Beliefs and Discourse Processing

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Imagine two students studying the genetic influences on homosexuality. One student believes that homosexuality is genetically determined and the other believes it is not. A Google search returns articles with some headlines stating that homosexuality is and some that it is not genetically determined. Next, imagine that the students read the following section from an Introductory Psychology textbook (Lilienfeld, Lynn, Namy, & Woolf, 2014):

> "In another study, they found concordance rates for lesbians of 48 percent in identical twins and 16 percent in fraternal twins (Bailey, et. al., 1993). The finding that a substantial percentage of identical twins aren't concordant tells us that environmental influences play a key role in homosexuality, although it doesn't tell us what these influences are."

This text passage is inconsistent with the beliefs of both students to some extent because it suggests that both genetic and environmental influences are at play in determining sexual orientation.

In this chapter, we address several questions that arise in situations such as this. How do the prior beliefs of students influence the way in which they process this information? Will students comprehend information with more or less success if it matches or does not match their prior beliefs? Under what circumstances might students change their beliefs? Do students change beliefs in order to make them consistent with data reported in scientific studies, or are other factors at play? We also argue that the traditional methods and theories from text comprehension are well suited to examine the influences of beliefs on the processing students do and the mental representations they form when reading belief related texts.

Defining Beliefs

The literature on beliefs contains a number of review papers that define beliefs or discuss variations in definitions across fields (Ableson, 1979; Alexander and Dochy, 1994; Murphy & Mason, 2006; Southerland, Sinatra, & Matthews, 2001). Many definitions involve beliefs as things that a person wishes to be true based on some affective component. This approach borrows from Plato's distinction between a *belief* in which some claim is accepted without rational justification, versus *knowledge* in which the believer has justification and the claim is objectively true (Fine, 2003). This philosophical distinction is problematic for empirical investigations of belief formation/revision processes, because it confounds the variables of what a person believes with why they believe it, and involves a 3rd non-psychological variable of X actually being objectively true, which is not scientifically measureable independent of rational justification for believing it. In contrast, cognitive and educational science refers to knowledge in terms of mentally represented perceptions and ideas without regard to whether this knowledge is believed or accurate. For example, learners can acquire knowledge of fictional creatures and make hypothetical predictions about their survival without actually believing in the existence of these fictional creatures (Jee and Wiley, 2014).

We confine our definition of these constructs to distinct psychological states and distinguish them from epistemic and psychological processes that give rise to them. We define knowledge as mental representation of concepts or propositions about relations among them. In

contrast, we define belief as a position about the truth value of a proposition (Griffin & Ohlsson, 2001; Quine & Ullian, 1970; Wolfe, Tanner, & Taylor, 2013). This makes beliefs independent of the actual truth or preponderance of evidence related to the proposition. Two important distinctions are relevant to our definition. First, beliefs are different from knowledge. A person can understand the principles of evolution that are taught in school (knowledge), but have a personal opinion that the information is false (belief). Second, beliefs are different from attitudes. More so than beliefs, attitudes are a focus in social psychology. They reflect valenced affective preferences toward something, but that preference might or might not form the basis of one's beliefs about that thing (Greenberg, Schmader, Arndt, & Landau, 2015). For example, many people who believe that the theory of evolution is true still have a negative attitude toward the theory and prefer that it was not true (Brem, Ranney, & Schindel, 2003). A similar distinction between beliefs and attitudes may exist for students' judgments about the genetic influences on homosexuality mentioned earlier. The belief-attitude distinction is important because the inherent affective nature of attitudes could make their role in text processing different from beliefs. However the literature on attitudes is more extensive than that on beliefs, so we do discuss research on attitudes where the tasks and findings are related to our questions.

Beliefs are a position on a question of fact, but they can arise from affective reactions. They can also follow from logical reasoning about knowledge and factual premises in the absence of emotional considerations. Beliefs can be logically contradicted or supported by factual premises, and a person following those logical implications may be compelled to hold a particular belief. Even with factual scientific subjects, beliefs can be based in either affective preferences or consideration of supporting information. Griffin (2008) developed a belief basis scale to determine the affective or evidence-based nature of beliefs for a subject within a topic. Example items include "I trust my heart and not my head on this topic." and "I considered the evidence that I'm personally aware of." These differences appear to be influenced by features of the specific topic (Griffin & Ohlsson, 2001) as well as dispositional individual differences across domains (Griffin, 2008). The basis of a belief represents what and how information was processed when a person arrives at a belief. Thus, belief-basis might impact what new information is processed, how it is processed, and what the outcomes (both learning and belief revision) of the discourse processing will be.

Discourse Comprehension

Our discussion of beliefs is placed within a context of research on discourse comprehension. Typically, the process of reading results in a mental representation of the information (McNamara & Magliano, 2009). According to Kintsch's prominent Construction Integration (CI) theory (Kintsch, 1998), comprehension begins with a construction phase in which components of a sentence are connected into a preliminary mental representation of what the sentence says. Some related knowledge is automatically activated and added to the preliminary representation. Next, an integration phase takes place in which mental activation spreads through this representation until it reaches a stable state. Relevant knowledge and important concepts remain part of the representation and are transferred to long-term memory

(LTM). Irrelevant knowledge and weakly related concepts are deactivated. The result is a mental representation in LTM of the text information, relevant knowledge, and inferences that have been generated.

