the variability in the recall data was attributable to participants' worldview preferences.

This effect size compares quite well to Pichert and Anderson's (1977) report of a

selective recall effect size (measured in terms of ω^2) of 0.23 (p. 311). Although I would

express caution about interpreting this comparison of effect sizes what I wish to

illuminate is that neither the present study nor the original work of Anderson and colleagues reported small effect sizes. Therefore, any alternative hypotheses regarding the current findings must account for the presence of such substantial effect sizes.

The ubiquity and purpose of worldviews. The effect sizes measured in this study are encouraging regarding the presence of worldviews as psychologically real entities. However, the word "world" in the term worldview is more indicative about their breadth of application than their ability to surpass a minimum effect size threshold. Worldviews, like mechanism and organicism (and speculatively others like those described by researchers like Babbage and Ronan (2000), Dewey and Bentley (1949), Koltko-Rivera (2004), Kramer, et al. (1992) or Von Wright (1971)) apply much more broadly to knowledge domains than the normal schemas generally taught about in an introductory cognitive psychology course. One would never attempt to apply a birthday or restaurant schema to a knowledge domain like the French Revolution or quantum mechanics because these schemas are by their very construction designed to apply to specific knowledge domains. On other hand, applying a worldview across disparate knowledge domains is not extraordinary because, in terms of Bransford et al. (1977), worldviews are schemas that we think *in terms of* rather than schemas that we think *about*.

Given that these worldviews work as lenses that people see through, it is not surprising that identifying and measuring the effect of these worldviews has been so elusive. Despite identifying a measurable influence on participants' patterns of selective recall, none of the participants that I spoke to after completing all the research activities were able to articulate that they suspected the presence of a "worldview" affecting their

recall. Worldviews appear to be a part of the tacit knowledge written about by Polanyi (1966), or alternatively as Broudy (1977, p. 4) might explain, worldviews seem to be used by people not for knowing *how* or *what*, but rather as part of an "implicit knowing *with*."

Speculations regarding the role of worldviews in educational research. Assuming that worldviews exist and that the evidence in this dissertation is enough to suggest that they possess a cognitive presence, one could speculate that worldviews play a role in educational settings. For this reason, I present below four speculative thoughts on how these worldviews *might* be relevant to educational researchers.

Curriculum and instruction. Worldviews could be viewed as important to the large community of researchers in curriculum and instruction assuming that they possess psychological reality. This is because this dissertation shows that worldviews affect recall in a task that is not too far removed from tasks that may be found in a school setting. Researchers who study curriculum design or instructional methods may, therefore, need to further investigate the effect of worldviews in the materials they create which are intended to affect learning outcomes. Educators that may be particularly interested in these findings are science and history educators since this dissertation specifically investigated, and found hypothesized effects, in these two knowledge domains.

Student learning. The results of this dissertation suggest that student learning, especially in the domains of history and physics, is affected by worldview preference based on the premise that learning, especially in the short term, is largely a product of memory. If worldviews are psychologically real, as is proposed and supported in this

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dissertation, then they likely affect other cognitive processes involved in learning like attention and problem solving. This means that worldviews should be able to be manipulated in ways that affect student learning. Although future studies will need to investigate the scope and limitations of these effects on student learning, their presence should no longer be ignored assuming their psychological reality has been adequately demonstrated.

Assessment. If worldviews are psychologically real and they can be shown to affect student learning, they are likely also involved in assessments of student learning. One hypothesis concerning the effect of worldviews on assessment could be that a teacher who assesses his students on organicist ways of thinking might see depressed test scores amongst students who do not prefer to think, or are at least less inclined to think, about the content in an organicist way. Furthermore, one may be able to affect students test scores depending on the worldview that test items are constructed from. Assuming that this dissertation shows that two of Pepper's worldviews possess psychological reality, these hypotheses, and others concerning the link between worldviews and assessment, will need to be further investigated.

Transfer. Although the study of transfer does not figure heavily in the text of this dissertation, it was one of the main influences for conducting the study in the first place. The fact that worldviews seem so capable of affecting diverse knowledge domains suggests that they may also play a role in mechanisms of transfer, especially in cases of far transfer where other generally successful theories of transfer like structural alignment (Gentner, 1983; Gentner, Loewenstein, & Thompson, 2003; Gentner, Rattermann, & Forbus, 1993), affordances and constraints (Greeno, Smith, & Moore, 1993), or schema

induction (Gick & Holyoak, 1983; Holyoak & Thagard, 1999) have failed to come up with adequate explanations.

Limitations

Despite the general finding that worldview preference affects patterns of selective recall there are a number of limitations in this dissertation that need to be acknowledged and addressed. In this section I describe five of these limitations.

Use of only two worldviews. Pepper originally described four worldviews, but this dissertation only investigates two of them. My justification for using only half of Pepper's worldviews is discussed elsewhere in this dissertation (see "Restricting the analysis down to mechanism and organicism" in the Methods chapter for more details), but despite these justifications there remains to basic reasons that investigating only two of Pepper's worldviews can still be seen as a limitation. First, by only measuring two worldviews I have likely included some participants who prefer neither mechanism nor organicism. Even though J. A. Johnson et al. (1988) explains how measuring preferences for only two worldview actually captures some of the traits of the two neglected worldviews, there still seems to be a face value concern for dropping two worldviews out of consideration due to the fact that Pepper would have only described two worldviews rather than four if he expected only two were sufficient. If Pepper were still alive it would have been useful to know more about his thoughts concerning the manner in which this study collapses the four worldviews down to two. Nevertheless, the dissertation is not the first study that investigates Pepper's worldviews based on a bimodal distribution. Furthermore the fact that selective recall effects were found based on a measurement of only two of Pepper's worldviews shows that this effect is large

enough to be detectable even in the presence of participants that might have had greater preference for formism or contextualism.

The second limitation concerning using only two of Pepper's worldviews has more to do with the limited number of instruments available for measuring Pepper's worldviews. Although the OMPI has been validated via psychometric testing I still would have rather chosen an instrument for determining participants' worldview preference based on all four worldviews rather than the two that are focused upon on the OMPI. Regardless, no such instrument exists at this time. Future studies that wish to measure individual's general preference for all four of Pepper's worldviews will need to develop the instrument first.

Text construction. One could argue that the contrived nature of the History and Physics texts present a source of limitation in this study. The artificial nature of these texts is not contested based on the fact so many of the participants mentioned to me after the study was concluded that they felt the texts were "disjointed" or "didn't flow well." However, these texts were intentionally designed with structural constraints so that the presence of both worldviews would be equally present. It is doubtful that the effects of selective recall found in this dissertation would be as large had I used texts with more naturally constructed prose.

Although the contrived nature of these texts represents a limitation in the study, it was also a necessary part of establishing the psychological reality of worldviews. This is because these carefully crafted texts were intended to block out many extraneous variables as possible that might have otherwise represented alternative interpretations regarding observed patterns of selective recall. Nevertheless, now that the effect of

worldview preference on selective recall has been demonstrated a follow-up study showing these selective recall patterns in a more naturally constructed text would be appropriate for expanding researchers' understanding about the capacity of worldviews effect on selective recall.

High correlation between age and vocabulary score. As was discussed in the Results chapter, there was a high correlation between participants' age and vocabulary score that was likely the result of having a mixture of young undergraduate students with older graduate students. This high correlation suggested the possibility that the reported effects of selective recall based on worldview preference across these two groups may have been conflated. Steps were taken to investigate whether these selective recall patterns were consistent across both groups, and the data suggest that there were consistent distributions of worldview preferences and background knowledge scores across these groups. Nevertheless, the high correlation was still less than ideal because if it was found that there were significant differences across these groups, the number of participants included in each group might have been too small to reveal any patterns of selective recall.

One way that this limitation could have been avoided would have been to limit the demographic of participants to either undergraduates or graduate students. However, the distribution of participants in this dissertation does highlight the need for a future study that focuses on directly investigating the effect of variables like age and verbal intelligence on individuals' worldview preferences when engaged in cognitive tasks like recall.

Limited analyses of the effect of background knowledge on patterns of selective recall. The findings in this dissertation suggest that selective recall patterns based on participants' worldview preferences remain present across differences in background knowledge. However, the instruments used to measure background knowledge may not have been good enough to discriminate between different levels of background knowledge since they consisted of only a small number (10) of multiple choice items. I do not mean to imply that these instruments were poorly crafted. On the contrary, both instruments were pilot tested to help remove poor items and care was taken not to include items that could be found directly in the texts. However, because background knowledge was only collected as a potential covariate to aid in the main purpose of investigating the effect of worldview preference on selective recall, these measures were not focused upon as much as they could have been. For this reason, the conclusion that background knowledge does not significantly affect these patterns of selective recall based on worldview preference may not be as conclusive as the results imply. Because of this potential limitation, it may be useful to develop a study in the future that is designed around investigating whether background knowledge affects patterns of selective recall based on worldview preference so that more data could be available to confirm or refute what is reported in this dissertation.

Measurements of inaccurate recall. Another limitation of this dissertation regards the findings about patterns of selective recall amongst measurements of inaccurate recall. Although the results trend in the hypothesized direction, patterns of selective recall based on worldview preference when measuring ambiguities and importations do not follow the same patterns of selective recall amongst measurements of

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accurate recall and distortions. However, it is possible that these findings are the result of how seldom importations and ambiguities were recorded. Put another way, there may not have been enough power to indicate the hypothesized patterns of selective recall which indicates a type II error.

Although a lack of power regarding measurements of importations and ambiguities may have been present in this study, which suggests a legitimate limitation, it is not unreasonable that so little inaccurate recall was recorded. This is because measuring inaccurate recall often requires texts that are specifically designed to induce this kind of recall (Loftus & Hoffman, 1989; McDermott, 1996; Spiro, 1980). Therefore, since the texts used in this dissertation were not specifically designed to produce larger amounts of inaccurate recall, they may not have been focused enough to effectively test the proposed hypothesis that patterns of selective recall based on worldview preferences measured by counts of inaccurate recall exhibit similar patterns of selective recall found amongst measures of accurate recall.

Future Research

The significance of these findings as well as the paucity of previous research regarding the use Pepper's worldviews in educational settings suggests the need for a large number of research studies aimed at expanding our understanding of worldviews as well as their potential influence in education. Although there are a number of directions that this future research could take I will limit my discussion to three. The first of these directions regards investigating the developmental origins of worldview preferences. Second, I will discuss the need to develop more ecologically valid materials for

measuring the effect of these worldviews on cognition. Last, I suggest research that would investigate the use of multiple worldviews as a strategy for meaningful learning.

The three studies described below do not exhaust all of the potential avenues for research, but they do exemplify how productive I believe research regarding worldviews' presence in educational settings could be. Other lines of research that are not discussed below could include investigating other worldviews' effects on cognition, improving the instruments used for investigating worldviews, and conducting studies that are more focused on investigating the relationship between worldviews' effect on cognition with changes in characteristics like reading comprehension or content knowledge.

Development of worldview preferences. When and how people develop their preference for a particular worldview is one of the more important questions to answer regarding the use of Pepper's worldviews in educational settings, because it is likely that the effect of selective recall is not constant across all levels of cognition. Up to this point, worldviews have been studied exclusively amongst adults (e.g., Fontana et. al, 1976; Johnson et. al, 1988; Koltko-Rivera, 2004; Super & Harkness, 2003) meaning that the lower boundary on the influence of worldviews upon cognition is still unknown. Therefore, without knowing the lower boundary on the effect of worldviews on cognitive processing (like recall) it would be unwise to assume that worldviews affect high school and middle school students in ways similar to college-aged and professional adults.

In order to investigate how the use of worldviews develop, one potential study would be to see at what age the selective recall effect presently demonstrated in this study would appear. For example a similarly designed selective recall task could be given to a group of junior high, high school and undergraduate students. Since it is likely that

the use of worldviews involves fairly high-order cognitive processing I would hypothesize that strong patterns of selective recall would diminish within the younger junior high students. A study like this could potentially show the lower limits of worldviews' effect on students' cognition as well as explore the factors involved regarding why some people prefer one worldview over another.

Research regarding the development of worldviews' influence on cognition will certainly need to construct materials more appropriate for younger students. For example the Physics text used in this study is likely an inappropriate topic for students at the junior high level. Although it is possible that some students would be able to understand some of the basic concepts in the current Physics text, it would subject the study to potential alternative interpretations about the lack of selective recall effects due to poor reading comprehension rather than undeveloped worldview preferences.

