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The Influence of Emotions and Beliefs on the Comprehension of Texts About Climate Change

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Abstract

Emotions and beliefs play a critical role in our everyday lives and may even interact to influence our processing of information. Prior research has proposed numerous models of emotion, belief, and comprehension processes that intersect in their methodology. The present study examines this interaction between emotions and beliefs on the comprehension of texts about the controversial topic of climate change. Given an emotion induction to elicit a positive or negative emotion, the comprehension of controversial texts about climate change is measured through the use of Inference Verification Tasks developed by Strømsø et al. (2010). It was anticipated that prior beliefs would interact with emotions to influence comprehension. In alignment with the results of Fiedler and Beier (2014), it was found that participants who held neutral beliefs about climate change that were induced to feel sad emotions performed better than happy-induced participants on questions assessing within-text inference verification. Beliefs removed the effects of emotions in the other conditions. The results provide insight into the implications of emotions and beliefs on the comprehension of controversial topics.

Literature Review

Introduction

Imagine you are scrolling through Twitter or reading a newspaper article about a current world issue for which you have strong opinions. In addition, imagine that you received a free item at a store, so your mood is quite upbeat and happy. Alternatively, what if your mood was downhearted and sad because your pet just died? These different factors of emotion and belief intensity may impact how you read and interact with the text regarding a controversial topic. If your mood is upbeat and happy while reading the text, your overall comprehension of the text may be more likely to be influenced by your strong prior beliefs, causing you to create more assimilative inferences from the text (Fiedler & Beier, 2014). On the other hand, if your mood is downhearted and sad, you may not be influenced by your beliefs, and you may instead engage in an increased form of analytical or accommodative thinking (Bohn-Gettler & McCrudden, 2021; Bohn-Gettler, 2019; Fiedler & Beier, 2014; Forgas, 1995). In fact, Trevors and Kendeou (2020) and Mills et al. (2019) found that negative emotions can, in fact, increase the activation of correct information and performance on deep-reasoning questions, thus increasing overall comprehension. Or, perhaps the sad mood would lead you to question your beliefs due to promoting more accommodative processing (Fiedler & Beier, 2014). Alternatively, if you do not have strong prior beliefs about the topic, the type of processing associated with positive affect may lead to more inferential processing whereas the processing associated with negative affect may facilitate detail-oriented within-text comprehension (Bohn-Gettler, 2019; Fiedler & Beier, 2014, Forgas, 1995).

These factors of emotions and beliefs may interact in different ways to influence comprehension of texts addressing a controversial issue. An informed citizenry requires that

individuals can learn from persuasive texts, especially texts describing evidence and viewpoints about controversial issues, regardless of whether they align or misalign with their beliefs (Andiliou et al., 2012; Buehl et al., 2001). This makes it especially important to study how beliefs and emotions interact to influence comprehension of controversial issues. Simple factors, such as a small event that could induce a positive or negative mood, can drastically alter how an individual interacts with and reacts to reading about a controversial issue. Similarly, someone who feels very strongly about the issue may drastically comprehend the text differently than someone with dissimilar beliefs. By understanding how these factors of emotion and beliefs interact, we can understand how one's comprehension of a controversial issue can be influenced, further allowing us to understand why people may react to texts in different ways.

The present study analyzes whether beliefs and emotions individually or interactively influence comprehension for texts addressing the controversial topic of climate change. Specifically, the study focuses on how the presence or absence of strong prior beliefs about the topic of climate change interacts with an induced positive or negative affect when reading texts containing belief-consistent and belief-inconsistent information about climate change.

Emotion

The human experience of emotion plays an important role in our everyday lives. Affect is a comprehensive term that encompasses moods, emotions, and attitudes (Batson et al., 1992). Control-Value Theory (CVT), proposed by Pekrun (2006), helps describe when and how emotions occur, and the resulting outcomes of various emotions. The precursors include appraisals, which are an individual's evaluation of a situation (Pekrun, 2006). Pekrun (2006) describes how individuals appraise situations along two dimensions: value and control. Value refers to whether the situation would be beneficial or harmful to the person (Pekrun, 2006).

Control refers to expectancy, which is whether the individual thinks they have the control to anticipate a positive outcome in the future (Pekrun, 2006). These different emotions are theorized to impact the cognitive and motivational processes that motivate one's performance and academic achievement (Putwain et al., 2020). According to CVT, not only can the experience of these emotions, called achievement emotions, influence one's performance and overall achievement, but their outcomes can also have a reciprocal effect of causation regarding the influence of achievement emotions (Putwain et al. 2020). Thus, it is crucial to consider emotions when learning.

Moods consist of long-term, general feelings that may be relatively low in intensity. On the other hand, emotions are shorter-lasting, specific, and are experienced more intensely than moods (Batson et al., 1992). Emotions can consist of varying levels of intensity (i.e., arousal/activation), thus dictating different responses from the individual in various situations. Valence describes whether an emotion is pleasant or unpleasant, while activation describes the energy level that is experienced with said emotion (Bohn-Gettler, 2019). These emotions can be classified into distinct categories depending on valence and physiological activation. For example, the emotion of enjoyment is a positive activating emotion, whereas boredom is a negative deactivating emotion, and anxiety is a negative activating emotion.

Understanding how different emotions can affect the ways in which we process information is important. For the purpose of this study, the Affect Infusion Model and Assimilation-Accommodation model will be described and discussed.

Affect Infusion Model. Forgas's Affect Infusion Model (AIM; 1995) examines how positive versus negative emotions can result in different levels and patterns of information processing. The AIM works to integrate two explanations of mood effects: affect-as-information

(Schwarz & Clore, 1988) and affective priming (Bower, 1981). The affect-as-information approach theorizes that people use their emotions as a relevant heuristic factor to guide the evaluation of different events (Schwarz & Clore, 1988). Thus, people use moods informatively, and they are used to guide their reaction to events. On the other hand, affective priming can be referred to as when the specific valence of an emotion that the individual is experiencing is facilitated when there is a preceding exposure, or prime, to the same valence of said emotion (Frings & Wentura, 2008).

Importantly, the AIM describes the conditions under which affect influences processing, as well as how positive versus negative affect influence processing. The Affect Infusion Model also works to clarify conditions in which mood would influence processing. Specifically, when the task is familiar and simple (reproductive tasks, such as restating the theme or supporting points of a text), the individual's current mood has less of an impact on task performance than when processing is more difficult and unfamiliar (Macaulay & Eich, 2002). Furthermore, when people pay more attention and exert an increased cognitive effort (constructive and generative tasks, such as generating inferences from a text), they are more likely to be impacted by their current mood state (Forgas, 1995).

Regarding processing, the AIM proposes that negative affect tends to encourage bottom-up, accommodative processing, suggesting that negative affect leads to more externally focused processing (Forgas, 2000). On the one hand, positive emotions tend to be associated with open, global information searches that support creativity and flexibility in information processing, such as using background knowledge to predict an outcome or understand the meaning of a word. On the other hand, negative emotions tend to be associated with local, analytic processing methods,

such as looking at specific details in the text to better comprehend it instead of considering the overall main points (Fiedler, 2000; Forgas, 1995; Pekrun, 2017).

Assimilation-Accommodation Model. Fiedler and Beier's (2014) Assimilation-Accommodation Model of emotion helps expand the Affect Infusion Model's description of information processing to examine how positive versus negative emotions are associated with different processing styles. Fielder and Beier (2014) posit that positive emotions facilitate assimilative top-down processing, in which individuals change the intake of external information to fit pre-existing internal representations (such as interpreting information to fit prior beliefs). On the other hand, negative emotions facilitate accommodative bottom-up processing, in which individuals change their internal representations to fit new, external stimuli that are being taken in (such as using new information to guide and alter prior beliefs; Fiedler & Beier, 2014).

Therefore, the combination of the AIM and the Assimilation-Accommodation Model of emotion describe *when* and *how* emotions influence processing. Regarding *when*, judgments requiring constructive, generative processing are more likely to be infused by affect than are simple, reconstructive judgements. An example of constructive, generative processing includes incorporating information from the text at hand to texts that have previously been read, whereas an example of simple, reconstructive processing includes simply restating what was read (Forgas, 1994). Regarding *how*, positive emotions tend to facilitate assimilative processing, whereas negative emotions tend to facilitate accommodative processing (Fiedler & Beier, 2014).