But comprehension is not always typical. As Kintsch (1998) states, "Text comprehension depends as much on the reader and the pragmatic situation as on the text itself" (pp. 188). Readers can exert control over their comprehension processes by generating more elaborate inferences, forming opinions, thinking about how they might use the content, or other processes "beyond" simple memory of what they read. These processes vary based on the reader's knowledge and goals at the time they read (Rapp & van den Broek, 2005). The CI theory proposes that the mental representation of the text can be conceptualized as existing at three levels. The *surface structure* represents the literal wording of the sentences. The *textbase* represents the content of the text in the way the text describes it. This is the representation a reader would have if they only attempted to remember what they read. Finally, the *situation model* contains the textbase, but also the activated knowledge, inferences, and reactions to the text. The situation model describes not just what was said, but the broader situation being described by the text.

Several aspects of this process are potentially subject to belief influences. Beliefs and basic reasons supporting them are part of our LTM representation, and therefore individual differences in beliefs or belief-basis will result in differences in what knowledge gets automatically activated (Voss, Fincher-Kiefer, Wiley, & Silfies, 1993). Also, the affective basis of some beliefs could motivate controlled processing strategies that result in different situation models. For example, readers may attempt to argue against a position while they read (Kunda, 1990).

Comprehension research supports an important distinction between mental processes during reading and the resulting mental representation. We propose that methods of evaluating belief influences should be understood as addressing one of three aspects of comprehension. First, *processing* of information refers to the on-line mental processes readers engage in while they consume discourse (Graesser, Singer, & Trabasso, 1994). Measures of processing include reading times, think aloud protocols, or response times to probes presented during reading. Second, processing results in a *mental representation* in LTM (Kintsch, 1998). Mental representation tasks require a memory of the content (e.g., word recognition, free or cued recall), or potentially elaboration and integration of what was read (e.g., inference-verification-tasks, concept maps, explanatory essays). Performance on these tasks should rely on accurate memory or understanding of the text rather than the reader's personal opinions. Finally, *evaluation* refers to performance on tasks in which the subject provides a critical evaluation of the text content against either some external standard (objective) or their own beliefs and attitudes (subjective). Evaluative responses should not be taken as direct assessments of a mental representation. Optimal performance on objective evaluation tasks require accurate mental representations, but also require knowledge of and skill in applying the standards (e.g., evaluating the claim-evidence structure of a text). Subjective evaluation tasks often lack any requirement of accurate

understanding, mostly reflecting the readers' subjective reactions (e.g., pre/post beliefs or attitudes on the topic, thought listing) to whatever their mental representation is along with any demand characteristics.

Why Study Beliefs?

One motivation for studying beliefs is that people regularly encounter information that is consistent or inconsistent with beliefs. In educational settings, students read scientific information that is inconsistent with beliefs they may have developed outside of school. Adults consume belief-relevant information through both print and audio-visual media about topics such as history, science, or politics. These situations involve aspects of comprehension. People vary in their beliefs, knowledge, desire to maintain beliefs, motivations for engaging in belief related information, and affective responses to information. These influences will likely lead people to alter their processing and influence the mental representations they construct when encountering belief related information.

Next, we are interested in beliefs because society benefits from a scientifically-literate populace, and yet many people hold misconceptions about scientific topics. Students have inaccurate beliefs, such as that humans use only 10% of our brains (Taylor & Kowalski, 2004). People hold beliefs contradicted by scientific evidence (Sinatra, Southerland, McConaughy, & Demestes, 2003) as indicated by a number of recent Gallup polls. For example, among Americans, 42% do not believe in biological evolution, 9% believe that vaccines are more dangerous than the diseases they prevent, and 6% believe vaccines cause autism and another 52% are unsure, despite overwhelming evidence refuting these beliefs. Even in 2015, 35% of Americans do not believe that global warming is happening or will happen in their lifetimes, which is up from 25% in 2008. Discourse processing researchers can potentially help address these misconceptions by understanding why they are so often resistant to change.

Finally, beliefs can trigger affective reactions that change readers' goals to differ dramatically from assigned tasks or presumed goals. People often are resistant to changing their beliefs, either because they think beliefs should not be changed (Alexander & Dochy, 1994), or out of a desire to maintain a consistent sense of self (Aronson, 1968; Gawronski & Strack, 2012). Readers can process belief related information with a goal of reaching a certain pre-determined conclusion (Kunda, 1990). When beliefs contradict text content, readers can also experience a sense of psychological threat (Hayes, Schimel, Williams, Howard, Webber et al., 2015). Much of this research has not traditionally been undertaken by discourse processing researchers. In fact, the first edition of this Handbook (Graesser, Gernsbacher, & Goldman, 2003a) did not have a chapter on beliefs or related issues. In short, it is important to understand belief influences because they introduce a number of potential factors that can influence processing and mental representation of information.

Processing and Mental Representation of Information as a Function of Beliefs

How do beliefs influence what we do with discourse? Do we put more effort into understanding information that is consistent or inconsistent with beliefs? Do we remember information better if we believe or don't believe it? What factors mediate or moderate the

relationship between beliefs and comprehension? The distinctions between processing, representation, and evaluation are important in addressing these questions. For example, research suggests that inferences that connect clauses in a text are sometimes generated during processing, and other times generated after processing when readers are responding to questions about the text (Kintsch & Keenan, 1973; Noordman & Vonk, 1992). Reader knowledge, the demands of the task, and linguistic cues like sentence connectives can all influence these processes. If readers only tend to think further about what they read *because* they are responding to others' questions, it is important to understand that.

Processing of belief-consistent and belief-inconsistent information

In any research study, online processing measures can provide information about the effort subjects put into reading. However, processing changes may not have a direct or obvious relationship to the reader's mental representation or evaluation of the content. A reader can take longer, pause on a word, or reread more prior sentences either because they are struggling to form even a superficial representation, or because they are slowing down to generate inferences and create an elaborate situation model.