Improving the ecological validity of worldviews' effect on cognition. As was discussed in the limitations section, the texts used to investigate patterns of selective recall possessed certain drawbacks that affect the ecological validity of this study. In other words, although the results in this study were shown using multiple measures of recall (i.e., at the target idea unit and target paragraph level), the construction of the texts used to demonstrate this effect were fairly contrived. There would be greater ecological validity if more natural texts had been used. However, as was discussed earlier, these texts were purposefully constructed to control for serial position effects that otherwise could have washed out any of the demonstrated effects on recall.

Now that worldviews' effect on participants' recall has been shown, especially with substantial effect sizes, new research should attempt to improve upon the present

study's ecological validity. One of the drawbacks to the texts used in this study concerned their length. Another drawback affecting the ecological validity concerned the presence of two worldviews within one text that alternated from one paragraph to the next. A simple variation on this study could eliminate both of these concerns and simultaneously improve the robustness of the present findings. First, split each text into two shorter texts that contain only the mechanist or organicist paragraphs. This would create an organicist and mechanist text about the same topic. Next, revise the new texts to account for changes in continuity and subject the new texts to similar worldview ratings. Lastly, recruit participants to read only one of the two new texts and then perform the same recall task utilized in this study. In this new study, the data would be subjected to a between subjects analysis rather than the within-subjects analyses used in this dissertation. Since the power of between-subjects studies are less than within-subjects designs, a greater number of participants should be recruited. Nevertheless, if worldviews' effect on selective recall is more than a product of the special way that these texts were constructed, a selective recall effect should still be demonstrable.

If a between-subjects study using shorter texts that focus on one worldview at a time also finds selective recall effects based on participants' worldview preference, the next step toward strengthening worldviews' ecological validity would be to find texts not written for the express purpose of demonstrating patterns of selective recall. As discussed in the literature review, a number of scholars have been identified with mechanist thinking (i.e., Galileo, Descartes, Hobbes, and Locke) and organicist thinking (i.e., Schelling, Hegel, Royce). If short texts from these scholars could be identified that exhibit archetypal characteristics of mechanism and organicism, a third test of

worldviews' influence on selective recall patterns could be conducted in an attempt to improve the ecological validity of the present findings.

Using multiple worldviews as a strategy for meaningful learning. Pepper's worldviews were originally investigated due to their potential effect on learning environments. Therefore, now that they have been shown to possess psychological reality, investigations regarding their potential use in educational settings need to begin. One potential line of research regarding these worldviews' effect on the process of education is to investigate their ability to promote meaningful learning.

Pepper suggested at the end of his book that the use of worldviews should have "rational clarity in theory and reasonable eclecticism in practice" (p. 330). This means that as a professional working under a specific theoretical construct, it is important to reason consistently from one worldview at a time so that results are not muddled by conflicting epistemological foundations. However, when working to gain new understanding, it is to a learner's advantage to use multiple worldviews. This advice by Pepper can be investigated empirically by teaching students about multiple worldviews and investigating whether this strategy improves learning. Developing lesson plans and instructional materials to teach students about the use of multiple worldviews as a strategy for learning would only be the first step for investigating these worldviews' influence on learning. Care would need to be taken with developing the experimental design so that alternative hypotheses regarding students' learning could be ruled out.

As an example of how to investigate the influence of using Pepper's worldviews as a strategy for learning consider the following example. Student learning outcomes could be compared across classrooms where instructors in one group teach content via

the use of multiple worldviews whereas another group of instructors teach the same content consistently within a single worldview. Pepper would hypothesize that the group of students who received instruction in a "multiple-worldview" format should exhibit patterns of more meaningful learning when compared to students who received instruction via a single worldview perspective.

In Conclusion

Although Pepper's ideas have had a small but steady presence in education and psychology over the last 60 years, no studies during this time period have attempted to show worldviews' ability to directly affect basic cognitive processes as was attempted and affirmed in this dissertation. More specifically, the results of this study indicate that one's preference for Pepper's mechanism or organicism worldviews affects selective recall patterns. Because of these results greater attention needs to be paid to worldviews' influence in educational settings. Furthermore the fact that so little research has already been conducted involving these worldviews suggests the possibility that many more studies aimed at expanding our understanding of worldviews as well as their potential influence in education remain possible.

[1]Definitions for these three kinds of inaccurate recall are described in greater detail in the *Method* chapter as well as in Appendix F, which is an alphabetized glossary of terms.

[2]Worldviews' purported capability of applying across diverse knowledge domains are described by two adjectives in this dissertation and they were chosen to emphasize a difference between worldviews, as described by Pepper, and other lower-level schemas. First, I will often refer to worldviews as "content-free." This is <u>not</u> meant to imply that worldviews themselves are devoid of any content. Rather, the description is intended to indicate that worldviews' are not externally bound by a small set of knowledge domains. Instead they are "free" to organize knowledge across many domains. The other adjective used in this dissertation is that lower-level schemas will often be described as "content-laden." This label is not meant to imply their lack of utility as an abstract knowledge structure. Instead it should be seen as a shorthand way of indicating their restrictedness in the kinds of topics they can be applied to (i.e., they are not "world" views).

[3] Several researchers in the fields of personality and developmental psychology (Babbage & Ronan, 2000; J. A. Johnson, et al., 1988; Lyddon, 1989; Super & Harkness, 2003) have conducted research suggesting that different occupations have significantly higher numbers of practitioners that espouse one worldview over another. Even Pepper himself (1942) suggests that scientists and historians are generally drawn to two different worldviews (mechanism and contextualism) over the others. This could be interpreted as evidence that worldviews are not completely content free (at least not equally applicable

to all knowledge domains). However, the propensity for one worldview over another in an occupation does not mean that all other worldviews are excluded from that profession, nor does it mean that other less commonly applied worldviews to a particular knowledge domain cannot be profitably utilized. Hayden White (1973) exemplifies this point masterfully in his book *Metahistory* by showing a number of top historians coming to different conclusions about the French revolution based on their adherence to different worldviews and for which the world would have less understanding if only one worldview were able to be successfully used in the field of history.

[4] A number of articles directly address the issue of whether adequate inter-rater reliability can be achieved when identifying worldviews (Babbage & Ronan, 2000; Harris, et al., 1977; J. A. Johnson, et al., 1988; Kramer, et al., 1992; Super & Harkness, 2003). However, to strengthen this claim 20 worldview statements were written and classified according to formism, mechanism, organicism and contextualism prior to writing any of the texts in this dissertation. These statements were then given to another person familiar with worldviews but unfamiliar with the statements and asked to identify which worldview was being portrayed in each statement. Out of the 17 statements that this person agreed to classify, 15 agreed with the original classification. Three were not answered because the rater felt these statements were not clear enough to successfully classify into one of the four worldviews. When asked to make a "guess" about how the remaining three statements should be classified the rater disagreed with the original classification on all three statements. A Chi-square test of independence was calculated between whether a statement was ruled clear enough to classify or not and whether agreement or disagreement occurred for how each statement was originally classified.

The first Chi-Square analysis was significant, F = 10.588, p = .0011, df =1. Since the

degrees of freedom were so low a Yates chi square test was alternatively run which

attempts to correct for errors when small cell numbers are used. This analysis also

yielded a significant effect, F = 6.405, p = .01. These results suggest that two people with

similar understanding of worldviews can evaluate to a sufficient degree of reliability a

number of statements derived from Pepper's scheme.

Table 1

Basic Characteristics of the Mechanist and Organicist Worldviews

Mechanism	Organicism
Ontology	
Stability	Change
Elementarism	Holism
Epistemology	
Objectivism	Interactionism
Realism	Constructivism
Explanation	
Reductionistic analysis	Synthetic understanding of organization
Parts related in antecedent-consequence	Functions served by structures
View of Persons	
Reactive	Active
Passive	Purposive
Determined by environment	Autonomous
No inherent functions	Inherent functions
No true development toward endpoints	Creative, changing, progressive
Separate from social environment	Integrated into social environment

Note. Adapted from `Personality as the basis for theoretical predilections', by J.A.

Johnson, C.K. Germer, J.S. Efran, & W.F. Overton, 1988, Journal of Personality and

Social Psychology, 55, p.828. Copyright 1982 by C.K. Germer, J.S. Efran, and W.F.

Overton. Reprinted with permission.

Table 2

Inter-rater Reliability Scores for Evaluating Idea Unit Ratings

Reliability Score	History Idea Unit Ratings		Physics Idea Unit Ratings	
	Organicism	Mechanism	Organicism	Mechanism
Cronbach's α	0.93	0.88	0.91	0.87
Percent Agreement	90%	85%	86%	81%

Note. Scores evaluated from 212 parsed idea units in the history text and 220 parsed idea units from the physics text.

Table 3

Worldview Ratings Assigned to a Sample[a] of Idea Units from the Physics Text

Worldview Rating		
Organicism	Mechanism	Idea Unit
2	3	One particle that is less familiar to most people
1	3	**(one particle) is the neutrino.**[b]
2	4	**Neutrinos are a natural product of radioactive decay**
1	4	**There are three masses of neutrinos**
1	4	**depending on the kind of decay that is happening.**
3	2	Once they are created,
2	3	they have the strange property of shifting
2	3	(they shift) between these three masses
1	4	**(they shift) over time.**
1	4	**In other words, over a known time interval**
1	2	a neutrino may be lighter or heavier
2	2	(lighter or heavier) than what it was
4	2	when it was originally created.

Note. The idea units presented in this table are the same idea units used in Figure 2 to

show how texts were parsed.

[a]This sample corresponds to the second mechanist paragraph in the Physics text.

[b]Bolded idea units and worldview ratings indicate "target idea units" (see p. 13).

Table 4

Sample of Accurate Recall Units Compared to their Corresponding Idea Units

Accurate Recall Unit	Idea Unit
History Text	
Robespierre was one of the main leaders	Robespierre was one of the main leaders
so they gathered at a nearby tennis court	(responded) by moving to a nearby tennis court
the king retained the power of veto	(king) retaining the right to veto
Louis established the Estates General	In 1789 he called for the Estates General
Marie Antoinette was Louis XVI's wife	(prominent figure) was the King's wife Marie Antoinette
Physics Text	
Neutrinos are one such particle	(one particle) is the neutrino
It is often referred to as "unintuitive"	Quantum mechanics has often been called "unintuitive"
there are four kinds of forces	In quantum mechanics there are four basic forces
somehow communicate faster than the speed of light	(they "communicate") faster than the speed of light
Dirac was called boring	Despite being described as boring and very asocial,

Note. Accurate recall units correspond to only one idea unit from a particular text. They must also have similar worldview ratings.

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Table 5

Sample of Organicist and Mechanist Distortions Compared to their Corresponding Idea
Units

Distorted Recall Unit	Idea Unit
Organicist Distortions[a]	
This constitution birthed a legislature	(constitution) which called for a legislative assembly
neutrinos can shift at will	(they shift) over time
One can explain every process and aspect of the universe	One could determine every cause for every effect in the universe
Mechanist Distortions[b]	
action on one particle causes reaction in the other particle	(particle) must immediately affect the other
opinions changed due to circumstances	(opinions changed) as the events of the revolution unfolded
they are explained by their individual descriptions	they cannot be completely described individually

Note. Distortions are when a recall unit accurately corresponds to the content of a

specific idea unit in a text but not according to idea unit's organicist and mechanist

rating.

[a]An "organicist distortion" is when the distortion's difference rating is greater than or

equal to three points higher than the difference rating of the corresponding idea unit.

[b]A "mechanist distortion" is when the distortion's difference rating is less than or equal

to three points lower than the difference rating of the corresponding idea unit.

Table 6

Descriptive Statistics of Participant's Memory Data from the History and Physics Texts

Variable	History Text (N = 54)				Physics Text (N = 51)[a]			
	Min	Max	M	SD	Min	Max	M	SD
Kinds of Recall								
Total	11	67	36.22[b]	15.1	10[a]	75	30.02[b]	14.34
Accurate Recall	11	60	31.23	14.3	8	63	25.72	13.41
Distortions	0	6	1.67	1.61	0	8	1.65	1.70
Ambiguities	0	9	1.15	1.82	0	3	0.71	0.83
Importations	0	8	2.19	2.21	0	9	2.00	2.12
Recalled Target Idea Units								
Mechanist	0	24	6.94	4.80	0	24	5.47	4.37
Organicist	0	19	5.93	4.66	0	16	6.33	4.41
Recalled Paragraphs								
Mechanist	0	8	2.00	1.74	0	7	1.57	1.74
Organicist	0	6	1.78	1.63	0	6	1.73	1.50

[a]Three Participants' memory data from the Physics text were excluded because there

were less than 10 total recall units.

[b]Participants' recorded significantly more recall units from the History text than from the

Physics text, $t(103) = 2.16$, $p = .03$.