These dimensions of emotion can help demonstrate that different emotions consist of varying levels of pleasantness and energy, thus leading to overall differences in the experience of varying emotions. In fact, negatively valenced emotions, such as sadness, appear to be specifically impactful: negatively valenced emotions tend to be felt more strongly among

females than males as measured via fMRI (Koch et al., 2007). Thus, various types of emotion can differentially influence people.

Beliefs

Not only can emotion impact information processing, but emotion has also been shown to influence one's beliefs. Beliefs are attitudes that one holds to be true (Primmer, 2018). However, previous studies have shown that when one's beliefs and expectations are violated, the individual experiences cognitive conflict (Angel & Seitz, 2017). Further, there has been an overall finding that one's affect influences the formation of beliefs (Kim et al., 1998). Before examining this role of emotion and beliefs, it is important to understand what beliefs are, and consider prior research on beliefs and attitudes.

Beliefs are attitudes that an individual holds to be true. The process of believing involves fundamental brain functions, such as perception, information storage, and prediction, that occur due to the presence of neural pathways in the brain. This results in meaningful representations, called beliefs (Angel & Seitz, 2016). When stable, these beliefs play a role in guiding the behavior of individuals and social groups. However, beliefs are also malleable and can be modified by information that the individual deems as new and relevant, interpersonal contact, societal pressure, and situational factors (Meyniel et al., 2015; d'Acremont et al., 2013; Henkel & Mattson, 2011; Chang et al., 2010). The current study focuses on how beliefs and emotions interact when engaging with texts presenting conflicting information about climate change.

Prior work has found that people tend to form beliefs in order to create mental representations that help them make predictions to guide actions toward rewards and away from harm (Sharot & Garrett, 2016). Eli and Rao (2011) exposed participants to receive either positive or negative feedback from strangers about their intelligence and beauty, and were instructed to

use their prior beliefs to perform a ranking task among the participants in the study. It was found that participants more willingly updated their prior beliefs, as measured by receiving personal feedback, when they received good news rather than bad news – even if the good news contradicted their prior beliefs (Eli & Rao, 2011). However, one's beliefs are constantly updated in response to new information that adjusts their views in either a stronger direction that enhances their beliefs, or a weaker direction that attenuates their beliefs. Therefore, this prior work has studied the role of valence in the formation and expression of beliefs. People do not necessarily update their beliefs when new information is simply presented, but rather update their beliefs when the new information is deemed good rather than bad (Eli & Rao, 2011). The research of Eli and Rao (2011) shows that when new information has a positive emotional connotation rather than negative emotional connotation, individuals tend to be more open to readily update their beliefs.

In fact, when the valence of one's preferences about a topic and its implied characteristics are congruent, people tend to overwhelmingly judge the topic as likely to have those implied attributes. When the characteristics of the topic are mismatched and go against the individual's perception of the topic, however, those judged likelihoods tend to decrease (Mensink & Rapp, 2011). For instance, as studied by Mensink and Rapp (2011), when reading a story and participant's preferences for character traits aligned with the traits displayed in the story, participants tended to judge characters as likely to possess those traits. When readers' preferences did not align with the traits, they were less likely to judge characters as likely to possess the desired traits. This shows how the inferences that guide an individual's comprehension are influenced both by the descriptions within a text about characters and events, as well as by the preferences that readers develop apart from what was outlined in the text for

those characters and events (Mensink & Rapp, 2011). Hence, both emotional connotation and belief congruence work together in the process of belief formation and revision. Furthermore, valence plays a role in both emotional experience and belief formation, thus tying the connection between the concepts of emotion and beliefs together.

Beliefs about Climate Change. These concepts of belief revision are especially important regarding the topic of climate change among pre-service teachers. How pre-service teachers understand the causes and consequences of climate change critically impacts the students they will teach. Prior research has found that pre-service teachers tend to be able to identify main concepts about climate change but are unable to elaborate on these topics and their details (Nyarko & Petcovic, 2021). However, although initial topic knowledge of climate change in pre-service teachers is quite low, instruction of this material may help increase pre-service teachers' topic knowledge and ability to teach the content. When taught more in-depth, factual information about climate change, pre-service teachers' topic knowledge increased, as did their ability to adequately describe these climate change concepts in an environmental education activity for young students (Breslyn & McGinnis, 2018). Therefore, because knowledge can be influenced by beliefs, it is critically important to understand how beliefs about climate change influence pre-service teachers' abilities to learn about this topic.

Numerous studies conducted by Sinatra and Lombardi further analyze and support this interaction between topic knowledge and beliefs toward climate change. In alignment with Breslyn and McGinnis' (2018) work on topic knowledge, when individuals are exposed to very brief instruction on different pieces of factual information about climate change, overall understanding of climate change tends to increase (Lombardi & Sinatra, 2012). However, plausibility perceptions (one's opinion of the probability of a climate change-related event

occurring) also tend to increase as well, thus showing the possible shift in beliefs about climate change. In fact, simply reading texts about climate change can prompt people to want to take action against climate change, thus either potentially reinforcing or contradicting one's prior beliefs (Sinatra et al., 2012).

Building on this work to understand incorporating topic emotions, which are emotions specific to the topic at hand, Lombardi and Sinatra (2013) found that one's topic emotions about climate change may also impact one's plausibility perceptions about climate change. Specifically, emotions such as anger tend to decrease plausibility perceptions whereas emotions such as hopelessness have been shown to increase plausibility perceptions about climate change indicating that emotions may play an important role in the possible shift in one's topic beliefs about climate change (Lombardi & Sinatra, 2013). More specifically, Lombardi and Sinatra (2014) show how both valence and arousal can also create different effects on plausibility perceptions. Topic beliefs and topic emotions, thus, potentially interact to influence people's perceptions of the issue of climate change.

Comprehension Processing

Given that the current study examines how individuals interact with texts containing information about climate change, it is important to understand theories of reading comprehension. Whether reading an article about climate change, studying for an exam, or training for a job, reading and comprehension are critical features of successful learning in school, professional, and everyday environments. Reading comprehension is an important tool while reading all texts, however, these comprehension processes can become especially important when they involve controversial topics like climate change. Like many controversial topics, an individual's collective understanding of the topic of climate change is largely linked to

reading and interacting with texts involving this subject. The texts that an individual chooses to interact with, and thus successfully comprehend, can play a large role in one's understanding of climate change. Successful reading not only involves reading quickly and accurately, but it also encompasses interpreting, integrating, and comprehending the text and its contents (Zaccoletti et al., 2020).

Understanding how comprehension can interact with emotion and prior beliefs is important. For the purpose of this study, the Tripartite Theory and Construction-Integration model will be described and discussed.

Tripartite Theory. The Tripartite Theory of comprehension indicates that readers use three different levels to encode information from a text: 1) the surface structure, which contains the exact words from the text; 2) the textbase, which involves encoding the core meanings of the text; and 3) the Situation Model, where inferences (i.e., connections not explicitly stated in the text) between the current portion of the text and both earlier text and prior knowledge are created (Kintsch, 1998). This theory thus proposes that multiple aspects of the text and the individual interact during the process of comprehension. Therefore, readers form representations of the surface structure and textbase, and from there can construct a Situation Model (van Dijk & Kintsch, 1983).

Situation Models are mental representations that are constructed by drawing inferences from a situation referred to in a text (Seger et al., 2021). Readers interpret information from the text to build a mental representation of what the text is about (Kintsch & van Dijk, 1978), make assumptions to draw conclusions across varying texts (Graesser et al., 1994), and utilize prior knowledge to explain the information in the text (Best et al., 2008; van den Broek & Kendeou,

2008). Therefore, readers utilize multiple strategies when reading a text, influencing overall comprehension.

Construction-Integration Model. The Construction-Integration (CI) Model assumes that the information in a text and a reader's prior knowledge work together to form a clear and coherent representation of the text in the reader's memory (Kintsch, 1998; Kintsch & van Dijk, 1978). The CI Model proposes that comprehension involves two steps: construction and integration. In the first step, readers construct a mental representation of the text from the content of the text as well as the activation of relevant prior knowledge. In the second step, the information from the text and the activated prior knowledge are integrated within the mental representation (Situation Model), whereas irrelevant information is deactivated and excluded from the mental representation (Kintsch, 1988). Therefore, the text encourages the activation of background information during this construction process through associative priming (Bohn-Gettler & Kendeou, 2014).

Factors that Influence Comprehension. However, a reader's background knowledge, task demands, and reading goals may also influence one's activation and integration by focusing the individual's attention on task-relevant information during reading. Thus, the CI Model theorizes multiple interactions that occur during reading that may influence comprehension: textual information, reader's background knowledge, and the context of reading the text (Kintsch, 1988).