There are few studies that actually measure on-line processing as a function of belief in the text content. In one study, Kardash and Howell (2000) had subjects think out loud as they read a text about HIV as the cause of AIDS. They found that when subjects read belief-consistent content, they made more metacognitive comments about their understanding or lack of understanding of the content. Belief-inconsistent content triggered more disagreements with the content. The distinction between metacognitive comments and disagreements illustrates the point that processing effort needs to be further differentiated in terms of the type of effort readers are engaged in (i.e., to understand versus discount the text content). However, all subjects in the study believed that HIV caused AIDS, so the belief-inconsistent content was always arguing that HIV did not cause AIDS. Any seeming effect of belief inconsistency could be simply due to the different nature of the content itself, regardless of its relation to prior beliefs. Wolfe et al., (2013) measured sentence reading times for extended texts about evolution and TV violence. Reading times were analyzed as a function of the extent to which individual sentences were consistent or inconsistent with subjects' beliefs. Critically, belief-consistency was orthogonal to the person's or the text's position on the topic, because there were both believers and disbelievers on each topic who were randomly assigned to read either a pro or anti text. Results showed that subjects slowed down reading for belief-inconsistent sentences for the evolution topic but not for the TV violence topic. Off-line assessments of the mental representations showed that these reading times were not associated with readers' memory for the text information, suggesting elaboration (e.g., counter-arguing) was responsible rather than readers struggling to form a basic representation of belief-inconsistent information.

In terms of potential variables that moderate processing, some evidence suggests that the reason why readers claim to hold their beliefs influences how they process texts. Griffin (2008; Griffin & Ohlsson, 2001) showed that some people are more *evidence-based* and others are more *affect-based* in terms of the reasons they claim to hold particular beliefs. These belief-basis

differences are proposed to reflect qualitative differences in how people arrive at their beliefs (based on evidence vs. emotional reasons), and in how they process and evaluate new evidence relating to them. Belief-basis is measured with a self-report questionnaire, and is specific to a particular topic for each person. Wolfe et al., (2013) found that for texts about evolution, subjects' belief-basis moderated whether they focused on arguments while reading. Evidence-based subjects showed stronger evidence of argument-focused processing than affect-based subjects, particularly for sentences that were inconsistent with the overall position of the text. In an eye-tracking study, Griffin and Salas (under review) found that readers with more evidence-based beliefs about evolution spent longer reading both belief-consistent and inconsistent texts, which was partially due to them looking back more often and rereading previously read sentences. These reading time differences were found while controlling for prior evolution knowledge and their reading times and look-backs while reading on a different topic. Also, path model analyses suggested that while poor comprehenders more often reread prior sentences, these evidence-based readers actually had superior comprehension, suggesting they reread as a way to engage in elaboration and improve their understanding. More research on belief-basis is needed, but preliminary data suggest that subjects who claim to hold their beliefs because of evidence may put greater effort towards integrating new information with existing knowledge.

In a number of other studies, terms are used that might imply conclusions about text processing, but processing is either not measured, or is combined with other tasks. Terms such as *biased assimilation* (Corner, Whitmarsh, & Xenias, 2012; Munro & Ditto, 1997), *motivated reasoning* (Hart & Nisbet, 2012; Kunda, 1990), *message scrutiny* (Petty & Cacioppo, 1984) and *processing* (Clark, Wegener, & Fabrigar, 2008) might imply that readers alter text processing based on the match between beliefs or attitudes and text content. Despite these terms, these experiments do not measure processing as a function of beliefs.

Some lessons can be gleaned from studies examining processing of attitude-inconsistent (rather than belief-inconsistent) texts. In an oft-cited study, Edwards and Smith (1996) found that subjects spent longer processing attitude-inconsistent arguments about a range of topics compared to attitude-consistent arguments. This paper is cited as evidence that readers put more effort into processing attitude-inconsistent than consistent information. The task in Edwards and Smith's (1996) study was to read and rate the strength of a series of arguments. Reading times for argument premises were collected and reported as a function of text position, but never analyzed as a function of attitude-consistency. Reading times for argument conclusions were combined with the time it took to make the argument-strength judgment, which means the processing and evaluation components of the task cannot be distinguished. Similarly, Taber and Lodge (2006) and Taber, Cann, and Kucsova (2009) found that people with more general political knowledge or stronger prior attitudes spent longer reading and rating attitude-inconsistent arguments about political policies. They also did not separate reading times from evaluation response times.

It is common for these "effortful processing" results to be interpreted as readers being motivated to protect their attitudes, or to mentally generate arguments against the attitude-

inconsistent points as they read them. This conclusion is also reached, for example, in reasoning studies in which subjects list more thoughts about attitude-inconsistent arguments after reading (Munro & Ditto, 1997). Thought listing is an evaluation task, however, so it is possible that the influence of attitudes on thoughts takes place during post-reading thought generation rather than text processing. Thought listing also involves potential demand characteristics in which readers might consider it more relevant to note points of disagreement than agreement, especially since they just reported their own attitude. In addition, these attitude studies are often discussed, including by their authors, in terms of "belief" consistency effects. But the texts and the participants' prior positions dealt with attitudes regarding preference for various political policies, such as the acceptability of using the death penalty, corporal punishment of children, and taxation of junk foods. Unlike beliefs, such attitudes cannot be objectively refuted by arguments any more than a preference for chocolate can be shown incorrect. Beliefs may trigger different reactions.