Table 7

Summary of Correlations between OMPI scores, Gender, Age, and Results from the Vocabulary Test, Background Knowledge Tests and Revised CFIs

Variable	1	2	3	4	5	6	7
1. OMPI[a]							
2. Gender[a]	.028						
3. Age[a, b]	.043	-.145					
4. Vocabulary Score[c]	.142	-.155	.422**				
5. QMBK Score[c]	-.317*	-.164	.115	.372**			
6. FRBK Score[c]	-.036	-.196	.155	.426**	.060		
7. Revised CFI Physics[a]	.028	-.020	.173	.033	-.026	.071	
8. Revised CFI History[a]	.064	-.001	.290*	.198	-.055	-.019	.042

Note. OMPI = Organicism Mechanism Paradigm Inventory, QMBK = Quantum

Mechanics Background Knowledge, FRBK = French Revolution Background

Knowledge. CFI = Cognitive Flexibility Inventory

[a]N = 60

[b]Males = 1 and females = 2.

[c]N = 54

*p< .05

**p< .01

Table 8

Summary of Fisher's r-to-z Transformations to Determine Statistical Differences between Correlation Coefficients Grouped by Age (High, Low) and Vocabulary Score (High, Low)

Variable	Age			Vocabulary Score		
	High[a]	Low[b]	Fisher's z[c]	High[a]	Low[b]	Fisher's z[c]
OMPI	.106	.062	0.15	-.161	.189	-1.22
QMBK Score	-.201	.050	-0.88	.442*	.236	0.81
FMBK Score	.211	-.037	0.87	.296	.418*	-0.49

Note. OMPI = Organicism Mechanism Paradigm Inventory, QMBK = Quantum

Mechanics Background Knowledge, FRBK = French Revolution Background

Knowledge.

[a]N = 26

[b]N = 28

[c]Fisher's z was non-significant, $p > .05$, for all comparisons.

*$p < .05$

Table 9

Summary of Worldview Preference by Type of Recalled Target Idea Unit (Type of Item) ANOVA on the Recall of Target Idea Units across Participants with High and Low Physics Knowledge

Source	SS	df	MS	F	η_p^2
High Physics Knowledge					
Worldview Preference	34.27	1	34.27	1.38	.054
Error (between)	594.67	24	24.78		
Type of Item	0.17	1	0.17	0.01	.001
Worldview Preference X Type of Item	135.56	1	135.56	8.82**	.269
Error (within)	368.77	24	15.37		
Low Physics Knowledge					
Worldview Preference	80.53	1	80.53	6.51*	.221
Error (between)	284.47	23	12.37		
Type of Item	31.66	1	31.66	3.50	.132
Worldview Preference X Type of Item	79.66	1	79.66	8.81**	.277
Error (within)	208.06	23	9.05		

Note. Participants were divided into groups of high and low physics knowledge based on a median split of scores from the Quantum Mechanics Background Knowledge Test.

*$p < .05$

**$p < .01$

Table 10

Summary of Worldview Preference by Type of Recalled Target Idea Unit (Type of Item)
ANOVA on the Recall of Target Idea Units across Participants with High and Low
French Revolution Knowledge

Source	SS	df	MS	F	η_p^2
High French Revolution Knowledge					
Worldview Preference	7.14	1	7.14	0.31	.013
Error (between)	531.18	23	23.10		
Type of Item	17.55	1	17.55	1.78	.072
Worldview Preference X Type of Item	269.55	1	269.55	27.82**	.543
Error (within)	226.50	23	9.85		
Low French Revolution Knowledge					
Worldview Preference	2.40	1	2.40	0.75	.004
Error (between)	620.98	27	23.00		
Type of Item	12.81	1	12.81	0.60	.022
Worldview Preference X Type of Item	107.64	1	107.64	5.07*	.158
Error (within)	572.85	27	21.22		

Note. Participants were divided into groups of high and low physics knowledge based on
a median split of scores from the French Revolution Background Knowledge Test.

*$p < .05$

**$p < .01$

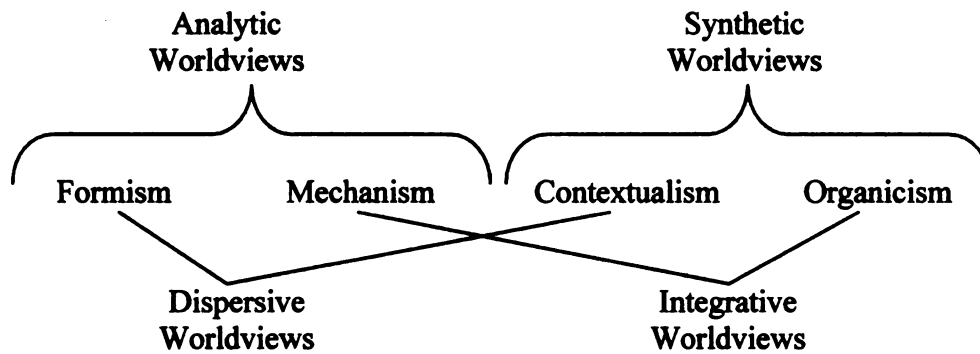*Figure 1.* Scheme of Pepper's four worldviews divided up into two types of investigative preference (Analytic and Synthetic) and across two interpretive tendencies (Dispersive and Integrative). From Stephen Pepper, *World Hypotheses: A Study in Evidence.* Copyright 1942 by the Regents of the University of California; Copyright renewed 1970 by Stephen Pepper. Published by the University of California Press.

Example Paragraph:

One particle that is less familiar to most people is the neutrino. Neutrinos are a natural product of radioactive decay. There are three masses of neutrinos depending on the kind of decay that is happening. Once they are created, they have the strange property of shifting between these three masses over time. In other words, over a known time interval a neutrino may be lighter or heavier than what it was when it was originally created.

Example Paragraph Parsed into Idea Units
- One particle that is less familiar to most people
- (one particle) is the neutrino.
- Neutrinos are a natural product of radioactive decay
- There are three masses of neutrinos
- depending on the kind of decay that is happening.
- Once they are created,
- they have the strange property of shifting
- (they shift) between these three masses
- (they shift) over time.
- In other words, over a known time interval
- a neutrino may be lighter or heavier
- (lighter or heavier) than what it was
- when it was originally created.

Figure 2. Example of one paragraph of text parsed into idea units. Words in parentheses indicate portions of text that overlap across two or more parsings to help ensure as many idea units as possible contain one subject and one predicate.
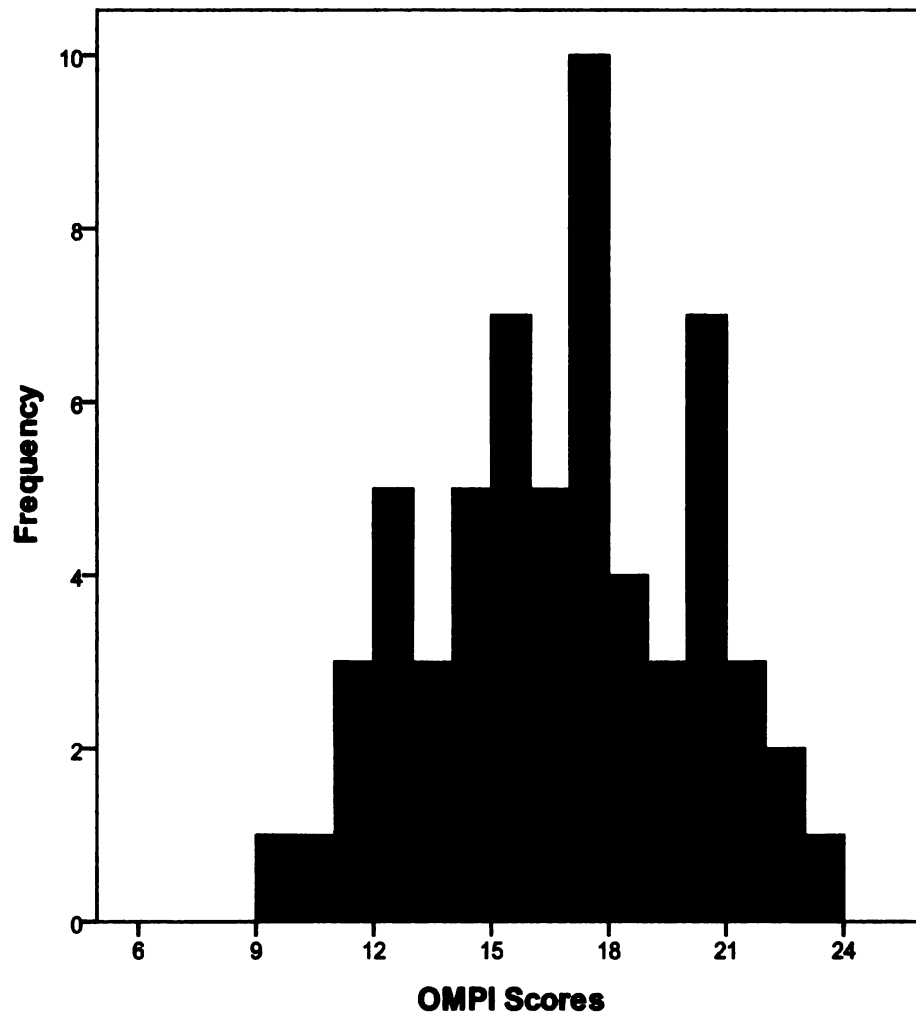
Figure 3. Histogram of Participants' OMPI scores (N =60, *M* = 16.25, *SD* = 3.32).

Figure 4. Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of recalled target idea unit (Mechanist, Organicist) from the History text. The interaction is significant, $F(1, 52) = 22.2$, $p < .001$, $\eta_p^2 = .30$.

Figure 5. Graph of the interaction between participants' worldview preference

(Mechanists, Organicists) and type of recalled target idea unit (Mechanist, Organicist)

from the Physics text. The interaction is significant, $F(1, 49) = 22.6, p < .001, \eta_p^2 = .32$.

Average Recall of Mechanist and Organicist Target Idea Units Across Texts

Figure 6. Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of recalled target idea unit (Mechanist, Organicist) across both texts and evaluated with vocabulary score as a covariate. The interaction is significant, $F(1, 48) = 30.0$, $p < .001$, $\eta_p^2 = .38$.