Other researchers have elaborated on the varying factors that can influence comprehension (Jenkins, 1979; Snow, 2002; van den Broek & Kremer, 1999). For example, readers approach texts with different goals and skills, thus influencing how people interact with texts (Linderholm et al., 2008). Prior research has largely focused on the interaction between

comprehension and cognitive characteristics (such as executive functions that monitor and control behavior), motivation, and reading goals. Analyzing these many factors that can influence comprehension, and van den Broek and Kremer (1999) proposed three main factors that may influence the processes of comprehension: characteristics of the reader, properties of the text, and the context and environment in which reading occurs.

When considering these three factors, a reader's emotions (which could fall into the category of characteristics of the reader) may also play a role in comprehension processing because emotions are crucial to the functioning of not only one's well-being but also one's attention in cognitive tasks that involve reading (Tennant et al., 2015). Understanding how emotions might impact a reader engaging with texts about climate change would be critically important because different emotions may lead to differences in comprehension of the text. Because emotions often guide our actions and decisions (Putwain et al., 2020), it is possible that these emotions may also drastically impact the way that readers interact with texts about the controversial issue of climate change.

Integrating Research in Emotion with Reading: The PET Framework

Developed by Bohn-Gettler (2019), the PET (Process, Emotion, Tasks) framework analyzes the interaction between a reader's emotions and comprehension as a function of the specific comprehension process, type of emotion, and task features. The PET framework assumes that we cannot fully understand the processes of comprehension without considering the multifaceted variables that interact with one another, which are situated in the Tripartite Theory and Construction-Integration Model. Therefore, this framework provides hypotheses for how these comprehension processes and products may interact with and be influenced by emotion (Bohn-Gettler, 2019).

The PET framework builds on the Tripartite Theory and CI Model by assuming that comprehension occurs due to the interaction of multiple factors within the text and individual, but this framework also discusses the role of emotion. Therefore, in line with previously discussed theories, the PET framework theorizes that one's emotion while reading a text may also interact with other influences during reading, thus influencing the overall comprehension of a text (Bohn-Gettler, 2019). It is important to discuss the role of emotion in comprehension because just like other influences (background knowledge and textual information), one's emotion while reading a text may drastically influence how an individual interprets and comprehends a text, thus influencing how people may interact differently with varying texts.

However, the influence of emotion on the different types of processes in which readers engage have not been as extensively studied. Specifically, tasks involving conceptual change tend to encourage accommodative processing (Trevors & Kendeou, 2017), whereas passive reading with the use of simple recall techniques tends to involve assimilative processing (van den Broek et al., 2001). Because positive emotions tend to be associated with assimilative processing, they tend to be associated with processing techniques that incorporate prior knowledge (Storbeck & Clore, 2005), which could facilitate constructive inferences among texts when reading. This assimilative processing is more constructive and creative (Bless & Fiedler, 1995), thus enhancing one's mental flexibility and problem-solving abilities. On the other hand, negative emotions tend to be associated with accommodative processing, meaning that they tend to be associated with processing techniques that do not tend to incorporate prior knowledge, but rather local and analytic processes that could lead to higher within-text comprehension (Fiedler & Beier, 2014).

Intra- and Intertextual Inference Verification Tasks. Because inferences are a constructive process that is likely to be influenced by emotion (per the AIM; Forgas, 1995), the present study focuses on comprehension as assessed via inferences. Developed by Strømsø et al. (2010), Intra- and Intertextual Inference Verification Tasks (Intra-IVT and Inter-IVT) are used to assess comprehension of individual texts as well as comprehension across texts. Situated in the research of Royer et al. (1996), the Intra-IVT was developed to measure the participants' deeper understanding of individual texts. However, since the Intra-IVT does not account for comprehension across texts, the authors developed an Inter-IVT to measure the participants ability to make inferences and draw conclusions between multiple texts (Strømsø et al., 2010).

Strømsø et al. (2010) asked participants to read multiple texts about climate change, akin to what happens when people come across conflicting, controversial texts while reading online. The ''Documents' Model'' proposed by Britt et al. (1999) describes how different sources of text may function to both separate and integrate information while reading multiple documents and is a basis upon which the IVTs were created. This model theorizes that a reader will construct a mental representation of texts that includes the content, the relationships among the texts, and relevant source information within each text. Therefore, the reader creates a mental representation of the relevant information among each text as well as a mental representation of where the different information comes from and how the information is similar. Furthermore, a reader paying less attention to the textual information may experience a more difficult time in judging how information units are interrelated as well as which units to focus on in the construction of a coherent understanding of the content. Thus, this model theorizes that readers of multiple texts may benefit most from creating mental representations of both the textual content as well as the attributes and relationships among the different texts (Perfetti et al., 1999).

Therefore, the Intra- and Intertextual IVTs are based on this Documents Model, in such that greater textual comprehension occurs from understanding the content of individual texts, but also the relationships between the content of multiple texts.

The Current Study

In the context of existing theory, the goal of the current study is to examine how emotion and beliefs can impact text comprehension about a controversial issue. This topic is important to study because it reveals how people may interact with texts about controversial topics in different ways. Furthermore, we can also understand how texts consisting of opposing information about the controversial topic of climate change can influence one's comprehension. For instance, prior studies have found that readers spend more time reading belief-consistent arguments with the intention to refute them (Edwards & Smith, 1996; Kardash & Howell, 2000), whereas other studies found that readers actually spend more time reading in order to process belief-consistent information (Taber & Lodge, 2006). Hence, people interact with belief (in)consistent texts with different intentions of comprehension altogether. The present study therefore analyzes beliefs about climate change and whether induced emotions will influence the overall comprehension of belief-consistent and belief-inconsistent texts.

Multiple theories intersect to inform hypotheses related to the research question. First, regarding emotion, Forgas' Affect Infusion Model (1995) and Fiedler and Beier's Assimilation-Accommodation Model (2014) work together to explain the differences between positive and negative emotions. Specifically, positive emotions tend to be associated with global information searches that are consistent with assimilative, top-down processing. On the other hand, negative emotions tend to be associated with local, analytic processing that is in alignment with accommodative, bottom-up processing. With regard to beliefs and attitudes, beliefs are

constantly updating and can be influenced depending on the type of information that the individual is exposed to, such that exposure to belief-consistent information can strengthen one's prior beliefs and vice versa (Eli & Rao, 2011). Thus, the presence of strong beliefs may interact with the processes of positive and negative emotions, such that stronger beliefs may either enhance or diminish emotion-based processes. Regarding comprehension, the Tripartite Theory (Kintsch, 1998) and the Construction-Integration Model (Kintsch, 1998) work together to help us understand that comprehension consists of multiple different levels and processes. The PET Framework (Bohn-Gettler, 2019) integrates these processes of comprehension with the overall influence of emotion, examining how emotion can influence comprehension. Thus, these factors of emotion, beliefs, and comprehension are all intertwined and interact with each other, with different outcomes produced from different interactions. Specifically, how emotion and beliefs interact to influence comprehension.

In the current study, participants were induced to feel positive (happy) or negative (sad) emotions prior to reading texts that presented conflicting viewpoints about climate change. Beliefs were measured through participants rating their agreement with each text. Comprehension was measured using an Inference Verification Task for individual texts as well as across texts.

Hypotheses. The present study examines how emotion and beliefs interact to influence comprehension for texts addressing a controversial topic. The first hypothesis is that when no strong beliefs about climate change are present, the assimilative processing associated with positive affect should lead to better inferential processing, regardless of beliefs. This should result in higher scores on both inference verification tasks compared to other conditions. This hypothesis aligns with the AIM (Forgas, 1995) and Assimilation-Accommodation Model of

emotion (Fiedler & Beier, 2014), and the findings of Bohn-Gettler and Rapp (2011) and Scrimin and Mason (2015).

However, what happens when readers do hold strong beliefs? The second hypothesis is that when strong beliefs are present, participants in the positive affect condition will be more influenced by their beliefs in comparison to the other groups. This should result in higher scores for belief-consistent texts and lower scores for belief-inconsistent texts, as well as lower scores for cross-text integration. This hypothesis is consistent with the AIM (Forgas, 1995) and the Assimilation-Accommodation Model of emotion (Fiedler & Beier, 2014), the integration of emotion and comprehension in the PET framework (Bohn-Gettler, 2019), as well as the belief-related findings of Bohn-Gettler and McCrudden (2018).