Much more research is needed to understand the influence of beliefs on processing. There seems to be a common assumption that belief-inconsistent information is processed in greater depth, or more critically, compared to belief-consistent information. We find relatively little evidence supporting this conclusion. We emphasize a few points that researchers should pay attention to. First, a clear distinction between processing, mental representation, and evaluation should be adhered to when researchers make conclusions. Second, the relationship between different types of processing effort and their influences on representation and evaluation should be examined. For example, if readers slow down reading for particular types of information, or some readers slow down more than others, what is this increased effort being devoted to? A combination of processing and representation measures may be needed to interpret processing effects. Finally, researchers should be mindful that different topics could affect processing differently. Some researchers have suggested that beliefs or attitudes function like schemas, which are organized bodies of knowledge about specific topics (Maier & Richter, 2013; Pratkanis, 1989; Wiley, 2005). If so, we may expect beliefs to be automatically activated during comprehension. Voss et al., (1993) presented evidence that informal arguments activate associated attitudes and reasons. But for many topics, such as the genetic bases of homosexuality, it is not clear whether most readers have beliefs that are well developed enough to function in a similar fashion.

Mental representation of belief-consistent and inconsistent information

Do readers' mental representations of text information differ based on the match between their beliefs and text content? A more focused question has been addressed extensively in the attitude literature; do people remember attitude-consistent information better than attitude-inconsistent information? Meta-analyses have evaluated studies in which subjects read lists of arguments on each side of an issue, then recall the arguments (Eagly, Chen, Chaiken, & Shaw-Barnes, 1999; Eagly, Kulsea, Chen, & Chaiken, 2000; Roberts, 1985). The lists of arguments are likely to produce a textbase type of representation, not an integrated situation model. Topics include abortion, gay soldiers in the military, or communism. Two main findings emerge. First,

there does appear to be a small but significant attitude consistency advantage, in which attitude-consistent information is recalled better than inconsistent information. Second, there is large variability in this finding, and there appear to be several moderators of this relationship. Two significant moderators of the consistency advantage were that studies with topics that were highly relevant to the subjects showed larger benefits for attitude-consistent information, while more highly controversial topics showed smaller benefits of attitude-consistent information (Eagly et al., 1999). More controversial topics may produce greater processing for both sides of the issue, thus decreasing the attitude consistency advantage (Eagly et al., 2000). In one experiment on abortion attitudes, Eagly et al., (2000) found no difference in recall of attitude-consistent vs. inconsistent arguments. After reading, subjects listed more counterattitudinal thoughts than proattitudinal thoughts, which the authors interpreted as students putting more processing effort into counterattitudinal than proattitudinal arguments, although argument processing was not measured. The assumption that biased processing in favor of attitude-inconsistent information leads to a lack of overall memory differences cannot be evaluated without experiments that evaluate processing in more detail.

In comparison to the attitude and memory literature, studies that examine beliefs and memory have used more extended texts, and assessed textbase as well as situation model representations. Wolfe et al., (2013) found no difference in recall of information about evolution or TV violence as a function of belief consistency. Griffin & Salas (under review) found no belief-consistency effects for textbase or situation model representations (using both closed and open-ended assessments) of texts on the topics of evolution and racial differences in intelligence. Britt, Kurby, Dandotkar, & Wolfe (2008) found no relationship between agreement with simple arguments and memory for the arguments. Maier and Richter (2013) found stronger memory for text content that was belief-inconsistent, but a stronger situation model understanding for belief-consistent information. Their results were moderated by text order and blocked or alternating presentation format. However, this was another study in which the belief consistency of the texts was confounded with the text content itself; the belief-inconsistent texts always argued for the non-scientific viewpoints that global warming is not impacted by humans and that vaccines are useless and more harmful than helpful.

In an examination of belief-basis, Griffin and Salas (under review) found that the more a reader's prior beliefs about evolution or racial differences in intelligences were evidence-based rather than affect-based, the better they performed on situation model measures for texts on those topics, regardless of belief consistency. They replicated these effects and showed that they emerge even after controlling for on-line reading behaviors, topic knowledge, general thinking dispositions, and ability to comprehend texts on other topics. Wolfe et al., (2013) had subjects read a one-sided text, then a neutral text, then write a summary of the neutral text. Affect-based subjects wrote summaries that contained more biased content from the one-sided text compared to evidence-based subjects, who wrote summaries with more balanced content. The results suggest that evidence-based subjects created situation models that reflected an effort to understand both sides of the topic even when reading a one-sided text. Overall, there is little

evidence for the common assumption that belief-consistency directly impacts the quality of the mental representation or comprehension of discourse, but some evidence that belief-basis does have such effects.

Various accounts for the belief-basis effect exist. Kunda (1990) discussed how information processing can be guided by either accuracy goals or directional goals. Accuracy goals exist when the person seeks to understand the information and make their own views as accurate as possible. Directional goals exist when information is processed in a biased manner to reach preferred conclusions. Affect-based beliefs can be seen as the result of directional goals, whereas evidence-based beliefs result from accuracy goals that direct the person to first understand the information and its implications before evaluating it. Alternatively, Griffin and Ohlsson (2001) postulated that evidence-based beliefs mean the person has already gone through a reasoning process to some extent. This should create greater coherence among their relevant concepts and knowledge representations that better enable them to represent any new information they encounter. More research is needed to test between these alternative (though not mutually exclusive) accounts of the belief-basis effects.