Average Recall of Mechanist and Organicist Distortions
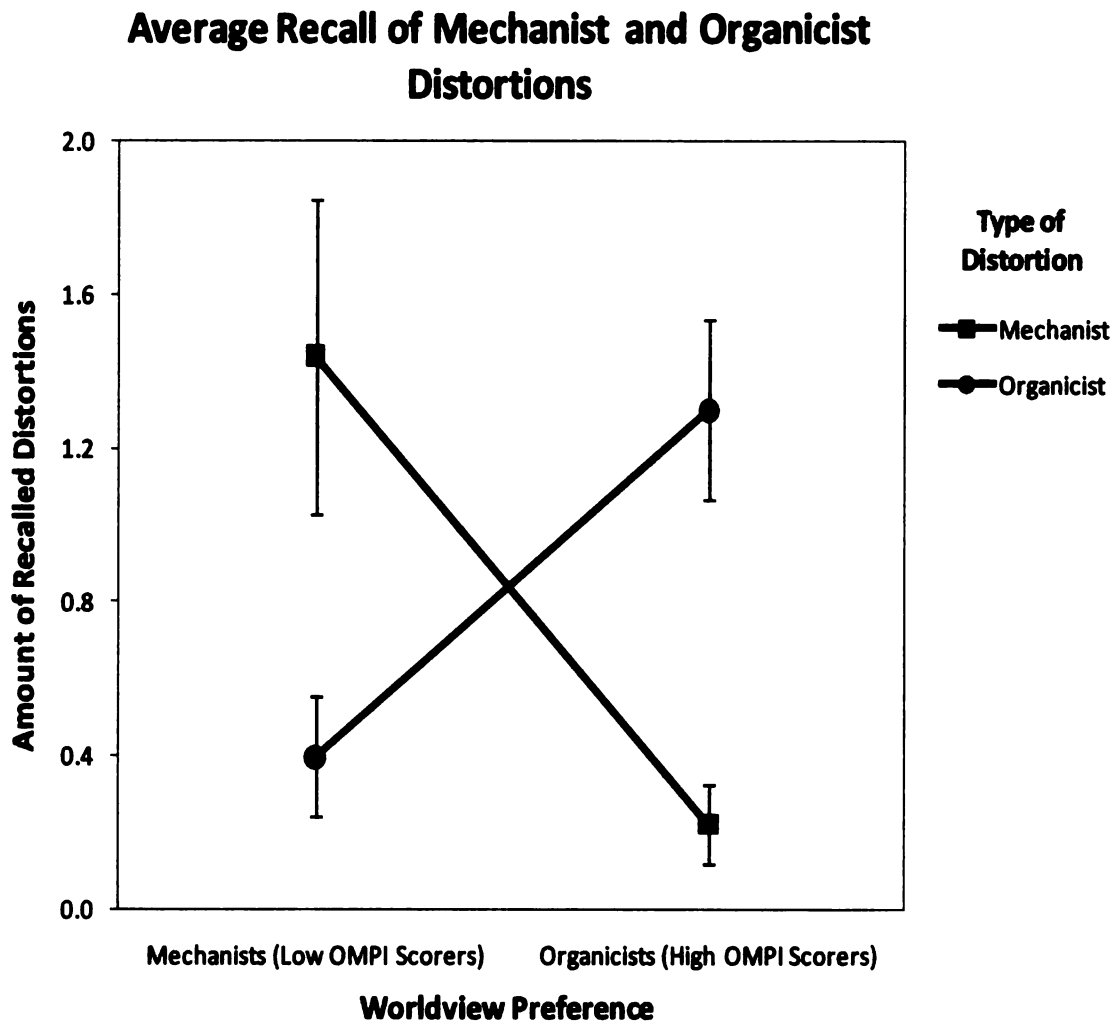
Figure 7. Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of distorted recall (Mechanist, Organicist) across both texts. The interaction is significant, $F(1, 49) = 26.1, p < .001, \eta_p^2 = .35$.
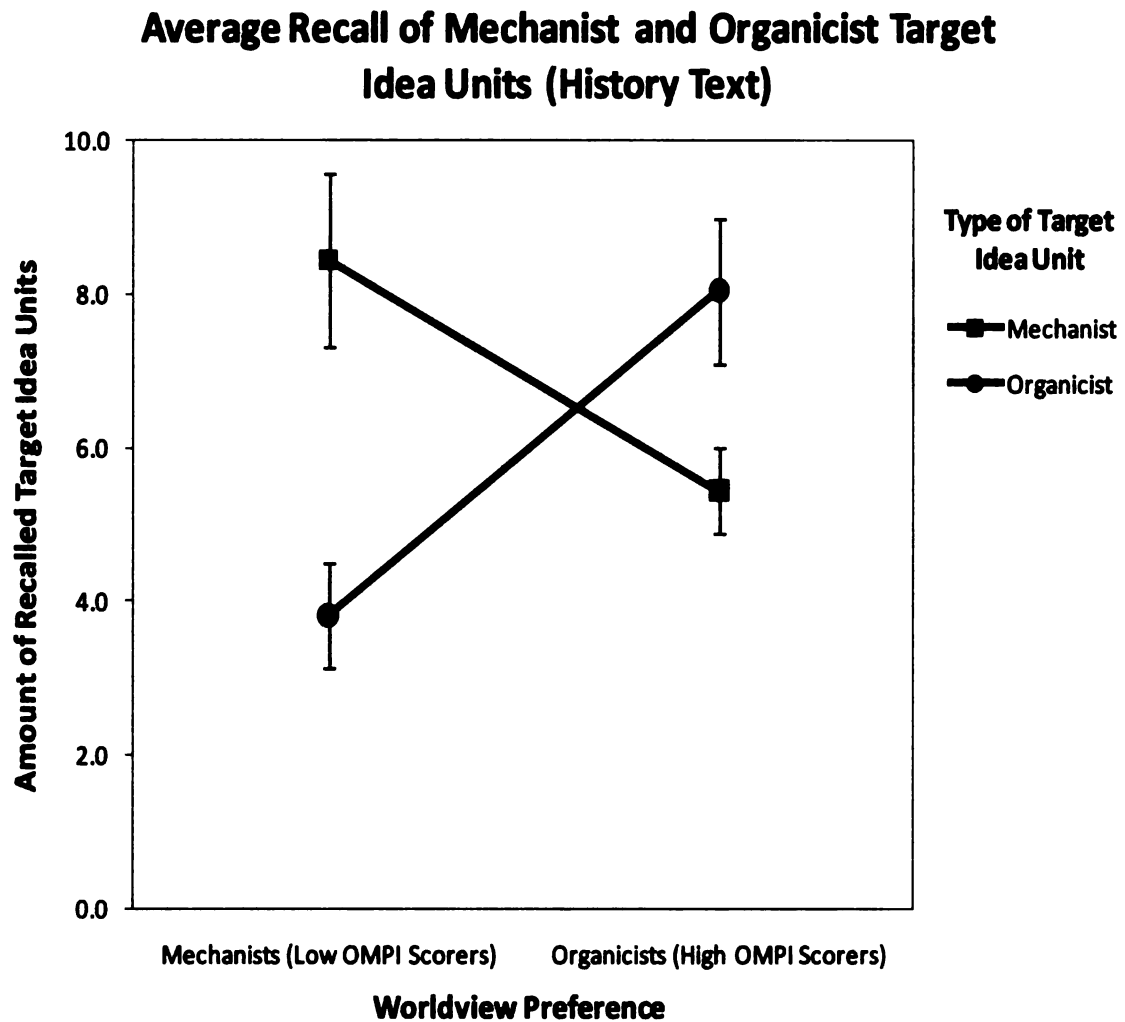
Average Recall of Mechanist and Organicist Importations
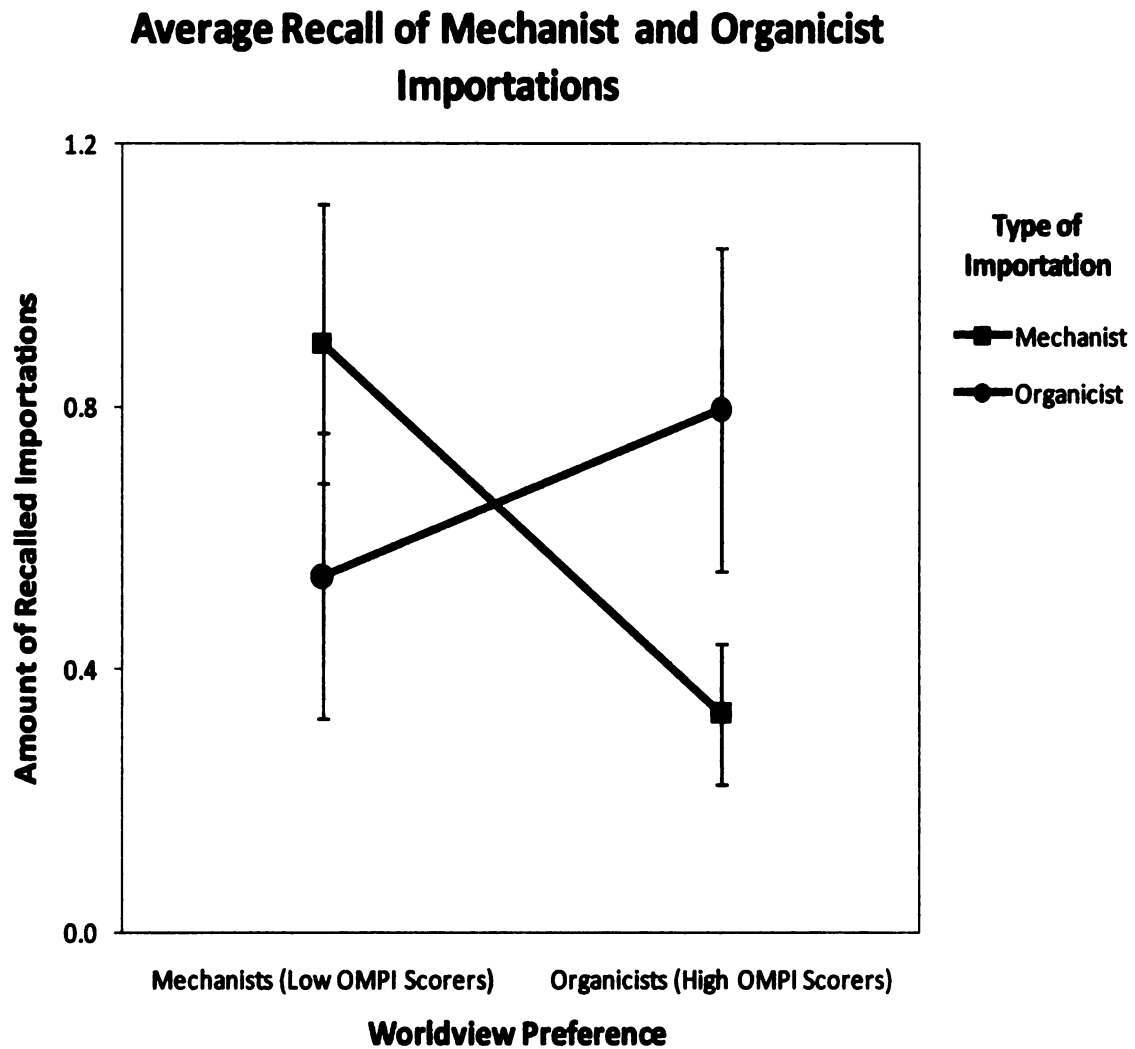
Figure 8. Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of imported recall (Mechanist, Organicist) across both texts. The interaction is significant, $F(1, 49) = 7.96, p = .007, \eta_p^2 = .14$.