The above hypotheses directly consider positive affect. However, negative affect also results in particular processing patterns. The third hypothesis is that when no strong beliefs are present, the local, analytic processing associated with sadness should result in higher within-text comprehension. This should result in higher scores for Intra-IVT and should explore whether sadness is associated with higher or lower Inter-IVT scores. This hypothesis is in alignment with the AIM (Forgas, 1995) and Assimilation-Accommodation Model of emotion (Fiedler & Beier, 2014), and consistent with the findings of Bohn-Gettler and Rapp (2011).

Again, what happens when sad-induced participants hold strong beliefs? The fourth hypothesis is that when strong beliefs are present, participants of the negative affect condition will be less influenced by their beliefs due to their accommodative nature of processing. This should result in no belief-based effects on IVT scores for sad-induced participants. This is consistent with the AIM (Forgas, 1995) and Assimilation-Accommodation Model of emotion (Fiedler & Beier, 2014), the integration of emotion and comprehension in the PET framework

(Bohn-Gettler, 2019), as well as the belief-related findings of Bohn-Gettler and McCrudden (2018).

Method

Study Design

This project occurred in two phases: the pretest phase and the reading task phase. Both phases took place during class with the researcher present. See Table 1 for the phases of the study.

Table 1

Phases of the Study

Pre-Test Phase	Reading Task Phase
Informed Consent	Emotion Ratings and Emotion Inductions
Prior Knowledge	Reading Texts about Climate Change
Political Orientation	Comprehension Tasks: Intra-IVT and Inter-IVT
Demographic Survey	

Participants

The participants of this study consisted of 57 college-aged students enrolled in elementary education science courses at CSBSJU. There were 6 males and 51 females, whose ages ranged from 18 to 22 years old. Approximately 85.7% of the sample were Caucasian, 3.6% African American, 3.6% Hispanic, 1.8% Asian, 1.8% Multiracial, and 3.6% unreported. Approximately 7.0% of the sample reported learning exceptionalities, reporting either ADHD (1.8%) or dyslexia (3.5%). All participants completed both the pre-test and reading task phases. The materials of this study were incorporated into the students' class time and course expectations.

Materials

Prior Knowledge

To assess the participants' prior knowledge about climate change, an adaptation of a topic knowledge questionnaire created by Bråten et al. (2011) was utilized. This questionnaire is a 17-item multiple choice test that refers to the information central to the issue of climate change, as discussed in the four texts that were utilized. Sample items from this questionnaire involve the Paris Agreement and the greenhouse effect (see Appendix A for complete scale). This measure was scored as a sum of the correct answers out of 17, which indicated the extent of the participant's prior knowledge about climate change, thus measuring a wider range of the topic of climate change.

Political Orientation

Participants completed the Social and Economic Conservatism Scale (SECS), which was developed and validated by Everett (2013) as a validated measure of political orientation. The SECS consists of 12 words or phrases that represent issues important to conservatism, such as abortion and limited government (see Appendix B for complete scale). The participants were asked to rate these words or phrases on a "feeling thermometer" in which they indicated their feelings about the issue, with ratings ranging from 0 (feeling negative) to 100 (feeling positive). Fifty was a neutral stance on each prompt. Scores that tended to be higher than 50 indicated more political conservatism, whereas scores lower than 50 indicated more political liberalism. Scores were determined by calculating the average score across the 12 prompts. The use of the Social and Economic Conservatism Scale is an important tool in helping us draw parallels between political attitudes and attitudes and responses to climate change.

Demographic Questionnaire

The demographic questionnaire prompted participants to enter their self-identification (last four digits of student ID number) as well as their age, ethnicity, gender, whether English is their primary language, as well as a self-report of any exceptionalities (such as learning disabilities) that may impact their reading performance (see Appendix C for full scale).

General Emotion Rating

The general emotion rating measured participants' baseline emotions as well as emotions throughout the study. Participants first completed a brief baseline emotion measurement using the Affective Slider (adapted from Betella & Verschure, 2016). The Affective slider consists of a brief rating of both arousal and valence. Although this scale is new, it is situated in the popular and validated emotion rating scale, the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). The affective slider has been effective in its emotion measurement in multiple previous studies (Ayling et al., 2019; López-Carral et al., 2020; Burel et al., 2020). When prompted for an emotion measurement, participants were shown two emotion sliders in which participants rated their arousal (activation) and pleasure (valence). The first slider, which measures arousal, displays one downhearted-looking face on the left side of the slider and one neutral-looking face on the other side of the slider. The second slider, which measures pleasure, displays one sad-looking face on the left side of the slider and one happy-looking face on the right side of the slider. (See Appendix D for the complete scale). Participants then indicated the extent of arousal and pleasure they felt at that moment using these two sliders. For the purposes of this study, the pleasure/valence scale was the emotion measurement used.

Emotion Induction

The emotion induction consisted of watching video clips aligning with the participant's randomly assigned emotion induction condition (positive or negative). When prompted,

participants in the positive emotion condition viewed one of four different video clips, approximately 3 minutes in length, from the popular show *Whose Line is it Anyway.* Participants in the negative emotion condition viewed one of four different video clips, approximately 3 minutes in length, from the films *Bambi, The Champ, The Lion King,* or *Return to Me.* This emotion induction process occurred four times throughout the study, with each repetition varying in visual stimulus for the induction.

Texts

Two pairs of conflicting texts (4 texts overall) regarding both the causes and consequences of climate change were utilized in this study. Utilizing the same four texts used by Muis et al. (2015; originally adopted from seven texts utilized by Strømsø et al., 2010), the first pair of texts presented conflicting information regarding the causes of climate change, whereas the second pair of texts presented conflicting information regarding the consequences of climate change. The first text was published by the Center for International Climate and Environmental Research at the University of Oslo, and discussed that the greenhouse effect is due to the human production of climate gases, which disturbs the balance of the climate system. The second text was written by a professor of astrophysics and was published in a research magazine, and explained historical variations in climate as a result of solar radiation and magnetism (forces outside of human control). The third text was a journalistic news article that described multiple negative consequences of a changing climate, such as inconsistent weather, the impact on farming and forestry, and the effects of rising ocean levels. The fourth text was another newspaper article that examined the positive consequences of climate change, such as the opening of arctic passageways for shipping as well as greater access to natural resources (see

Appendix E for full texts). Each text was presented separately in this order, with questions and another brief emotion induction following each text.

Comprehension

Adopted from Strømsø et al. (2010), the Intra- and Intertextual Inference Verification Tasks (Intra-IVT and Inter-IVT) were used to assess comprehension of individual texts as well as comprehension across texts. The Intra-IVT involves the measurement of deeper understanding of individual texts. Strømsø et al. (2010) created 19 inference prompts that consisted of valid or invalid information within the 4 texts. The sentences were either valid (can be a reasonable inference) or invalid (cannot be a reasonable inference). There were 10 valid and 9 invalid sentences (see Appendix F for full scale). Participants marked "yes" if the sentence can be inferred from one of the texts, or "no" if it cannot be inferred from one of the texts. Participant's scores were the number of correct responses out of 19. However, this Intratextual IVT did not assess participants' abilities to draw inferences across texts.

The Inter-IVT involves taking information from multiple texts and drawing an inference that connects them. Correct answers required participants to understand all the texts because the inferences were not pulled from just one text, but rather from at least 2 texts. Once again, valid and invalid statements were extracted from the texts. There were 8 valid and 7 invalid sentences (see Appendix G for full scale). Participants marked "yes" if the sentence could be inferred from combining information from at least 2 of the 4 texts, or "no" if it could not be inferred from combining information from at least 2 of the 4 texts. The Intra- and Intertextual Inference Verification Tasks work together to assess the participant's overall comprehension of the texts. Scores were calculated as the number correct out of 15, which was determined as one score across the Intra-IVT and one score across the Inter-IVT. A high score represents a higher number

of correct answers, suggesting a higher level of comprehension, whereas a low score represents a lower number of correct answers, suggesting a lower level of comprehension of the text(s).

Procedures

Pretest Phase. Following an informed consent process, participants completed the pretest measures during class time using the online program, Qualtrics. The program first prompted participants to complete the 17-item topic knowledge questionnaire developed by Bråten et al. (2011). Then, participants were prompted to complete the Social and Economic Conservatism Scale (SECS), which measures participant's political attitudes. Lastly, the participants were asked to answer demographic questions including the participant's age, ethnicity, and gender.