Belief Change

One of the most important challenges in belief related research is to understand the circumstances under which people will change or revise their beliefs. In the first edition of the *Handbook of Discourse Processes*, Graesser, Gernsbacher, and Goldman, (2003b) argued that research on discourse processes should become more interdisciplinary, meaning that researchers collaborate across disciplines to create an integrated understanding or theory to explain the issue. Current research on belief change comes from researchers in social psychology, educational psychology, cognitive psychology, science education, communications, health, political science, and other fields. However, each discipline approaches it in their own way, making it multidisciplinary, but lacking the integration of interdisciplinary research. Several summaries of the multidisciplinary nature of research on belief change have been published (Dole & Sinatra, 1998; Murphy & Mason, 2006; Southerland, Sinatra, & Matthews, 2001; Vosniadou & Mason, 2012). In this section, we summarize research suggesting that people sometimes (but not always) change beliefs after exposure to new information. We describe factors that influence, mediate, or moderate the belief change process, and offer suggestions for how discourse researchers might contribute to this field.

It is well established that in laboratory experiments, subjects change beliefs after reading evidence or arguments suggesting they are incorrect. In many experiments, subjects first report beliefs (or attitudes) about a controversial topic, often in a separate session from the main experiment. Next, subjects read evidence or arguments on one side of the topic or the other (or both). Finally, subjects report beliefs or attitudes again, and often complete mental representation or evaluation tasks. Many of these studies show that on average, when subjects read evidence or arguments supporting a position, their beliefs change in the direction of the text position (Buehl et al., 2001; Clark, Wegener, & Fabrigar, 2008; Cobb & Kuklinski, 1997; Hart & Nisbet, 2012; Hayes et al., 2015; Kendeou, Walsh, Smith, & O'Brien, 2014; Murphy, Long, Holleran, &

Easterly, 2003; Petty & Cacioppo, 1984; Sinatra, Kardash, Taasoobshirazi, Lombardi, 2012; Slusher & Anderson, 1996). The picture of when beliefs change in response to evidence is complicated by a subset of studies that do not show reliable belief changes in response to belief-inconsistent evidence (Cobb & Kuklinski, 1997; Nyhan, Reifler, Richey, & Freed, 2014; Prasad et al., 2009). It is important to note that belief change is typically small and along a continuum, not a binary change from one belief to its opposite. Also, belief change is rarely measured in a separate session after a delay (Kendeou et al., (2014) and Slusher & Anderson (1996) are exceptions). In some experiments, subjects read evidence or arguments on both sides of the topic, which makes it unclear what belief change to expect.

Text factors in belief change

What aspects of a text affect belief change? Probably the most consistent set of findings deals with refutation texts (Hynd, 2001). In a refutation text, misconceptions about topics are made explicit, then refuted. This text format has been shown to result in greater change in readers' beliefs than texts that merely present the more accurate alternative conception without mentioning the misconceptions. An important caveat about the research on refutation texts, however, is that the majority of studies examining them use topics that are unlikely to challenge students' worldviews or deeply held beliefs. Students reduce misconceptions about topics such as the visual system, or correct basic conceptual errors such as believing that humans only use 10% of their brain or that ostriches hide their head in the ground (Kowalski & Taylor, 2009). Not only are such beliefs less likely to have a strong affective component, but they may lack coherence with relevant knowledge and stand largely isolated as trivia facts repeated often in pop-culture. Other prior beliefs refuted in these studies are "implicit", where a person might find a misconception intuitively appealing without having formed an explicit belief about it (e.g. "heavier objects fall faster".) It is an important topic for future research to examine whether refutation texts would be effective at changing beliefs about topics that are more central to students' worldviews such as evolution, vaccines, or climate change.

Argument structure is another text factor that impacts belief change. Slusher and Anderson (1996) had subjects read one of two texts that both explained that AIDS does not spread through casual contact. Only one text included a causal explanation about why that is the case, and this text led to more change in beliefs about AIDS transmission. Mediation analyses suggested that this greater change was due to greater memory for the causal text. Cobb and Kuklinski (1997) found that opinions changed more when subjects read easy to understand arguments than when the arguments were more complex. This pattern only held for the topic of free-trade, and not for health care.

Moderating factors in belief change

A moderating factor in belief change is one in which people differ on some characteristic that predicts greater or lesser amounts of belief change. Prior knowledge influences on comprehension success are well known; high knowledge readers generally comprehend information better than low knowledge readers (e.g. Spilich, Vesonder, Chiesi & Voss, 1979). However, readers with low knowledge on the topic may be more likely to change beliefs in the

direction of the text position. Nyhan, Reifler, & Ubel (2013) found that reading a text refuting the existence of "death panels" related to the U.S. Affordable Care Act led to reduced belief in such panels among readers with low knowledge of the topic but increased belief among readers with high knowledge. However, Buehl et al., (2001) found no difference in belief change about educational reform as a function of prior knowledge. Higher knowledge people may better understand the text and how it contradicts their belief, yet this knowledge can also make the texts' arguments insufficient to trigger belief change. The moderating effect of knowledge may itself be moderated by additional factors.