Average Recall of Mechanist and Organicist Target Paragraphs (History Text)
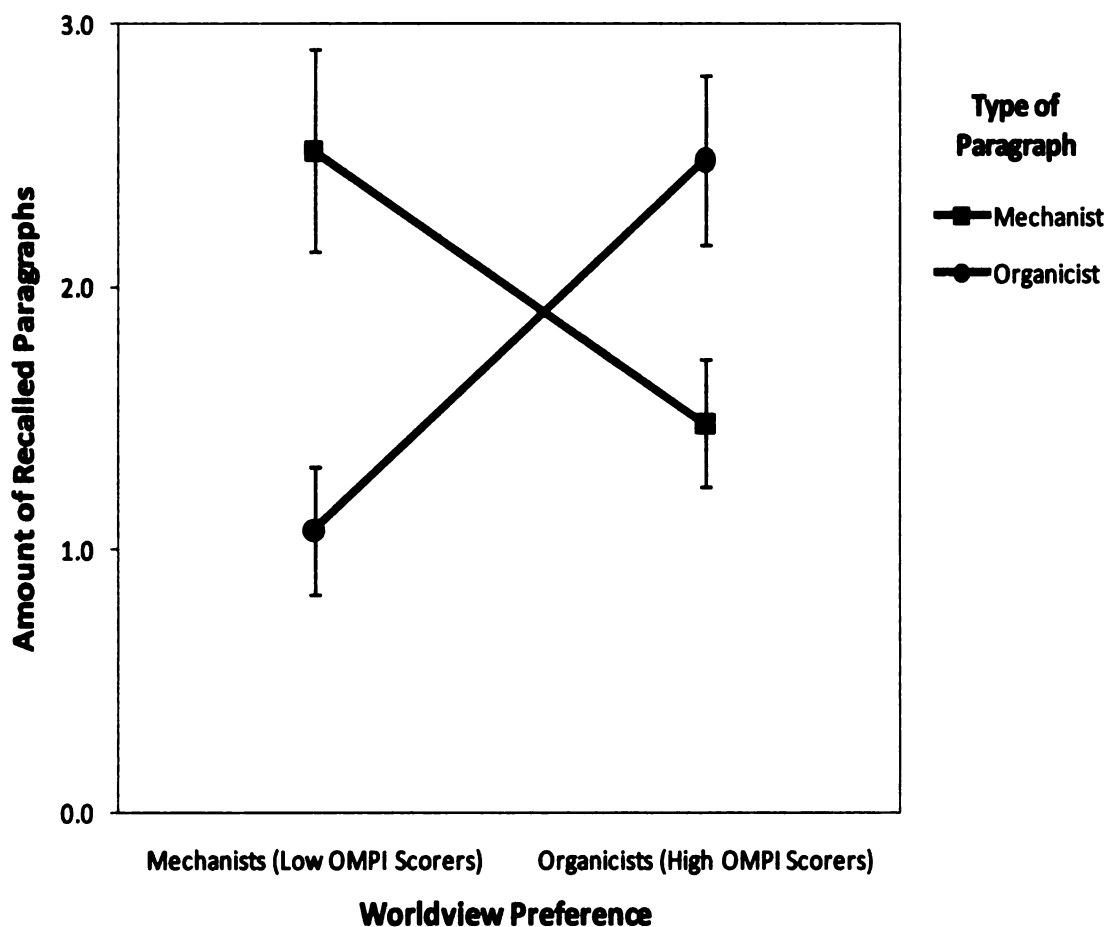
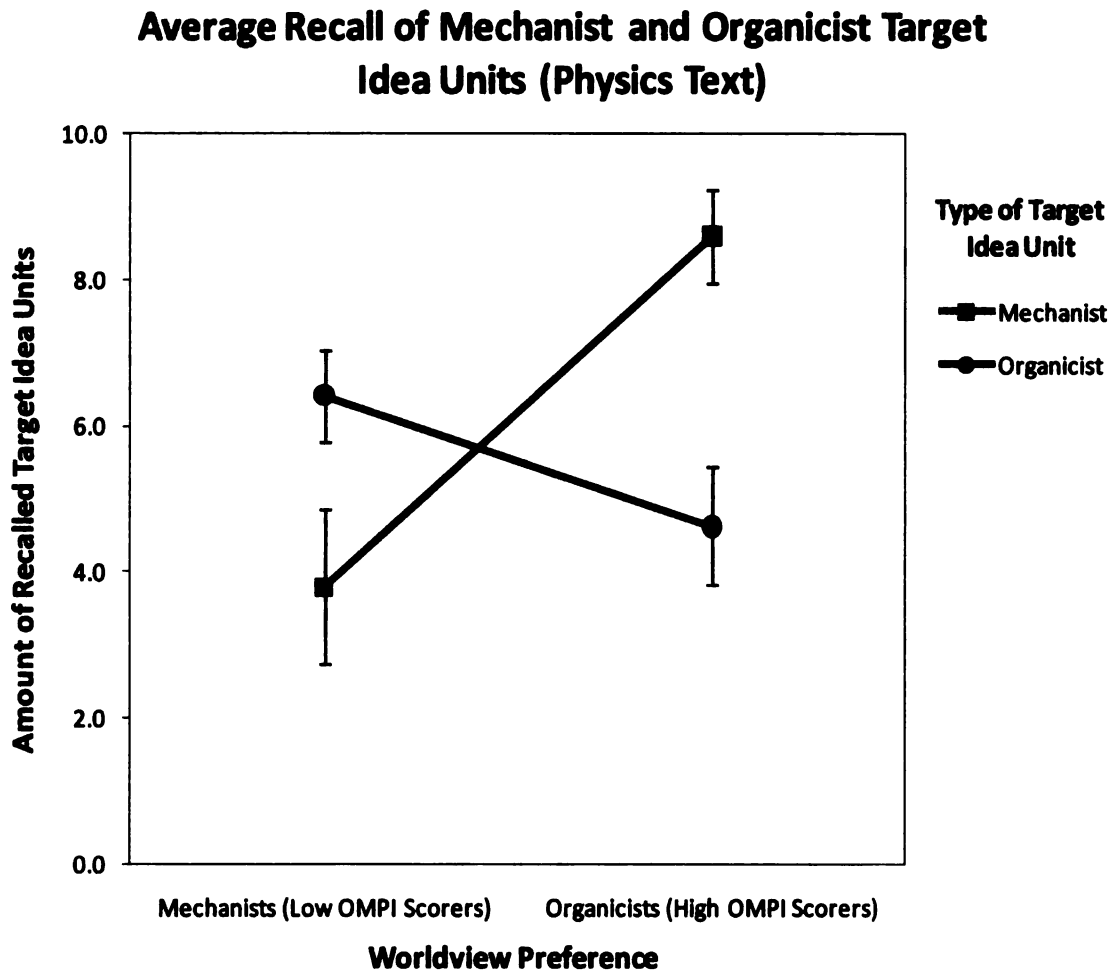*Figure 9.* Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of Recalled Paragraph (Mechanist, Organicist) from the History text. Paragraphs are counted as "recalled" when a participant accurately recalls two or more target idea units from the paragraph. The interaction is significant, $F(1, 52) = 17.0, p < .001, \eta_p^2 = .25$.

Average Recall of Mechanist and Organicist Target Paragraphs (Physics Text)
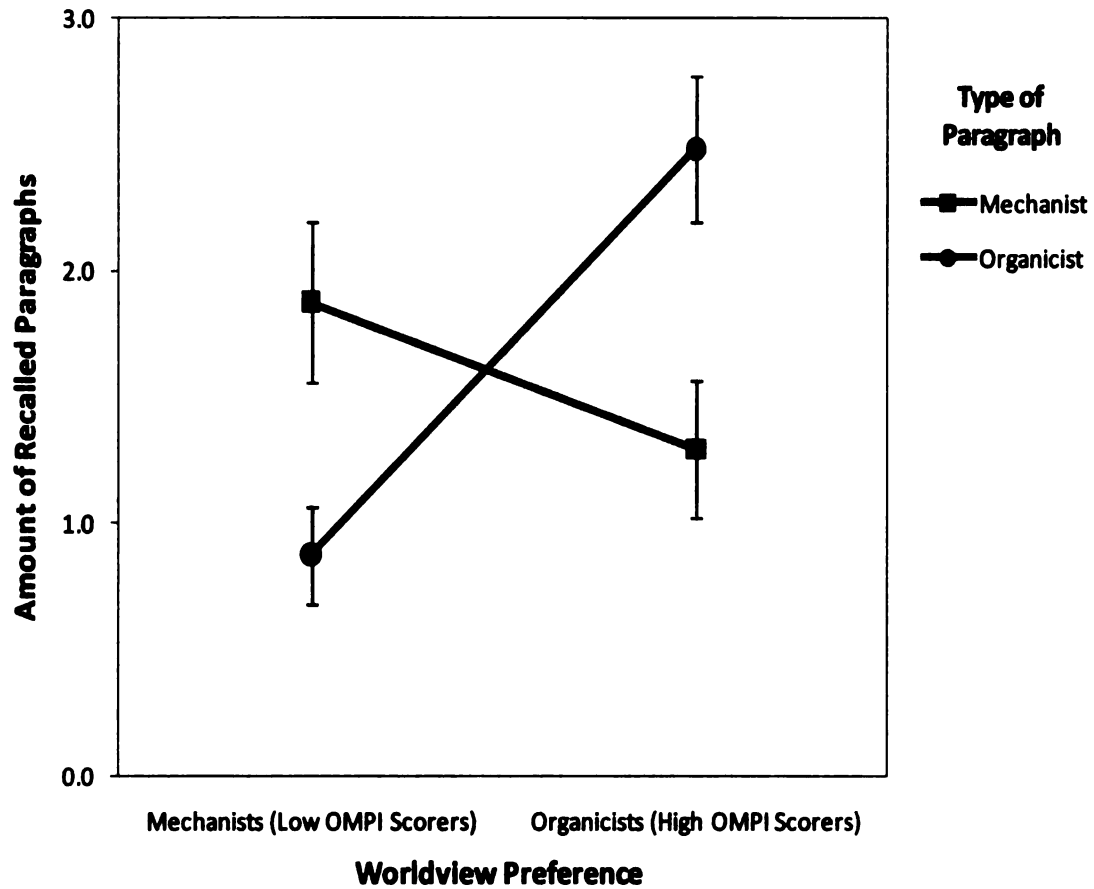
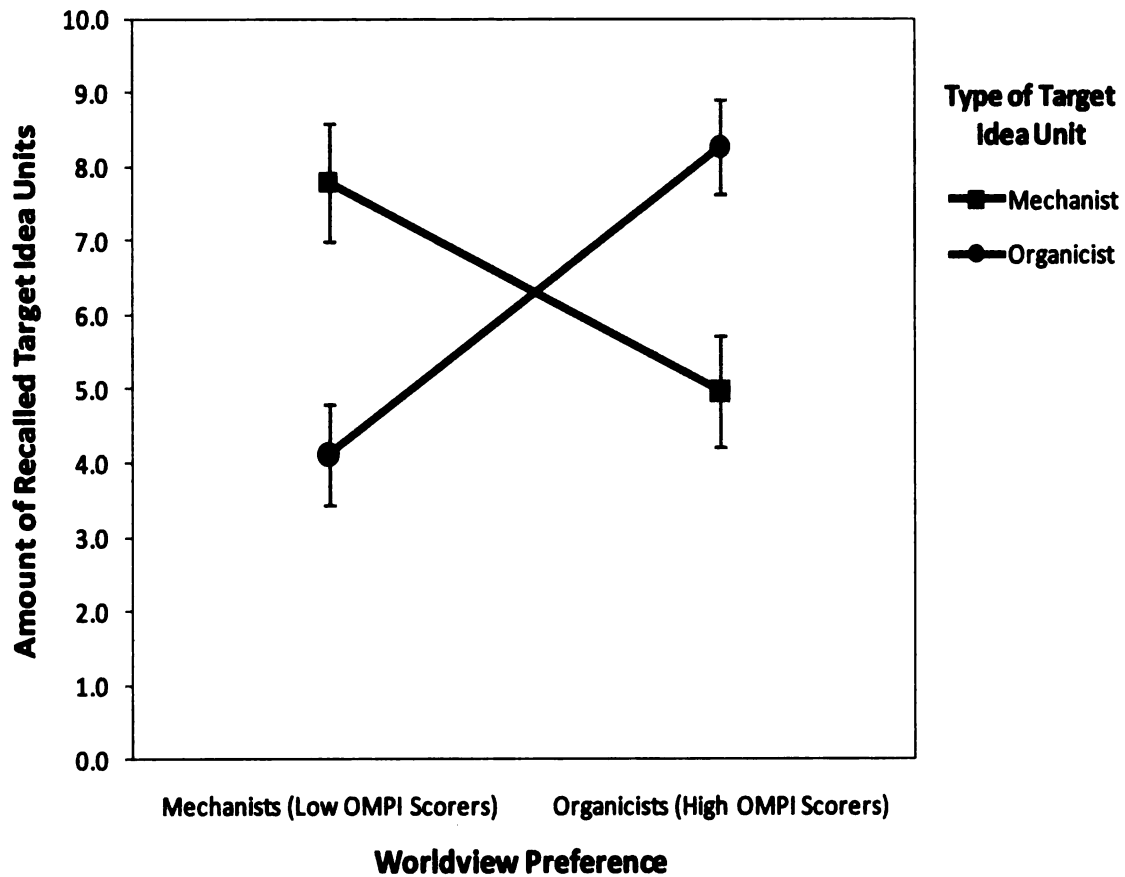*Figure 10.* Graph of the interaction between participants' worldview preference

(Mechanists, Organicists) and type of Recalled Paragraph (Mechanist, Organicist) from

the Physics text. Paragraphs are counted as "recalled" when a participant accurately

recalls two or more target idea units from the paragraph. The interaction is significant,

$F(1, 49) = 21.5, p < .001, \eta_p^2 = .31.$

Average Recall of Mechanist and Organicist Target Paragraphs Across Texts
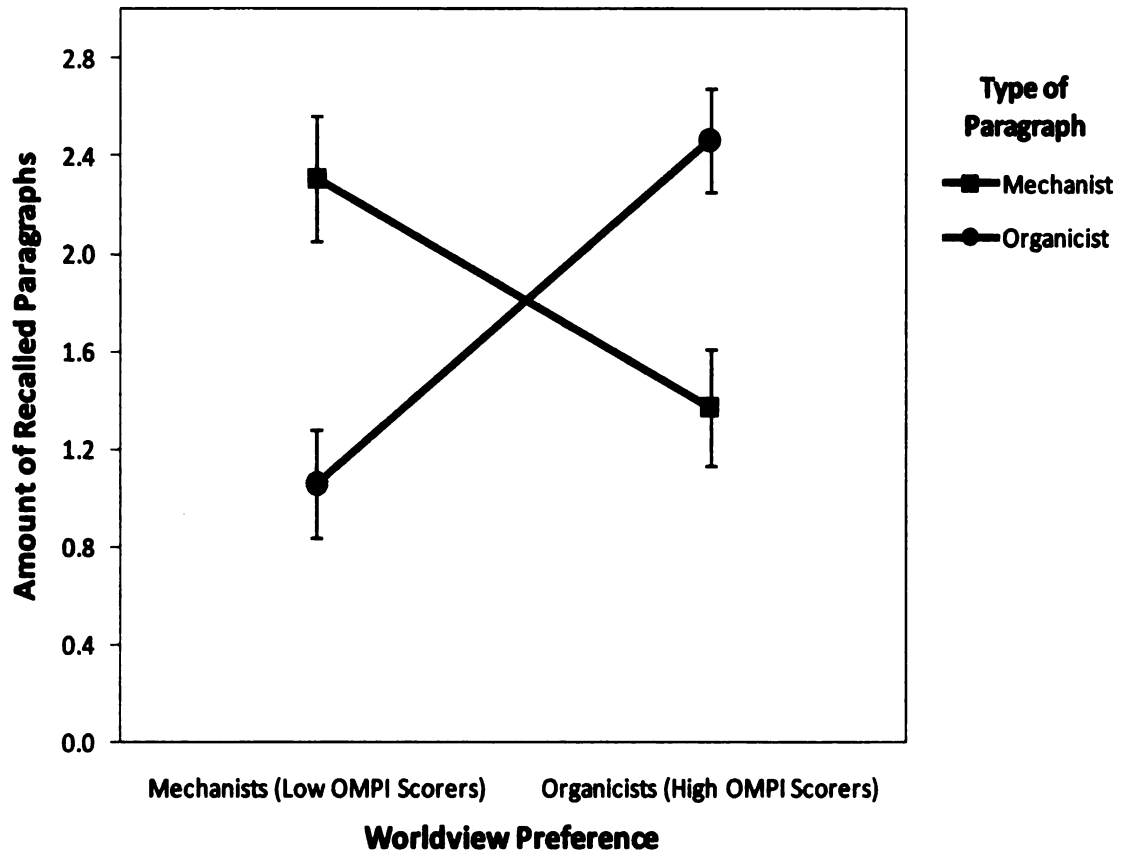
Figure 11. Graph of the interaction between participants' worldview preference (Mechanists, Organicists) and type of recalled target paragraph (Mechanist, Organicist) across both texts and evaluated with vocabulary score as a covariate. The interaction is significant, $F(1, 48) = 28.5, p < .001, \eta_p^2 = .37$.