Reading Task Phase. The next phase occurred in person during class, in the presence of the researchers (see Figure 1 for an overview of the reading task phase). Each participant first completed a baseline emotion measurement using the affective slider (Betella & Verschure, 2016). Then, participants were randomly assigned to either a positive or negative emotion condition. Based on their respective condition, either positive or negative, each participant watched a short video clip to induce the desired emotion. Following the emotion induction, participants completed the affective slider measurement again to ensure that the emotion induction was successful.

Next, participants read the four texts adopted from Strømsø et al. (2010). The order in which participants read the texts was counterbalanced. Within the counterbalancing, the order of the texts included the two texts on the causes of climate change and the two texts on the consequences of climate change. Following each text, participants rated their overall agreement with the content of the text.

After reading all four texts, the participants were prompted to complete the Intratextual Inference Verification Task, which assessed comprehension of individual texts. Then, participants were prompted to complete the Intertextual Inference Verification Task which assessed their comprehension across the four texts.

Figure 1

Steps for Reading Task Phase

Baseline	Emotion Induction and Reading Tasks (Repeated 4 times, once for each text)	End of Session
• Baseline Affective Slider	• **Emotion Induction** -View happy or sad video -Affective slider • **Read Text** • **Rate Agreement with Text**	• Comprehension: Intra-IVT and Inter-IVT

Results

Manipulation Check

As a manipulation check to ensure the emotion induction was successful, a 2 x 2 mixed ANOVA was used. The independent variables were the emotion induction condition (happy vs. sad), which was between-subjects, and time (pre-emotion induction rating vs. the average of each post-emotion induction ratings), which was within-subjects. The dependent variable was valence, as indicated by the participant. It was expected that the average post-emotion induction ratings of valence would be reflective of the emotion condition. It was also expected that pre-induction, there would be no differences between happy- and sad-induced participants in terms of valence.

At post-induction, it was expected that participants of the happy condition would indicate higher valence, and participants in the sad condition would indicate lower valence.

See Table 2 for the descriptive statistics of the emotion induction. For the time variable, the main effect was significant, $F(1, 55) = 15.01$, $p < 0.01$, $\eta^2 = 0.21$. For the emotion condition variable, the main effect was significant, $F(1, 55) = 60.09$, $p < .01$, $\eta^2 = 0.52$. The main effects of emotion condition and time were qualified by a significant interaction, $F(1, 55) = 81.97$, $p < .01$, $\eta^2 = 0.60$. See Table 2 for descriptive statistics of the valence ratings, and Figure 2 for a visual depiction of this interaction. At baseline, there were no differences between the happy and sad conditions. At post-induction, participants in the happy group had higher happiness ratings than participants in the sad group. Happy-induced participants' ratings of emotional valence increased, whereas sad-induced participants' ratings of emotional valence decreased.

Prior Knowledge

A descriptive analysis was run on the prior knowledge questionnaire data to test for homogeneity or heterogeneity among the participant's prior knowledge about climate change ($M = 5.85$, $SD = 2.25$). Recall that prior knowledge scores were assessed on a scale from 0 to 17. The participant's scores ranged from 2.00 to 12.00. The confidence interval ranged from 5.28 to 6.43. Based on these results, there appeared to be sufficient variation in the participant's prior knowledge. See Figure 3 for histogram of the total scores.

Interactions Between Beliefs and Emotions on Comprehension

Results will be presented in the following sections in relation to the previously mentioned hypotheses: (1) when no strong beliefs about climate change are present, the assimilative processing associated with positive affect should lead to better inferential processing, regardless of beliefs, (2) when strong beliefs are present, participants in the positive affect condition will be

more influenced by their beliefs in comparison to the other groups, (3) when no strong beliefs are present, local, analytic processing associated with sadness should result in higher within-text comprehension, and (4) when strong beliefs are present, participants of the negative affect condition will be less influenced by their beliefs due to their accommodative nature of processing.

Strong versus Neutral Beliefs. The participants were broken up into groups based on their responses on the belief questionnaire. Participants with average scores between 1 to 2.33 were considered to have strong beliefs in denying the impact of climate change (the "strong denial" group), and 3.67 to 5 were considered to have strong beliefs in accepting the impact of climate change is real (the "strong acceptance" group). Participants with average scores between 2.34 to 3.67 were considered to have neutral beliefs. Because only one participant fell into the "strong denial" belief group, this participant's data was excluded. The rest of the participants were in either the strong for (37 participants) or neutral belief groups (19 participants), and only participants in the strong acceptance and neutral belief groups were analyzed.

Inter-IVT. Separate simple regression analyses for participants with strong versus neutral beliefs were used to predict Inter-IVT scores, in which the independent variables were emotion (1 = happy, 2 = sad), prior knowledge (continuous), and political orientation (continuous). See Table 3 for descriptive and inferential statistics. For participants with strong beliefs, the overall model did not explain a significant amount of the variance in scores, $F(3, 36) = 0.53$, $p = .67$, $r^2 = .04$, $r^2_{\text{adjusted}} = 0.04$.

For participants with neutral beliefs, the overall model did not explain a significant amount of the variance in scores, $F(3, 17) = 0.64$, $p = .60$, $r^2 = .10$, $r^2_{\text{adjusted}} = -0.06$.

Intra-IVT. Separate simple regression analyses for participants with strong versus neutral beliefs were used to predict Inter-IVT scores, in which the independent variables were emotion (1 = happy, 2 = sad), prior knowledge (continuous), and political orientation (continuous). See Table 3 for descriptive and inferential statistics. For the Intra-IVT total for participants with strong acceptance beliefs, the overall model did not explain a significant amount of the variance in scores, $F(3, 36) = 0.37$, $p = .77$, $r^2 = .03$, $r^2_{\text{adjusted}} = -0.05$. For participants with neutral beliefs, the overall model did explain a significant amount of the variance in scores, $F(3, 17) = 3.95$, $p = .03$, $r^2 = .41$, $r^2_{\text{adjusted}} = 0.31$. For emotion, the regression coefficient ($\beta = 0.62$) indicated that participants induced to feel sad emotions performed better than participants induced to feel happy emotions.

For the Intra-IVT items accepting of climate change, for participants with strong acceptance beliefs, the overall model did not explain a significant amount of the variance in scores: $F(3, 36) = 0.27$, $p = .85$, $r^2 = .02$, $r^2_{\text{adjusted}} = -0.06$.

For the Intra-IVT items accepting of climate change, for participants with neutral beliefs, the overall model did explain a significant amount of the variance in scores, $F(3, 17) = 4.97$, $p = .01$, $r^2 = .47$, $r^2_{\text{adjusted}} = 0.37$. For emotion, the regression coefficient ($\beta = 0.56$) indicated that participants induced to feel sad emotions performed better than participants induced to feel happy emotions.

For the Intra-IVT items denying climate change, for the participants with strong acceptance beliefs, the overall model did not explain a significant amount of the variance in scores, $F(3, 36) = 0.65$, $p = .59$, $r^2 = .05$, $r^2_{\text{adjusted}} = -0.03$.

For the Intra-IVT items denying climate change for participants with neutral beliefs, the overall model did not explain a significant amount of the variance in scores, $F(3, 17) = 0.53$, $p = .67$, $r^2 = .09$, $r^2_{adjusted} = -0.08$.

There was a significant effect for participants with neutral beliefs, such that higher prior knowledge scores predicted higher inference verification scores across all texts ($p = .005$), and for texts accepting of climate change ($p = .001$).

Discussion

The current study examined the influence of emotions and beliefs on the comprehension of texts containing conflicting information about climate change. It was hypothesized that: (1) when no strong beliefs about climate change are present, the assimilative processing associated with positive affect should lead to better inferential processing, regardless of beliefs, (2) when strong beliefs are present, participants in the positive affect condition will be more influenced by their beliefs in comparison to the other groups, (3) when no strong beliefs are present, local, analytic processing associated with sadness should result in higher within-text comprehension, (4) when strong beliefs are present, participants of the negative affect condition will be less influenced by their beliefs due to their accommodative nature of processing.

Consistent with Hypothesis 3, in the absence of strong beliefs, negative emotion and higher prior knowledge facilitated total Intra-IVT scores and Intra-IVT items supporting the existence of climate change. However, in contrast to the hypotheses, positive emotion did not, on its own or interacting with beliefs, influence scores. Thus, negative emotion influenced processing in the absence of strong beliefs and for texts in support of the existence of climate change, which had a negative valence, making them emotion-aligning. When strong beliefs were present, emotions did not influence processing.