Mediating factors in belief change

A factor that serves as a mediator in belief change is one in which readers encountering belief-consistent or inconsistent information may have some sort of psychological reaction to the information, and that reaction, in turn, would influence potential changes in beliefs. One potential mediating factor in belief change is psychological threat. According to cognitive dissonance theory (Aronson, 1968; Festinger, 1957) and terror management theory (Schimel, Hayes, Williams, & Jahrig, 2007), when people encounter information that is inconsistent with beliefs that relate to important values the person holds, they may feel some level of threat or dissonance. Changing beliefs to better align with new information is one response that would reduce threat. For example, Hayes et al., (2015) had subjects read a belief-inconsistent text about evolution. Psychological threat was manipulated by subjects writing a short essay about their own mortality. Belief change was greater when threat was active at the time of the post belief reporting compared to when subjects had an opportunity to reduce threat before reporting post beliefs. Williams, Schimel, Hayes, and Faucher (2012) manipulated threat by having subjects write an essay about their own mortality (or a control essay). They found that readers under this mortality threat answered more conceptual questions about a belief-inconsistent evolution text compared to the low threat readers. The authors suggest that psychological threat triggers subjects to put extra processing effort into the text in order to defend their worldviews. Psychological threat is relatively unexamined by the discourse processing community, however. One important topic for future research is to examine the generalizability of this phenomenon beyond issues such as evolution, which is a topic that is likely to be centrally related to readers' worldview. For example, researchers who study refutation texts in science learning do not tend to discuss threat as a potential mechanism or explanation for their results.

Other experiments examine strategies that readers employ when faced with belief-inconsistent information but do not directly examine belief change. Most of these studies suggest reasoning strategies readers may employ in an effort to maintain current beliefs. For example, one response subjects may have to reading belief-inconsistent information about scientific topics is to lessen the extent to which the topic is considered something that is open to scientific study. Munro (2010) found that when subjects read evidence relating to stereotypes about homosexuality, those who read belief-inconsistent texts rated the topic as a whole to be less amenable to scientific investigation than subjects who read belief-consistent texts. Similarly, Friesen, Campbell, and Kay (2015) found that when highly religious subjects read an article on

the discovery of the Higgs-Boson particle that suggested religion is invalid, they altered their reasons for being religious to be more unfalsifiable. In another experiment, both opponents and proponents of same-sex parenting rated the issue as more unfalsifiable after reading an article that was inconsistent with their belief about the psychological outcomes of children of same-sex parents.

Awareness of belief change

When people change their beliefs after reading, do they have metacognitive awareness that their beliefs have changed? One way to determine this is to have people read a belief-inconsistent text that changes their belief, then have them recall their prior belief. Research on this question with scientific beliefs is sparse. But research on attitudes and behaviors suggest that recollections of previous attitudes and behaviors are highly biased by current estimates (Goethals & Reckman, 1973; Ross, 1989; Safer, Levine, & Drapalski, 2002). In the standard procedure, subjects rate an attitude about something in an initial session. Then subjects either learn some new information that may change their attitude, or time passes and attitudes change naturally. In a different session, subjects report their current attitudes again and recollect their previous attitudes. With topics ranging from bussing to achieve racial integration to anxiety about exam performance, results indicate that recollection of previous attitudes is biased towards current attitudes. These results suggest that when attitudes change, people may lack awareness that they have done so. In recent work, Wolfe, Williams, Geers, Hessler, and Simon (2014) found strong evidence of this memory bias with scientific beliefs about TV violence influences. Subjects changed beliefs towards the text position after reading a belief-inconsistent text. Recollections of previous beliefs were much closer to current beliefs than to actual previous beliefs. This preliminary evidence suggests that with beliefs about science topics, subjects may also lack metacognitive awareness of having changed beliefs.

Backfire/Polarization effects in belief change?

In a classic social psychology study, Lord, Ross, and Lepper (1979) found attitude polarization about capital punishment, where attitudes became more extreme and shifted away from the position supported by the texts. Munro and Ditto (1997) replicated that result with attitudes about homosexuality. These results are cited as "belief polarization" or "backfire" effects, and assumed to apply to beliefs. However, these seminal studies actually showed that only general attitudes (e.g., support for capital punishment) became polarized whereas prior beliefs about the specific claims that were targeted by the texts (e.g., capital punishment reduces crime rates) changed in the direction argued by the belief-inconsistent texts. When readers were later given additional texts that supported their beliefs and critiqued the belief-inconsistent research they had just read about, then they became more extreme in their beliefs. But this is not a "backfire" effect so much as selective use of mixed evidence. Subsequent research has either measured only attitude and not belief change (Hart & Nisbet, 2012; Taber et al., 2009), or belief change only in response to mixed evidence (Corner, Whitmarsh, and Xenias, 2012).

The studies supporting "backfire effects" have a particular methodology in common. In all cases, the effect only emerged when participants themselves subjectively rated the degree

their attitudes or beliefs changed over the course of the experiment. In fact, some studies show backfire effects for this *perceived change* measure, but found no evidence of it based upon the empirical difference between separate pre and post reading attitude ratings (Corner et al., 2012; Munro & Ditto, 1997; Munro et al., 2002). Given the evidence that subjects have poor metacognitive awareness of belief or attitude change, it is plausible that the backfire effect is a byproduct of incorrectly recalling prior beliefs or attitudes. On the other hand, demonstrating evidence of a more extreme pre-post change would be difficult if subjects are selected for experiments for their already polarized beliefs on the topics.

A final note about backfire effects is that they may not be consistent between beliefs about information and intentions to act on that information. Nyhan, Reifler, Richey, and Freed (2014) had one group of subjects read a text discrediting the link between vaccines and autism. After reading, these subjects overall did report lower levels of belief in the link between vaccines and autism. Within that group, however, subjects who were the most negative about vaccines to begin with reported *less* willingness to vaccinate their children than before reading. These results suggest that beliefs changed to be more consistent with text content, but intentions to act on those beliefs showed a backfire effect. The disconnect between beliefs and stated intentions to take an action is an important issue that should be studied more.