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APPENDIX A:
SUMMARY OF TWO PAPERS BY R. C. ANDERSON AND COLLEAGUES

Anderson, et al. (1977)

In the Anderson et al. study (1977), two ambiguous texts were created. The first was a text that was normally interpreted as a prison break, but could be alternatively interpreted as a wrestling match. The second text was normally interpreted as a group of friends playing cards, but could also be viewed as a wind ensemble practicing. Wrestlers, music players and a control group were selected to read both texts, take two vocabulary tests and then answer a set of multiple choice questions about the two texts. It was found that wrestlers were more likely to answer questions about the prison break text as if it was about wrestling and musicians were more likely to answer questions about the card playing text as if it was about practicing music. Furthermore, it was found that participants' assumptions about the texts often precluded them from even noticing that the texts could be interpreted alternatively as a prison break or card game.

Pichert, J. W., & Anderson, R. C. (1977)

In the Pichert and Anderson study two texts were created for participants to recall. One was about a boy showing his friend around his family's house and the other was about two birds flying over an island that described what the birds were seeing. Participants in the house story were divided into three groups. The first group was to read the story as if they were burglars. The second group was to read as if they were realtors and the third control group was given no prior identity with which to read the story. In the island story, the first group was to read as if they were a florist, the second group was to read as if they were shipwrecked and the third group was a control given no prior

identity with which to read the story. The stories were broken up into "idea units" according to which perspective they espoused (burglar, florist, etc.). Participants were then asked to work on a Wide Range Vocabulary Test (French, Ekstrom, & Price, 1963). After the vocabulary test participants had to recall as much of the story as possible with as much accuracy as possible. Scoring was based on recall of individual idea units. Inter-rater reliability was achieved by two raters sampling a portion of the free recall protocols. The main finding was that participants who were assigned to read as burglars recalled more "burglar" idea units, realtors recalled more "realtor" idea units, florists recalled more "florist" units and botanists recalled more "botanist" idea units. In other words, the schemata with which participants were asked to read the story affected the content that they later recalled.

APPENDIX B:
ORGANICISM MECHANISM PARADIGM INVENTORY

This is a questionnaire about how people relate to their world. Listed below are pairs of statements concerning thoughts, attitudes, and ways of behaving.

Please read each statement carefully and find the one which pertains to you more closely. No statement is more "correct" than the other.

Please answer all items, but circle only one statement ("a" or "b") in each pair.

---

1) a. Schools should be where a child learns to think for him/herself.

b. Schools should be where a child learns basic information.

2) a. Things really look different if we change how we see them.

b. Things really look different only if they are changed.

3) a. Organisms change by forces from outside themselves.

b. Organisms can change themselves.

4) a. A good judge is purely objective.

b. A good judge is not objective and knows it.

5) a. Great discoveries come from scientific imagination.

b. Great discoveries come from scientific experimentation.

6) a. All things stay basically the same over time.

b. All things change from one moment to the next.

7) a. A business executive needs time to analyze the facts.

b. A business executive needs time for creative thinking.

8) a. Before making a big decision, I like to sleep on it.

b. Before making a big decision, I like to get all the information.

9) a. Progress in science occurs when there is a new way of looking at events.

b. Progress in science occurs when an important observation is made.

10) a. A criminal is just a burden to society.

b. A criminal has a function in society.

11) a. Our knowledge is limited by our observations.

b. Our knowledge is limited by our imagination.

12) a. Living is a process of using up the available supplies.

b. Living is a process of exchanging supplies back and forth.

13) a. Events are sometimes just the same as before.

b. Events are always new and different in some way.

14) a. Divorce is often a phase in each partner's growth.

b. Divorce is usually the result of incompatible personalities.

15) a. Facts are more useful than a good idea.

b. Facts are less useful than a good idea.

16) a. Each relationship I have is different.

b. Each relationship I have is much like the previous one.

17) a. Things are changed only when they are directly affected.

b. Things are changed by everything else.

18) a. We learn by carefully examining individual facts.

b. We learn by finding order in an array of facts.

19) a. To live independently of other people is not a realistic goal.

b. To live independently of other people is a realistic goal.

20) a. War can be understood by examining what purpose it served.

   b. War can be understood by examining its causes.

21) a. The world is like a large, living organism.

   b. The world is like a large, complex machine.

22) a. A child discovers the world by being praised and punished.

   b. A child discovers the world by testing his/her dreams and fears.

23) a. I can change things in my family only by planned action.

   b. I can change things in my family just by being who I am.

24) a. A child's world is different from mine.

   b. A child's world is like mine, but he/she knows less.

25) a. Persons are made by their environments.

   b. Persons and their environments affect each other.

26) a. To resolve a family dispute, it is important how we look at the facts.

   b. To resolve a family dispute, it is important to discover all the facts.

The first paragraph in each text was considered an introductory paragraph and was not included in any analyses involving counts of paragraphs or counts of target idea units. All subsequent paragraphs were either written to portray a mechanist worldview or an organicist worldview. For the reader's convenience, organicist paragraphs in each text have been italicized. These paragraphs were not italicized when presented to participants.

History Text

Instructions. Please read the following text about the French Revolution. Read it carefully. You will be asked about this text later but will not be able to refer back it. There is no time limit for reading this text. When you are finished let the researcher know and he will tell you what to do next.

The French Revolution

The French Revolution occurred during the waning years of the 18th century. It is difficult for the revolution to be bounded by specific dates because its causes and effects are complex and can be tracked much further beyond the specific occurrences of the time period. Despite the complex nature of the French revolution, many historians can still agree on a large body of facts and events that should be included as part of the revolution. The following paragraphs are meant to give you a taste of some of those facts and events.

The French Revolution can very effectively be seen through the lens of politics. However, the political spectrum of revolutionary France cannot be simply reduced to the two major parties during the conflict consisting of the Girondins and Jacobins. To do so

neglects the wide array of opinions and allegiances held by the people. It also neglects the fact that opinions and allegiances changed as the events of the revolution unfolded. This can be exemplified by the Parisian crowd who stormed the Bastille would be heard only two weeks later crying out "long live the King!" in admiration of Louis XVI for accepting the revolutionary flag.

A majority of the group of Parisians involved in the storming of the Bastille were called sans-culottes. These were very poor Parisian laborers who had been exposed to some of the harshest economic consequences brought about by inept ruling aristocracy, the clerical land tax, years of prolonged war and general famine.

The storming of the Bastille represented for the sans-culottes all that they felt they were fighting for. The details of the events that surround the fall of the Parisian fortress can all be understood in reference to their plight. The fortress was a symbol of royal power and demolishing it was also a symbol of throwing down that power to make way for a new order.

King Louis XVI is identified as the king who ruled France during the onset of the revolution. In 1789 he called for the Estates General to help shore up France's financial burdens. The Estates General was an assembly of representatives from the three classes of society recognized in France which comprised of the nobility, the clergy, and the common people. This move directly led to his dramatic loss of power over a period of only a few months. His fall from power continued until he was eventually executed for treason via the guillotine.

Another prominent figure in the French revolution was the King's wife Marie Antoinette. Interestingly there is no legitimate proof that she ever made the famous

statement, "let them eat cake" in reference to the poverty of the French people. In fact, it

can be argued that the Queen was more suited to understand the plight of her people

better than any other monarch due to her upbringing in Austria. Even from a young age,

she was chronically misunderstood and devalued by those who were put in positions of

authority over her.

Any discussion about the French Revolution would not be complete without a

discussion about the guillotine which gained its fame and name from this time period.

The guillotine was an execution device that worked by decapitating the heads of its

victims. The machine was originally seen as a replacement for more tortuous forms of

execution. It was made the official means whereby executions were performed in France

in 1791. This allowed it to be firmly established as the standard form of capital

punishment by the time the "reign of terror" occurred two years later.

The formation of the Estates General can be viewed as the embodiment of the

change that was being called for not only politically, but socially and economically as

well. Though the Estates General was initially organized to give more representative

power to the nobility and clergy, the lower class of people purposed that it would serve

their needs for change.

When the nobility and clergy took measures to keep the balance of power in their

favor the third estate (representatives of the lower classes) responded by unilaterally

changing the representative makeup of the Estates General and renaming themselves the

National Assembly. This move by the third estate led King Louis to close the hall where

the National Assembly was meeting. The National Assembly responded by moving to a

nearby tennis court where an oath was made not to separate until a constitution was created.

At one point before the constitution was fully established the King and his family attempted, and ultimately failed, to flee Paris to begin a counter revolution in Montmedy. The failure underscores the chronic indecisive nature of Louis XVI. It can be said that the indecisiveness of Louis XVI contributed to nearly all of the early events of the French Revolution. Therefore, a better understanding of the revolution can be gained by viewing it through the long list of Louis' poor decisions.

The completed constitution called for a constitutional monarchy which called for a legislative assembly to rule France with the king retaining the right to veto. The combination was an absolute failure due to the king vetoing most of the radical measures proposed by a very inexperienced legislative assembly. This combination led to a penniless country, a weakened military and a nation in social disarray. All these issues led to a call for a new constitutional convention which quickly abolished the monarchy and set the stage for the eventual period known as the reign of terror.

The reign of terror was the period of time in revolutionary France where the political and social ideals of the enlightenment were allowed to come to full maturity. Led by political extremists and upset Parisian commoners, tens of thousands were executed. The backgrounds and motivations for being executed varied across political, social and economic boundaries. However, each execution was sanctioned by those who wielded the power as necessary for protecting France from enemies of the revolution.

An important revolt against the revolution occurred in the Vendee region of France around the beginning of the reign of terror in 1793. This was due to the fact that

the nobility and clergy were less resented and because the amount of military presence supporting revolutionary policies was reduced in this area. The revolt was ended three years later by an overpowering use of force on the men, women and children of this region.

Robespierre was one of the main leaders during the time known as the reign of terror. His education in the enlightenment and his strict adherence to its teachings about a virtuous society bound him to rule over this time. In fact, despite his gruesome use of the guillotine, he was seen as "virtuous" due to how closely he ruled his life according to enlightenment principles.

On July 9, 1794 two reign of terror leaders, Robespierre and Saint-Just, were confronted and finally attacked by other members of the committee of public safety for abusing their executive powers. Without a trial, these men were executed along with many of their closest associates. The effect was to temper some of the most extreme practices of the revolution. This part of the French Revolution is known to us today as the Thermidorian reaction.

Financial turmoil in France was at the heart of nearly all the events surrounding the French Revolution. Grievances against the clergy and nobility were due to the fact that both groups imposed taxes upon the common people. It can be said that the French Revolution likely would not have happened if the financial circumstances had been better. It was also one of the principal reasons that Napoleon was able to come into such power in such a short amount of time.

Napoleon's rise to power can be described as a direct result of the political and social unrest that unfolded around him. A corrupt government encouraged him to expand

his military exploits, and this self same corruption also led the French people to become disillusioned with the ruling class. Therefore, when he led a successful military coup, the people were ready to follow him.