Consistent with the Affect Infusion Model (Forgas, 1995), the Assimilation-Accommodation Model (Fiedler & Beier, 2014), and the PET Framework (Bohn-Gettler, 2019), these results show that negative emotions facilitated within-text inference verification, but only under certain conditions. That is, in the absence of strong beliefs. However, positive emotions did not facilitate processing as hypothesized. This may be because the texts supporting the existence of climate change inherently contained negatively-valenced content, thus demonstrating a congruency effect (Trevors et al., 2021). In support of that, sad-induced participants (with neutral beliefs) had higher scores for texts describing the negative impact of climate change.

The PET framework theorizes that emotion may interact with other influences during reading (Bohn-Gettler, 2019). Specifically, negative emotions tend to be associated with local and analytic processes that could lead to higher within-text comprehension (Fiedler & Beier, 2014). Our results showed partial support for the PET framework. Consistent with this framework, participants induced to feel negative emotions performed better than those with positive emotions under the conditions of neutral beliefs. However, these effects were negated for participants with strong beliefs. Bohn-Gettler and McCrudden (2018) found that it is possible for strong beliefs to override other conditions during reading. Thus, perhaps when strong beliefs about a topic are present, the influence of these beliefs is more overpowering than the effects of the emotive state. These findings suggest the need for a possible revision to the PET framework.

Furthermore, these results may also support the findings of Wolfe et al. (2013), who found that argumentative texts about controversial topics primarily affected reading time, independently of whether the arguments were consistent with participants' prior knowledge. Our findings may support these results because, regardless of whether or not our participants held an

extensive prior understanding of climate change, holding strong beliefs changed whether emotions played a role. Thus, perhaps sometimes beliefs can make us learn and behave in ways that may run counter to what our knowledge base is.

Limitations and Future Directions

Like all studies, there are potential limitations and alternative explanations for these findings. First, the sample for this study is relatively small, making it possible that these results will not be representative or generalizable to other demographics. In addition, the sample is comprised of undergraduate students from two science education courses at CSB/SJU. It is possible that the results from this convenience sample are skewed based on working with pre-service teachers in a residential liberal arts college enrolled in specific classes. Or, since the population is exclusively education students in a science course, perhaps they have different beliefs about climate change because they have previously learned about it and have needed to learn how to teach about controversial issues, such as climate change.

Conversely, this sample may also be a strength of the study. This sample is meaningful because the participants will teach concepts of climate change to their future students. This makes it important to study their beliefs and consider possible implications for teaching. Future research should incorporate a larger and potentially broader sample to test the generalizability of the results.

Additionally, because the sample consisted of education students and not students involved/majoring in science, perhaps the sample had a typical knowledge of climate change and may be generalizable. Nonetheless, this sample of the population of pre-service teachers is an important population to study because these individuals will eventually be teaching this content of the controversial issue of climate change. By understanding how their emotions and beliefs

impact their comprehension, we can understand how teachers can best teach this content to their students in accordance with these effects of emotions and beliefs.

There was an absence of participants in our sample that held strong beliefs against climate change. Future research should include larger sample sizes with more variation in beliefs. Additionally, the texts were negatively-valenced, as they were about the detrimental impacts of climate change. Future research would benefit by including positively-valenced texts to compare emotion congruence with emotion-induced processing. Regardless, it is critical to study the interaction between emotions and beliefs to understand how people respond to controversial texts.

Implications

Despite these limitations, the results have important implications. As previously discussed, both emotions and beliefs play a critical role in one's day-to-day life and can impact the way that we respond to different events, or in this case, texts. It is critical to study this interaction between emotion and beliefs because it may explain why people respond to controversial texts differently.

Not only do comprehension processes differ based on different emotive states among the individual, but also the individual's prior beliefs about the topic. Our results showed that participants induced to feel negative emotions performed better than those induced to feel positive emotions. However, our results also showed that participants with neutral beliefs performed better on the Intra-IVT items in support of climate change. Thus, these results reveal an important interaction, being that perhaps strong beliefs mediate the possible effects of emotions.

These findings may be especially useful to apply in the real-world setting of learning in a classroom. Given that our sample consisted of pre-service teachers, teachers might apply these findings to their own pedagogies. Given that our findings revealed that strong beliefs may override the influence of an emotive state, teachers can perhaps account for this overriding impact of having strong beliefs by applying new strategies to students with strong beliefs when engaging with controversial issues. Although future research would be needed to test these applications, such instruction may include the use of refutational teaching (Kim & Kendeou (2021). Additionally, since people with neutral beliefs who were induced to feel sadness tended to better comprehend the texts in support of climate change, perhaps teachers can use this correlation to their advantage to better teach about the overall negative impact of climate change.

For this sample, other measures that were not included in the current study indicated that prior knowledge on the topic of climate change among this sample was rather low. Perhaps when prior knowledge is low, people may over-rely on beliefs to help inform their decisions, thus resulting in our findings. Future research should further analyze these effects of levels of prior knowledge on this topic of climate change and how it may impact the influences of emotions and beliefs on comprehension.

By understanding this interaction and its impact on text comprehension, we can more fully understand why the same stimulus may elicit different responses from people, and how to possibly counteract these contradicting responses to help build a more informed citizenry.

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Table 2

Emotion Induction Descriptive Statistics

	Emotion Condition							
	Happy				Sad			
	n	*Mean*	*SD*	*95% CI*	*n*	*Mean*	*SD*	*95% CI*
Baseline	27	61.67	21.12	[52.53, 70.81]	30	59.07	25.76	[50.40, 67.77]
Post-Induction	27	78.22	14.57	[72.78, 83.66]	30	17.75	13.68	[12.59, 22.01]

Table 3

Regression Statistics for IVTs

	Strong Beliefs			Neutral Beliefs		
Effect	***Estimate***	***SE***	***p***	***Estimate***	***SE***	***p***
Inter-IVT: Total Score						
Intercept	10.83	2.09	<0.001	5.10	3.36	0.15
Emotion	0.01	0.62	0.99	0.48	1.11	0.67
Prior Knowledge	-0.06	0.15	0.70	0.27	0.22	0.23
Political Orientation	-0.03	0.03	0.25	0.02	0.04	0.66
Intra-IVT: Total Score across All Texts						
Intercept	9.04	2.07	<0.001	5.92	2.85	0.05
Emotion Condition	0.45	0.61	0.46	2.42	0.94	0.02*
Prior Knowledge	0.01	0.15	0.94	0.61	0.19	0.005**
Political Orientation	0.02	0.03	0.46	-0.04	0.04	0.29
Intra-IVT: Scores for Acceptance of Existence of Effects of Climate Change Texts Only						
Intercept	0.50	0.12	<0.001	0.19	0.17	0.27
Emotion Condition	0.01	0.04	0.80	0.14	0.06	0.03*
Prior Knowledge	0.01	0.01	0.52	0.04	0.01	0.001**
Political Orientation	0.001	0.002	0.61	-0.001	0.002	0.57
Intra-IVT: Scores for Denial of Existence of Effects of Climate Change Texts Only						
Intercept	0.44	0.16	0.01	0.52	0.32	0.13
Emotion Condition	0.05	0.05	0.30	0.11	0.11	0.31
Prior Knowledge	-0.01	0.01	0.49	0.01	0.02	0.52
Political Orientation	0.002	0.002	0.48	-0.004	0.004	0.40