Theories of belief change

The Knowledge Revision Components (KReC) Framework of Kendeou and O'Brien (2014) addresses the updating of incorrect knowledge or misconceptions when new information is incorporated into a mental representation. One of the key components of the Framework is that, consistent with theories of memory, once knowledge is encoded into long-term memory, it does not get deleted or overwritten. As a result, new information and old information continually compete for mental activation. Another important assumption is that in order for new information to correct a misconception, the new and old information must be activated in working memory at the same time. This co-activation of new and old information in working memory is proposed as a key component in refutation texts' effectiveness at correcting misconceptions. The KReC framework, however, has been tested mostly with beliefs that either lack a strong affective component, or lack a rich network of knowledge related to the belief. With such beliefs it could be difficult (and perhaps irrelevant) to empirically distinguish between knowledge-revision (i.e., an updated mental-representation) versus belief revision.

Some models of knowledge/conceptual change are often applied as models of belief change. For example, Dole & Sinatra (1998) reviewed and integrated some of these models from social, cognitive, and educational, psychology (e.g., Posner, Strike, Hewson, & Gertzog, 1982; Thagard, 1992; Petty and Cacioppo, 1986) into the Cognitive Reconstruction of Knowledge Model (CRKM). Although Dole and Sinatra (1998) discuss "conceptions" as the objects of change, they also make frequent reference to "belief" and provide examples that entail a learner's personal beliefs on a topic being changed. According to the CRKM the likelihood of conceptual change after encountering inconsistent information is based on three factors. Prior

conceptions are less likely to change when they have greater *strength* (well formed), are more *coherent* and the person has a high level of *commitment* to the conception.

There is an important caveat when describing or evaluating theories related to belief change. Beliefs and knowledge as defined here are distinct mental states that can change independently, and thus must have partially distinct process models of how and when they change. In principle, (and likely in practice) conceptual change and knowledge reconstruction can occur in the absence of any belief revision. For example, a Biblical creationist who rejects evolution on an affective basis may have a prior misconception that evolution presumes that animals intentionally adapt their biological traits to suit their environment. Through instruction, they may realize their conception of evolution is incorrect and acquire a new conception of random variation and natural selection of traits. Such a change in the learner's conception of evolutionary processes would qualify as "strong conceptual change" under the CRKM. But the learner's disbelief in evolution may remain unchanged. In contrast, the same conceptual change could trigger a belief change and acceptance of evolution if the learner's prior disbelief was based in thinking that intentional adaptation is implausible, but they find their new conception for adaptive change more plausible.

Narrative texts and belief change

This chapter has focused on the relation between prior beliefs and processing of non-fiction expository/argumentative texts that explicitly make claims and arguments about the real world, in order to alter the reader's knowledge and beliefs related to those claims. Narrative texts tell stories of specific events, typically lacking any effort to connect to and alter readers' real world beliefs. Texts that do attempt to alter beliefs are expositional, utilizing the narratives primarily as rhetorical devices to support a more explicit argument (Wolfe & Mienko, 2007). For these reasons, the literatures on how prior beliefs relate to expository and narrative texts cannot be assumed to apply to one another.

Fictional events are generally free to vary without direct conflict with real world beliefs. Given that narratives lack general real-world implications, readers may limit how much they critically evaluate ideas and claims in narratives. This point is aligned with the notion that narratives trigger *a willing suspension of disbelief,* in which readers are *transported* into the narrative world, making aspects of their real world less accessible (Prentice, Gerrig, & Bailis, 1997). One implication is that this chapter's focus upon the impact of belief-consistency on text processing and comprehension is less relevant to narrative texts. Although recent research shows that the *plausibility* of inaccurate claims impacts their acceptance, plausibility is orthogonal to whether the claim is directly consistent with beliefs, instead reflecting the degree of latent-semantic overlap between various inaccurate claims and the accurate claim that is commonly believed (Hinze, Slaten, Horton, Jenkins, & Rapp, 2014).

Another implication of the transportation theory is that narratives could have a strong passive impact on belief revision, due to their claims being processed less critically and accepted within the local story context. This hypothesis is supported by research showing that readers' beliefs about even well established and widely accepted facts (e.g., seatbelts save lives) can be

weakened or altered by reading fictional narratives with events that run counter to these ideas (e.g., Prentice et al., 1997). Also, Jacovina, Hinze, & Rapp, (2014) found no reliable reading-time slow down when readers read blatantly inaccurate versus accurate historical claims (e.g., the South won the US civil war), so long as the preceding narrative context supported and foreshadowed that inaccurate claim. Thus, local narrative context can override the influence of prior beliefs on how readers process inaccurate information.

There is also support for a presumed passive mechanism whereby narrative claims are not evaluatively processed in relation to prior beliefs. Appel and Richter (2007) found that the impact of fictional narratives on prior beliefs increased after a two week delay, and that the effect was unrelated to dispositions toward more elaborative processing. Those findings support the idea that narratives impact beliefs via passive processes rather than direct persuasion. As readers forget the source of the information (fictional text), the isolated ideas that made their way into memory without critical examination now simply count as a piece of information that impact construction of a response to a belief prompt. In addition, Green and Brock (2000) showed that the degree of impact of narratives on beliefs was tied to readers' degree of "transportation" into the narrative, whether due to individual differences or contextual manipulations. Disrupting transportation by instructing readers to correct inaccuracies within narratives can reduce the impact of those inaccuracies on readers' beliefs (Rapp, Hinze, Kohlhepp, & Ryskin, 2014). In sum, narrative texts tend to be processed in a manner that reduces the impact of prior beliefs on that processing, and yet allows ideas within those texts to have a kind of back-door influence on beliefs.