Physics Text

Instructions. Please read the following text about quantum mechanics. Read it carefully. You will be asked about this text later but will not be able to refer back to it. There is no time limit for reading this text. When you are finished let the researcher know and he will tell you what to do next.

Quantum Mechanics

Quantum mechanics is a relatively new branch of physics that describes how the smallest parts of our world work. The topics in quantum mechanics are easier to break down than you might think. However, it is more difficult to explain how the consequences and purposes behind quantum mechanics have changed how scientists view the world. The following paragraphs are meant to give you a taste of some of the most relevant facts, events, and implications that explain quantum mechanics.

Before quantum mechanics was classical mechanics. Its basic details were worked out by Isaac Newton and then improved upon by countless physicists over the next 300 years. Classical mechanics was and still is a very powerful theory when it comes to explaining how the world works. By the end of the 1800's many physicists felt that nearly every part of nature could be described by classical mechanics. If a physicist could determine the factors involved in a problem, they could explain quite accurately how those factors would interact.

Quantum mechanics originated as a means to describe the smallest things in the universe like atoms and light that were not described well by classical mechanics. Physicists are able to use organizing principles in quantum mechanics to show common properties behind a large diversity of known particles. Also, particles that do not fit current quantum mechanical theories force physicists to rethink how they look at all the rest of the particles known to them.

One particle that is less familiar to most people is the neutrino. Neutrinos are a natural product of radioactive decay. There are three masses of neutrinos depending on the kind of decay that is happening. Once they are created, they have the strange property of shifting between these three masses over time. In other words, over a known time interval a neutrino may be lighter or heavier than what it was when it was originally created.

A very famous experiment in the development of quantum mechanics was the double slit experiment. It was originally interpreted as evidence that light had wave-like properties. However, a quantum mechanical understanding of the universe shifted the way physicists understand this experiment. It is now interpreted as evidence that light can be seen either as a wave or as a particle.

The double slit experiment relied on a property of light called superposition which refers to the ability of any wave to either amplify or cancel out when it overlaps with another wave. This same thing is important for solving quantum mechanics problems and is specifically called "quantum superposition." When dealing with a problem in quantum mechanics physicists will break down a problem into its possible

"quantum states" and determine what will happen based on the ability of these states to amplify or cancel each other out like overlapping waves.

Another powerful idea in quantum mechanics that should not be forgotten is the Heisenberg uncertainty principle. This principle states that the more someone knows about a particle's position the less they can know for certain about its momentum and vice versa. This is because the very measurements we take on particles change their initial positions and momentum. This means that our ability to observe the world is not wholly independent from how the world works. One could even say that at least at a very small scale we can change the world based on our interactions with it.

In quantum mechanics there are four basic forces in the universe called the gravitational force, electro-magnetic force, weak force and strong force. Many physicists have theorized that extremely high energies would cause these different forces to lose their distinctive properties. So far, they have been able to show what conditions in nature would cause three of the four forces to combine.

Albert Einstein worked on showing how forces combine and his way of thinking about all physics problems was always the same. He felt that any good theory had to describe what was actually being observed in experiments. If a theory just estimated what was occurring in nature, it needed to be revised and improved. This view of physics led him to think about what the most fundamental laws in nature were. It also forced him to shift his understanding of physics enough "discover" the theory of relativity.

Relativity is often seen as a different topic from quantum mechanics. It deals with the strange effects on length, time, and mass as objects approach velocities near the speed of light. Quantum mechanics is instead focused on explaining physical properties at

atomic and subatomic levels. Physicists who specifically study subatomic particles traveling near the speed of light would need to know facts from both relativity and quantum mechanics.

Paul Dirac was a physicist who combined quantum mechanics with relativity. He was a brilliant mathematician and very methodical. Despite being described as boring and very asocial, his motivation behind his work was based on the pursuit of beauty. To him a well constructed mathematical equation was not good enough to be correct; it also had to have a sense of beauty to it. Dirac's work and motives for engaging in physics are a prime example of the pleasure to be found in the field of physics.

Another important physicist from the field of quantum mechanics was Richard Feynman. He came up with a way to diagram complex behaviors of subatomic particles that are otherwise very difficult to imagine. Although his work may sound quite complex, it was directly affected by a much more familiar event. The mathematics he used in his Nobel prizing winning work was originally developed during a time in his life when he studied the physics behind rotating, wobbling dishes!

Quantum mechanics has often been called "unintuitive" based on the strange predictions that it makes and entanglement is one of those predictions. When two or more particles are "entangled" they cannot be completely described individually even if they are separated by large distances. This makes the strange prediction that any change made to one of the particles must immediately affect the other as if the particles were "communicating" faster than the speed of light which is not supposed to be possible.

Another strange effect in quantum mechanics is called tunneling. This happens when particles are able to "jump" over barriers that they normally should not be able to

cross. For example, an electron travelling through a specific circuit on a computer chip can sometimes mysteriously jump over onto another circuit that is close by. This effect is no mystery for physicists. They can tell you the exact conditions that will make it happen and the frequency with which it can be expected to occur.

One "founder" of quantum mechanics who struggled with accepting strange quantum mechanical findings was Max Planck. He at first scarcely believed his own research, but despite his disbelief, he continued to work with the results. This is a perfect example of his purposeful and methodical approach to life which he often termed "persevere and continue working." This same approach applied to how he dealt with family tragedies and difficulties caused by both world wars.

With so many strange predictions in quantum mechanics physicists have sought out general guidelines for how experiments should be interpreted. One of these interpretations is the Bohm Interpretation. Quantum mechanics often uses probability to explain how the world works, but the Bohm interpretation says that these probabilistic explanations would go away if we account for the "hidden variables" that are not yet well known. According to this interpretation, once all the variables in nature are discovered, scientists will not have to rely on probabilistic results. They could theoretically determine the cause for every effect in the universe.

The most common interpretation of quantum mechanics is called the Copenhagen interpretation. This interpretation states that observations of quantum mechanical phenomena change predictably depending on how they are measured. For example if instruments are used to measure light as a particle, the light will manifest itself as a

particle. On the other hand, if light is measured for its wave-like properties, scientists will get wave-like data.

APPENDIX D:
FRENCH REVOLUTION AND QUANTUM MECHANICS BACKGROUND
KNOWLEDGE TESTS

French Revolution Background Knowledge Test:

Here are ten multiple choice questions intended to test your basic knowledge about

the French Revolution. Your score will be the number marked correctly minus a fraction

of the number marked incorrectly. Answer to the best of your ability. Circle only one

answer per question.

1. What are the three colors of the French flag adopted during the French

   Revolution?

   a. Yellow Black and Red

   b. Red Yellow and Blue

   c. Blue Red and White

   d. Red White and Green

2. Who of the following historic figures are <u>not</u> French?

   a. Joan of Arc

   b. Louis Pasteur

   c. Claude Monet

   d. Leo Tolstoy

3. Who was the French Revolution leader famously murdered in a bath tub?

    a. Sarkozy

    b. De Gaulle

    c. Sieyes

    d. Marat

4. Where was Louis XVI and Marie Antoinette's principle residence before they were forced to move to Paris during the revolution?

    a. Bordeaux

    b. Versailles

    c. Geneva

    d. Lille

5. Who were émigré's?

    a. Poor French commoners seeking a better life in other countries

    b. Poor foreigners within France who made economic times harder

    c. Wealthy French aristocrats seeking a better life in other countries

    d. Wealthy foreigners within France who made economic times harder

6. On what island was Napoleon born?

    a. Sardinia

    b. Elba

    c. Corsica

    d. Haiti

7. Which of the following works of fiction is <u>not</u> set during the French Revolution?

    a. Hunchback of Notre Dame

    b. The Scarlet Pimpernel

    c. Ninety Three

    d. A Tale of Two Cities

8. Which was <u>not</u> a cause for high food prices at the beginning of the French Revolution?

    a. High taxation

    b. A recent black plague outbreak

    c. The cost of the Seven Years War

    d. Widespread and longstanding famine

9. Which of the following foods is from France?

    a. Dim Sum

    b. Borscht soup

    c. Poy

    d. Brie cheese

10. What is meant by the term Ancien Regime?

    a. An ancient ancestral myth about the Gauls

    b. A political club established during the revolution

    c. The French social and political system before the revolution

    d. The ideal political state hoped for by revolutionary Frenchmen

Quantum Mechanics Background Knowledge Test:

Here are ten multiple choice questions intended to test your basic knowledge about quantum mechanics and physics in general. Your score will be the number marked correctly minus a fraction of the number marked incorrectly. Answer to the best of your ability. Circle only one answer per question.

1. How many laws of motion did Newton come up with?

    a. 2

    b. 3

    c. 4

    d. 5

2. What are the three basic particles that make up an atom?

    a. Electrons, Neutrons, and Protons

    b. Protons, Photons, and Nucleotides

    c. Neutrons, Electrons, and Platelets

    d. Quasars, Nucleotides, and Photons

3. What symbol do physicists use for Planck's constant?

    a. μ

    b. k

    c. h

    d. λ

4. What happens to the length of an object in the direction it is travelling as it approaches the speed of light?

    a. It gets longer

    b. It gets shorter

    c. It stays the same

    d. None of the above

5. What is electromagnetic radiation?

    a. A kind of radiation emitted by accelerated electrons

    b. Light

    c. X-rays

    d. All of the above

6. Which of the following is <u>not</u> a real kind of particle?

    a. Camtons

    b. Fermions

    c. Hadrons

    d. Leptons

7. What does the "m" and "a" stand for in the equation F = ma?

    a. Momentum and Angle

    b. Length and Current

    c. Mass and Acceleration

    d. Weight and Speed

8. Which of the following has the shortest wavelength?

   a. Microwaves

   b. Infrared

   c. Radio Waves

   d. Ultraviolet

9. Who was the first to successfully explain the photo-electric effect?

   a. Albert Einstein

   b. Christiaan Huygens

   c. Isaac Newton

   d. Stephen Hawking

10. Which of the following is a unit of measurement for energy?

    a. Coulombs

    b. Farads

    c. Henrys

    d. Joules

APPENDIX E:
REVISED COGNITIVE FLEXIBILITY INVENTORY FOR LEARNING PHYSICS

For the reader's convenience, the organicist statement of each item has been italicized. These statements were not italicized when presented to participants. Un-italicized statements are mechanist statements. All statements and instructions are the same in the history version except that the word "physics" is replaced with "history."

Instructions

Listed below are 9 pairs of statements concerning thoughts, attitudes, and reasons for how we best learn physics. Read each set of statements carefully and mark the one that most closely aligns with how you feel physics should be learned. Please answer each set of statements even if you have never taken a physics course. No statement is more "correct" than the other.

Items

1) a. *Learning physics works best when it is self directed. Students should figure a lot of things out for themselves.*

   b. Learning physics works best under the guidance of experts (e.g., teachers). Everything should be made explicit to students.

2) a. *Different sub topics in physics should be highly interrelated in the mind in many ways so that students see the main physics principles over and over again.*

   b. Different sub topics of knowledge in physics should be compartmentalized in the mind so that students see how one sub-topic neatly builds off the other.

3)   a.   Explanations for two different topics in physics will be similar only when the causes surrounding each topic are the same.

      b.   *Explanations for two different topics in physics will be similar only when the application for each topic is the same.*

4)   a.   *Conflicting descriptions of a situation in physics are only tolerated if a similar underlying principle or purpose can be identified in both situations.*

      b.   Conflicting descriptions of a situation in physics are not tolerated because it indicates a limit to what is known about that situation.

5)   a.   Complex physics topics are best broken down into parts and studied separately. In most areas of physics, the whole topic is usually equal to the sum of its parts.

      b.   *Breaking down complex physics topics into separate parts so they can be studied separately is often misleading. In most areas of physics the whole is usually not the same as the sum of the parts.*

6)   a.   When previously learned physics has to be applied, people can come up with a plan for what they should do by remembering how a very similar example was applied in the same way.

      b.   *When previously learned physics has to be applied, people can come up with a plan for what they should do by remembering a general rule they have been taught.*

7)   a.   *Problem solving in physics generally tries to make you relate what you know to a single central vision and then to solve the problem from that central vision.*

       b.   Problem solving in physics generally tries to make you break down what you know into appropriate parts, and then to find the answer by recombining the parts in a new way.

8)   a.   Learning physics is essentially a passive process of receiving bits of information and remembering it accurately for later use.

       b.   *Learning physics is essentially an active process in which information is personally constructed and applied according to an individual's specific experiences.*

9)   a.   *You have probably learned a topic well in physics when you can see some single, more abstract, explanatory system or perspective in any of its various aspects.*

       b.   You have probably learned a topic in physics well when you can account for all of its various aspects using some abstract, explanatory system or perspective.