*$p < .05$; **$p < .001$

Figure 2

Time and Emotion Condition Interaction

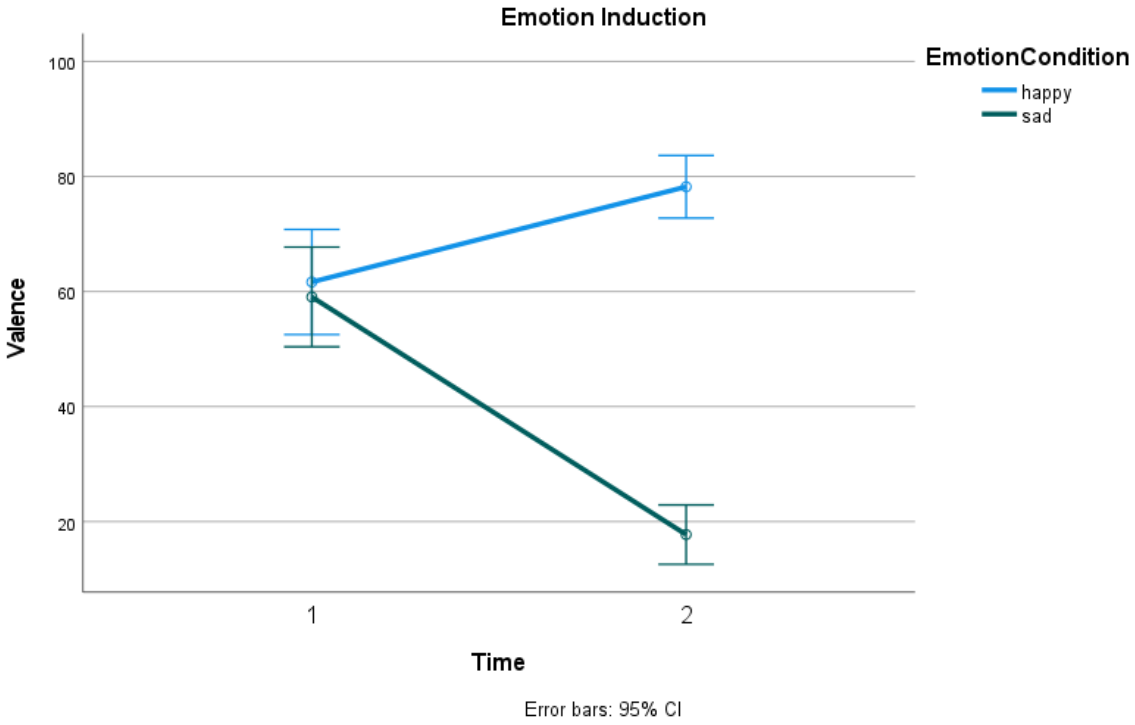
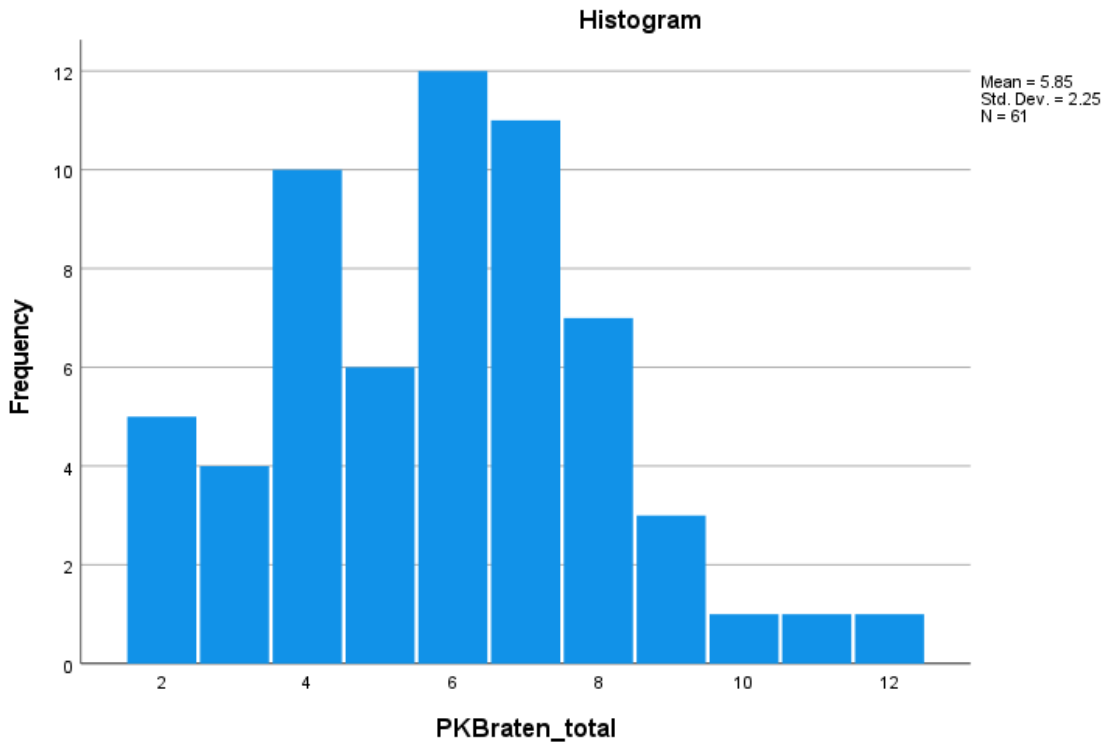


Figure 3

Total Scores for Prior Knowledge



Appendix A

Topic Knowledge Questionnaire (Bråten, Strømsø, & Salmeron, 2011).

Below are some tasks with different statements about central topics concerning natural and environmental issues. Please circle the statement that you believe is correct in each task.

1. The Paris Agreement deals with
a) trade agreements between rich and poor countries
b) reduction in the discharge of greenhouse gases
c) the pollution of the Pacific Ocean
d) protection of the ozone layer
e) limitations on international whaling

2. The greenhouse effect is due to
a) holes in the ozone layer
b) increased use of nuclear energy
c) increased occurrence of acidic precipitation
d) streams of heat that do not get out of the atmosphere
e) the pollution of the oceans

3. Mankind's discharges of carbon dioxide (CO 2) are due to the use of
a) propellants (chlorofluorocarbon) in spray cans
b) fertilizers in farming
c) phosphatic detergents
d) fossil fuels
e) atomic energy

4. Research indicates that the earth's average temperature
a) has risen by more than 5 °C in the last 100 years
b) has risen by more than 5 °C in the last 10 years
c) has risen by less than 1 °C in the last 100 years
d) has risen by more than 10 °C in the last 100 years
e) is in the process of becoming stabilized

5. Some of the most important climate gases are
a) chlorine and hydrogen
b) oxygen and propane
c) nitrogen oxides and butane
d) propellants and aerosols
e) water vapour and laughing-gas

6. A consequence of global warming can be
a) less industrial activity in the northerly regions

b) better conditions for farming in the developing countries
c) more easy access to large oil and gas deposits in the northerly regions
d) greater petroleum activity in tropical regions
e) less possibility of extracting gold and diamonds in the northerly regions

7. The earth's climate has changed
a) due to astronomical conditions
b) due to changes in the earth's circumference at the equator
c) primarily due to increased discharges of ozone gas
d) due to reduced discharges of ozone gas
e) because the ocean currents have increased in intensity

8. The concentration of carbon dioxide (CO_2) in the atmosphere
a) varies between high and low degrees of longitude
b) varies very little from place to place
c) is greatest in industrialized parts of the world
d) is greatest in the polar regions
e) varies a lot from place to place

9. The greenhouse effect is
a) primarily a natural process
b) manmade
c) a relatively new phenomenon
d) greatest in the stratosphere
e) strongest in industrialized parts of the world

10. Global climate change can
a) lead to a lowering of ocean levels
b) lead to less extreme weather on the entire earth
c) influence ocean currents
d) lead to increased volcanic activity
e) lead to more solar energy escaping from the atmosphere

11. Climate gases
a) do not occur naturally in the atmosphere
b) are necessary for much of the life on the earth
c) did not exist in pre-industrial times
d) are exclusively synthetic combinations
e) can cause legionaires' disease

12. Mankind's discharges of carbon dioxide (CO_2)
a) can lead to an increase in the ozone layer
b) are substantially reduced through international environmental initiatives
c) are necessary for the life on the earth
d) can change the heat balance of the earth
e) introduce into the atmosphere the largest part of the climate gases

13. The Paris Agreement is
a) a binding agreement between USA and EU
b) a binding agreement managed by the World Trade Organization (WTO)
c) a binding international agreement managed by the UN
d) ratified by all the large industrialised countries
e) an important agreement about the storing of radioactive waste

14. Human activities
a) form the basis of the greenhouse effect
b) strengthen the greenhouse effect
c) have increased the amount of ozone in the stratosphere
d) have made the earth resemble a greenhouse
e) can influence the radiation from the sun

15. The earth's average temperature increases
a) because of a rise in temperature in the core of the earth
b) because of changes in the moon's reflection of the sunlight
c) because of less clouds in the atmosphere
d) because of increased discharges of climate gases
e) because the radiation of heat from the sun penetrates more easily down to the surface
of the earth

16. The greenhouse effect is strengthened by
a) increased use of fossil fuels
b) radiation of heat from the sun
c) holes in the ozone layer
d) increased planting in tropical regions
e) more growth of gene modified plants

17. Global climate change can lead to
a) more cultivable land in desert areas
b) smaller differences in farm production between different areas of the world
c) considerable reduction in the total global food production
d) more stable conditions for farming in exposed coastal areas
e) larger differences in farm production between different areas of the world

Appendix B

Social and Economic Conservatism Scale (Everett, 2013).