Conclusions and Future Directions

Existing research on belief influences on comprehension and belief change has been characterized by multidisciplinarity, but not interdisciplinarity. Researchers from different fields study different topics, people, and types of tasks. Not surprisingly the results, conclusions, and even definitions of beliefs themselves are not consistent across the literature. We propose that one guideline for future researchers is to be mindful of the distinction between processing, mental representation, and evaluation as experimental tasks and levels of interpretation. In proposing these distinctions, we are guided by previous research on discourse processing, much of which is summarized in the chapters of this Handbook. In the remainder of the Conclusions, we suggest a few general issues and directions for future research.

In considering the research on processing of belief related information and belief change, there is a seemingly inconsistent pattern in the results and conclusions of these studies. The majority of studies that demonstrate belief change show that change happening towards the direction of the text position, suggesting that readers are partially persuaded by the text content to change beliefs. This change does not always take place, and when it does it is incremental rather than absolute. In terms of processing, however, the most common interpretation of the data (mostly from attitude studies) is that subjects put extra scrutiny or processing attention on information they do not agree with. It seems potentially contradictory to suggest that subjects put mental effort into discrediting information that is inconsistent with their beliefs, but are more

likely to shift beliefs towards those arguments than away from them. We suggest that systematic research examining the relationship between processing, mental representation, and belief change be undertaken to better understand these findings. Also, researchers should be mindful of the distinction between beliefs and attitudes. The circumstances are not clear under which beliefs and attitudes may influence processing differently, and whether they change in similar ways in response to conflicting discourse.

Another topic that should receive more systematic study is the influence of worldview on belief related phenomena. Worldview refers to the set of shared values, beliefs, and practices within a culture that serve to give people a kind of meaning beyond their existence as an individual person. Traditional text comprehension research is guided by an often unstated assumption that the reader's goal is to understand the text and update their mental model to be consistent with the text content. This assumption may be reasonable when addressing beliefs related to rather benign topics such as those sometimes addressed in the conceptual change literature (e.g. physics conceptions, the visual system, or basic factual misconceptions.) But other topics are likely to be affect-laden, or address topics that are central to the self-concept of people, or are likely to trigger fears and anxieties (e.g., vaccines, race issues, or evolution.) These topics may differ in the reactions and reading behaviors they elicit. This point has been addressed by a number of previous researchers (Cobern, 1996; Dole & Sinatra, 1998; Pintrich, Marx, & Boyle, 1993; Schimel et al., 2007). However the literature does not contain a systematic means for quantifying the extent to which topics may vary in terms of how central or peripheral they are to readers' worldviews, nor how readers' worldviews may vary within a single topic. We suggest that interdisciplinary collaboration between discourse researchers and social psychologists may be fruitful in addressing worldview influences.

A couple of methodological points are also worth considering. First, there is a possibility that some belief related comprehension phenomena may suffer from the file drawer problem. This name refers to the situation in which a researcher conducts an experiment and the results fail to reject the null hypothesis. The standard interpretation of null results is that they are not interpretable, and thus they do not tend to be published. Consider, for example, students reading in order to study for an exam in a class. There is an external motivation to learn all of the assigned content equally regardless of belief consistency. Under these circumstances, processing effort may not differ between belief-consistent and belief-inconsistent information. Valid evidence supporting this conclusion would be interesting and relevant, but such null findings would be unlikely to be published. In fact, we (authors of this chapter) have multiple such studies in our file drawers, and you (readers) will not read about them. One possible remedy for the file drawer problem is the use of Bayesian statistics in which traditional null hypotheses can be tested (Lee & Wagenmakers, 2005). Another possible remedy is the use of experimental designs in which an interaction is predicted such that an independent variable is expected to influence a dependent variable at one level of a second independent variable but not at the other level of the second variable. Second, belief-consistency effects cannot be tested adequately unless such consistency is fully orthogonal to the two variables of reader beliefs and text position within a

topic. Readers with different beliefs should be crossed with texts that take opposing positions. Without this design, there is no way to determine whether any effects are simply due to the content of the texts, or to other general individual differences that happen to covary with differing prior beliefs on a topic. Third, it is important to consider how our research contexts may underestimate the impact of beliefs in less formal contexts where people encounter belief-relevant discourse, such as when someone chooses to read a news article about climate change or listen to a podcast about gun control. Our research settings may impose external goals and expectations on readers that override the influence of their own intrinsic motivations tied to their beliefs. Beliefs and the variable knowledge, emotions, and goals they trigger could have their greatest impact in those situations where the reader chooses what and when to read, and chooses how they will elaborate and think about the text beyond what is minimally required for the most basic understanding.

Finally as a general point, it seems implausible that many valid conclusions could be drawn about the effects of prior beliefs on discourse processing at the most general level. Prior beliefs are themselves the result of discourse processing, with variable processing motivated by variable goals. Any given belief is likely to be tied to particular processing goals and to a mental representation shaped by past processing. Those goals and current representation features are likely to impact future processing of belief-relevant discourse. Belief-basis is one construct aimed at capturing some of this variability in goals and representations stemming from an interaction between the nature of the topic and the individual-level factors. However, the current context (e.g., reading for a grade versus personal interest or discussing to persuade versus to learn about a topic) can alter the goals that influence how prior beliefs are utilized in discourse processing. Thus, even when consistent findings appear to emerge across studies, it is critical to question whether that consistency arises due to shared focus on narrow and non-representative types of readers, topics, or contexts.

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