APPENDIX F:
GLOSSARY OF TERMS

Many of these terms are initially introduced in the text under the *Scoring* subsection of the *Methods* chapter. They are provided here in alphabetical order for quicker reference.

Alternative Worldview

The non-targeted worldview in a paragraph or target idea unit.

Accurate Recall

A recall unit that corresponds to one and only one idea unit from the text. In order for a recall unit be considered accurate, it must not only correspond to the content of the idea unit, but it must also have a similar organicism and mechanism rating. This is operationally defined as a recall unit whose difference rating differs less than three points from the corresponding idea unit. If a recall unit is accurate it assumes the corresponding idea unit's worldview ratings.

Ambiguous Recall (Ambiguities)

A recall unit that corresponds to content present in the text at the paragraph level rather than at the idea unit level. All ambiguities are assigned a mechanist and organicist rating. Also, the paragraph to which the ambiguity refers is also recorded. If a recall unit is so vague that it cannot be determined which paragraph in the text it is referring to, the recall unit is categorized as an importation. Ambiguities are considered "mechanist recall units" if their difference rating is less than or equal to negative two. If their difference rating is greater than or equal to two, they are considered "organicist recall units."

Finally, an ambiguity is considered a "neutral recall unit" if its difference rating is less than two and greater than negative two.

Difference Rating

A score ranging between -4 and 4 calculated by subtracting an idea- or recall unit's mechanist rating from its organicist rating. The more negative the difference rating, the more "mechanist" a recall- or idea unit is without any organicist influences. The more positive the rating, the more "organicist" the recall- or idea unit is without any mechanist influences.

Distorted Recall (Distortions)

When a recall unit accurately corresponds to the content of a specific idea unit in a text but not according to idea unit's organicist and mechanist rating. A distortion is operationally defined as a recall unit whose difference rating is greater than or equal to three points different from the difference rating of the corresponding idea unit. An "organicist distortion" is when the distortion's difference rating is greater than or equal to three points higher than the difference rating of the corresponding idea unit. A "mechanist distortion" is when the distortion's difference rating is less than or equal to three points lower than the difference rating of the corresponding idea unit.

Idea Unit

The smallest unit of analysis in the History and Physics texts for this study. An idea unit is operationally defined as a portion of text one clause in length reduced down in most cases to contain one subject and one predicate.

Imported Recall (Importations)

When a parsed recall unit does not correspond to any idea units in a text. Each importation is given a mechanist and organicist rating so they can be analyzed alongside other recall units. Importations are considered "mechanist recall units" if their difference rating is less than or equal to negative two. If their difference rating is greater than or equal to two, they are considered "organicist recall units." Finally, an importation is considered a "neutral recall unit" if its difference rating is less than two and greater than negative two.

Intended Worldview

The worldview that a target paragraph or target idea unit is intended to portray.

Mechanist Distortion

A distorted recall that has a difference rating at least three points *lower* than the difference rating of the corresponding idea unit.

Mechanist Paragraph

A paragraph in a text written to reflect a mechanist worldview.

Mechanist Rating

A rating of how strongly the content of an idea unit or recall unit reflects the mechanist worldview. The rating is based on a scale from one to five with five indicating an idea unit or recall unit that strongly reflects a mechanist worldview and one indicating that the idea unit does not reflect a mechanist worldview.

Mechanist Recall Unit

A recall unit whose difference rating is less than or equal to negative two.

Neutral Recall Unit

A recall unit whose difference rating is less than two and greater than negative two.

Organicist Distortion

A distorted recall unit that has a difference rating at least three points *higher* than the difference rating of the corresponding idea unit.

Organicist Paragraph

A paragraph in a text written to reflect an organicist worldview.

Organicist Rating

A rating of how strongly the content of an idea unit or recall unit reflects the organicist worldview. The rating is based on a scale from one to five with five indicating an idea unit or recall unit that strongly reflects an organicist worldview and one indicating that the idea unit does not reflect an organicist worldview.

Organicist Recall Unit

A recall unit whose difference rating is greater than or equal to two.

Recall Unit

Memory data from a participant that is one idea unit in length (i.e., one clause ideally reduced down to one subject and one predicate). Every recall unit is given a worldview rating and it is also assigned to one of four kinds of recall: (1) accurate recall, (2) ambiguous recall, (3) distorted recall, or (4) imported recall.

Target Idea Unit

The top six idea units in each target paragraph that most strongly reflect the intended worldview of the target paragraph. Target idea units were determined by

identifying the six idea units of a target paragraph with the strongest difference ratings in the direction of the intended worldview. Ties were decided by keeping the idea unit with the higher intended worldview rating. There are 48 mechanist target idea units and 48 organicist target idea units in each text.

Target Paragraph

Any of the eight mechanist and eight organicist paragraphs from the History and Physics texts. Of the 17 paragraphs in each text, 16 are considered "target paragraphs" wherein eight target paragraphs are written according to a mechanist worldview and eight are written according to an organicist worldview. The remaining paragraph is an introductory paragraph and it was written to not favor either mechanism or organicism. Target paragraphs are counted as "recalled" when a participant recalls two or more of its six target idea units.

Worldview Rating

Two independent ratings of an idea unit or recall unit according to how well it reflects characteristics from the mechanist and organicist worldviews. Each rating is on a scale of one to five with five indicating that the idea unit or recall unit strongly reflects the target worldview and a one indicating that the idea unit or recall unit does not reflect the target worldview.

PARTICIPANTS' SELECTIVE RECALL PATTERNS USING TARGET
PARAGRAPHS AS A DEPENDENT VARIABLE

This appendix records the results regarding the History and Physics texts'

structural similarity and participants' selective recall patterns at the target paragraph

level.

Structural Similarity of the Texts

Organicist Ratings. An independent samples t-test was performed to test

whether the average organicist ratings of History text idea units from *organicist*

paragraphs (N = 97), M = 3.43, SD = 1.14, was significantly different from the average

organicist rating of Physics text idea units from *organicist* paragraphs (N = 106), M =

3.25, SD = 1.20. The t-test concluded that there is no significant difference [t(201) =

1.08, p = .28]. An independent samples t-test was also performed to test whether the

average organicist rating of History text idea units from *mechanist* paragraphs (N = 100),

M = 1.54, SD = .689, was significantly different from the average organicist rating of

Physics text idea units from *mechanist* paragraphs (N = 104), M = 1.53, SD = .737. The t-

test concluded that there is no significant difference [t(202) = .112, p = .91].

Mechanist Ratings. An independent samples t-test was performed to test

whether the average mechanist ratings of History text idea units from *organicist*

paragraphs (N = 97), M = 1.45, SD = .646, was significantly different from the average

mechanist rating of Physics text idea units from *organicist* paragraphs (N = 106), M =

1.66, SD = .827. The t-test concluded that there *is* a significant difference [t(201) = 1.97,

p = .05]. An independent samples t-test was also performed to test whether the average

mechanist rating of History text idea units from *mechanist* paragraphs (N = 100), M = 3.50, SD = 1.00, was significantly different from the average mechanist rating of Physics text units from *mechanist* paragraphs (N = 104), M = 3.37, SD = 1.14. The t-test concluded that there is no significant difference [t(202) = .895, p = .37].

Research Question 1a Results

History text. A two-way mixed design ANOVA was conducted on the recall of target paragraphs from the History text with worldview preference (Mechanists [Low OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor and type of recalled paragraph (Mechanist, Organicist) as a within-subjects factor. Neither worldview preference, F(1, 52) = .352, p = .56, η_p^2 = .007, or type of recalled paragraph, F(1, 52) = .562, p = .46, η_p^2 = .011, produced main effects. However, there was a significant interaction between worldview preference and type of recalled paragraph, F(1, 52) = 17.0, p < .001, η_p^2 = .25, which supports the hypothesis proposed for research question 1a. A graph of this interaction is illustrated in Figure 9.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of recalled paragraph. These tests revealed that *Mechanists* recall significantly more Mechanist Paragraphs (M = 2.52, SEM = .386) than Organicist Paragraphs (M = 1.07, SEM = .244), t(23) = 3.37, p = .002. Furthermore, *Organicists* recall significantly more Organicist Paragraphs (M = 2.48, SEM = .322) than Mechanist Paragraphs (M = 1.48, SEM = .241), t(26) = 2.44, p = .02. These results are consistent with the proposed hypothesis for research question 1a.

Physics text. A two-way mixed design ANOVA was conducted on the recall of

target paragraphs from the Physics text with worldview preference (Mechanists [Low

OMPI Scorers], Organicists [High OMPI Scorers]) as a between-subjects factor and type

of recalled paragraph (Mechanist, Organicist) as a within-subjects factor. Neither

worldview preference, $F(1, 49) = 2.77$, $p = .10$, $\eta_p^2 = .05$, or type of recalled paragraph,

$F(1, 49) = .155$, $p = .70$, $\eta_p^2 = .003$, produced main effects. However, there was a

significant interaction effect between worldview preference and type of recalled

paragraph, $F(1, 49) = 21.5$, $p < .001$, $\eta_p^2 = .31$, which supports the hypothesis proposed

for research question 1a. A graph of this interaction is illustrated in Figure 10.

Paired samples t-tests were conducted to test the simple effects of the interaction

between worldview preference and type of recalled paragraph. These tests revealed that

Mechanists recall significantly more Mechanist Paragraphs ($M = 1.88$, $SEM = .320$) than

Organicist Paragraphs ($M = 0.88$, $SEM = .191$), $t(23) = 2.98$, $p = .007$. Furthermore,

Organicists recall significantly more Organicist Paragraphs ($M = 2.48$, $SEM = .289$) than

Mechanist Paragraphs ($M = 1.30$, $SEM = .271$), $t(26) = 3.60$, $p = .001$. These results are

consistent with the proposed hypothesis for research question 1a.

Research Question 1b Results

A three-way mixed design ANOVA (full factorial) was conducted on the recall of

target paragraphs with worldview preference (Mechanists [Low OMPI Scorers],

Organicists [High OMPI Scorers]) as a between-subjects factor, text (History, Physics) as

a within subjects factor, and type of recalled paragraph (Mechanist, Organicist) as a

within-subjects factor. As in the previously reported two-way ANOVAs for evaluating

research question 1a, there were no significant main effects for worldview preference or type of recalled paragraph. There was also no significant main effect for text although it approached significance, $F(1, 49) = 3.99, p = .051, \eta_p^2 = .08$. However, this marginally significant main effect was qualified by a significant interaction between worldview preference and type of recalled target idea unit, $F(1, 49) = 29.2, p < .001, \eta_p^2 = .37$, which was similar to the interaction effects found in the two-way ANOVAs used to answer research question 1a. The interaction between text and type of recalled paragraph was not significant, $F(1, 49) = .987, p = .33, \eta_p^2 = .02$, which is different from the three-way ANOVA that was used to evaluate participants' recall of target idea units as a dependent variable. All other main effects and interaction effects in the ANOVA were insignificant.

Re-evaluating participants' recall of target paragraphs via an ANCOVA with vocabulary score as a covariate eliminated the marginally significant main effect for text, $F(1, 48) = 2.06, p = .16, \eta_p^2 = .04$, whereas the interaction between worldview preference and type of recalled target idea unit, $F(1, 48) = 28.5, p < .001, \eta_p^2 = .37$, remained significant (see Figure 11 for a graph depicting this interaction). Also, the text by type of recalled paragraph remained insignificant, $F(1, 49) = 1.94, p = .17, \eta_p^2 = .04$, which is consistent with the proposed hypothesis for research question 1b. Besides introducing a vocabulary score main effect, $F(1, 48) = 7.67, p = .008, \eta_p^2 = .14$, all other effects remained insignificant as they were in the original three-way ANOVA with recall of target paragraphs as the dependent variable.

Paired samples t-tests were conducted to test the simple effects of the interaction between worldview preference and type of recalled target paragraph interaction from the three-way ANCOVA discussed in the previous paragraph using vocabulary score as a covariate. These tests revealed that *Mechanists* recall significantly more Mechanist Paragraphs ($M = 2.31$, *SEM* $= .255$) than Organicist Paragraphs ($M = 1.06$, *SEM* $= .224$), $t(23) = 3.77$, $p = .001$. Furthermore, *Organicists* recall significantly more Organicist Paragraphs ($M = 2.47$, *SEM* $= .240$) than Mechanist Paragraphs ($M = 1.37$, *SEM* $= .211$), $t(26) = 4.29$, $p < .001$. These data suggest that Peppers' worldviews are capable of affecting patterns of selective recall across two texts from different knowledge domains in similar ways which is consistent with the proposed hypothesis for research question 1b.

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