How positive or negative do you feel about each issue on the scale of 0 to 100, where 0 represents very negative, 50 represents neutral, and 100 represents very positive?

1. Abortion. _____
2. Welfare benefits (reverse scored). _____
3. Limited government. _____
4. Military and national security. _____
5. Climate change. _____
6. Religion. _____
7. Gun ownership. _____
8. Traditional marriage. _____
9.Traditional values. _____
10.Fiscal responsibility. _____
11.Business. _____
12.The family unit. _____
13.Patriotism. _____

Appendix C

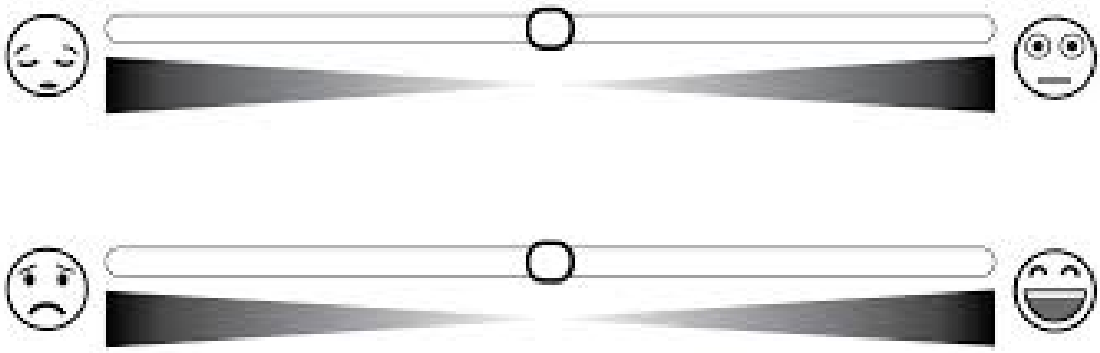
Demographic Questions.

Please answer the following questions:
Student ID number: _____
Age: _____
Ethnicity: _____
Gender: _____
Is English is your primary language? Yes or No: _____
Do you have any exceptionalities (such as learning disabilities) that may impact your reading performance? If so, please specify: _____

Appendix D

The Affective Slider (Betella & Verschure, 2016).

On the first slider, please rate your current state of arousal:
On the second slider, please rate your current state of pleasure:



Appendix E

Texts (Strømsø, Bråten & Britt, 2010).

Text #1:

Manmade greenhouse effect

CICERO Center for International Climate and Environmental Research - University of Oslo
http://www.cicero.uio.no/abc/klimaendringer.html
8th February 2005

The UN's climate panel concludes in its third main report from 2001 that it is highly probable that manmade discharges of climate gases have contributed significantly to the climate changes observed in the last 30 to 50 years.

Manmade greenhouse effect
Since pre-industrial times (around 1750) the concentration of carbon dioxide (CO_2) has increased by around 31 per cent, the concentration of methane (CH_4) has increased by around 151 per cent and the concentration of nitrogen oxide (N_2O) has increased by around 17 per cent. These increases are due to manmade discharges and have resulted in a *stronger* greenhouse effect. Human activities have also introduced into the atmosphere smaller quantities of a number of climate gases that do not exist in the atmosphere naturally.

The increase in the concentration of CO_2 in the atmosphere forms the primary constituent (around 60%) of the strengthening of the greenhouse effect for which mankind is responsible. These manmade discharges of CO_2 are first and foremost due to the consumption of fossil fuels (coal, oil and gas) and the deforestation of tropical regions.

Mankind's discharges amount to only a small part of the quantity of climate gases released into the atmosphere and the effect is minor in relation to, for example, the effect of naturally occurring water vapour. The problem is that the climate system is very complex and sensitive, and even small changes in the system can trigger major consequences. Nature's own discharges of climate gases form part of a cycle in which, for example, rotting trees release CO_2 and living trees absorb CO_2 through photosynthesis. Our CO_2 discharges from, among other things, the burning of fossil fuels do not form part of this cycle and result in surplus CO_2 which remains in the atmosphere for a long time.

Text #2:

Could climate changes be due to natural causes?

APOLLON – University of Oslo research magazine, 1st March 2002

Professor Oddbjørn Engvold, Institute of Theoretical Astrophysics, University of Oslo

Climate has always varied over time and will continue to do so. This is a normal state of affairs. Changes to the earth's climate are to a large extent steered by astronomical conditions. For example, small changes in the earth's orbit around the sun and changes in the tilt with respect to the earth's rotational axis – which is responsible for us having seasons – are associated with significant climate changes. Changeovers between ice ages and warmer periods are demonstrably linked to these external astronomical conditions.

The sun affects the layer of clouds
Without the sun we would not have the greenhouse effect, which is a prerequisite for us having liveable conditions on our planet. Even small variations in the radiation from the sun will affect the climate. The sun is a magnetic star and areas of its surface have strong magnetic fields. These affect its radiation and can result in both weak increases and decreases, and these in turn affect the climate even in the case of changes at the per thousand level.

The sun's magnetic fields surround both the earth and the other planets. When particles that originate from previously exploded stars penetrate the atmosphere, they could affect the formation of low clouds. This in turn has an effect on the earth's weather. The sun's magnetic field will, to a varying degree, stem the quantity of particles that penetrate our atmosphere. This could function as an "on/off" switch for the layer of clouds around the earth.

There has been much debate about climate in recent years and the discussion has often been about the extent to which mankind's activities are affecting our climate in relation to the natural variations. We still do not have a basis for establishing that human pollution of the atmosphere is the main cause of climate change.

Text #3:

Dagbladet.no

The negative consequences of a stronger greenhouse effect

Stronger storms, more hurricanes and increasingly tumultuous weather are just a few of the negative consequences we can expect in the next few years. Global warming may also weaken the Gulf Stream and result in serious cooling in Northern Europe.

JOURNALIST GUSTAV JENSEN

1st December 2004

A number of oceanographers fear highly uncomfortable side effects due to global warming. It may weaken the ocean currents in the North Atlantic to such a degree that there is a genuine risk

of serious and long-term cooling both in the Nordic Region and large parts of Europe and North America. The Nordic Region would be significantly colder without the Gulf Stream.

Oceanographers know all too well that the warnings will cause surprise because we are reminded almost daily of the opposite, namely that global warming will raise the earth's average temperature. However, paradoxically, both things could well occur at the same time. If the circulation of the Atlantic is disturbed, we could have a fall in the average temperature of 3-5 °C. This will have a dramatic effect on farming and forestry, while at the same time there will be a greater need for heating.

And there is much that indicates that the disturbances are well underway. More ice is melting due to global warming and more precipitation is falling over, among other places, Russia. This is resulting in greater outward flows of freshwater from the major Russian rivers into the Arctic Ocean. At the same time we risk losing the Western Arctic ice and Greenland ice.

When the ice surrounding the poles melts, this will not just result in an increased mass of water, it will also result in increased evaporation from the oceans. This will provide hurricanes with energy. *Time* magazine reports that hurricanes have increased in both number and intensity since 1995.

According to the UN's climate panel, an increased greenhouse effect resulted in water levels rising between 10 and 20 cm in the last century and by 2100 ocean levels will rise by between 9 and 88 cm. This will be catastrophic for many coastal communities – especially in developing countries.

Text #4: Aftenposten

Warmer climate presents new opportunities

Regions that are now becoming accessible due to global warming conceal enormous riches. The melting of the ice permits the exploitation of resources in the northerly regions.

JOURNALIST JOHN HULTGREN
24th January 2006

Temperatures around the North Pole are increasing at double the rate of other places around the globe according to UN experts. The Arctic ice is melting so quickly that a sea passage between the Atlantic Ocean and the Pacific Ocean may be accessible to ordinary ships during the summer by 2050. The route through the Northwest Passage to Asia will reduce the journey distance between London and Tokyo from 21,000 to 16,000 kilometres.

The northerly regions that are becoming accessible also conceal enormous riches. The oil and gas deposits that are concealed there are estimated to amount to 30 per cent of the earth's deposits.

And there is more to be found in the northerly regions than petroleum. There is also gold, diamonds, copper and zinc. There will be a lot of traffic due to such exploration says Frederic Lasserre, a geographer at Laval University in Quebec in Canada who is a specialist in Arctic regions.

The director of the Nansen Environmental and Remote Sensing Center, also points out positive consequences of global warming, which occurs in the Arctic in particular: - A warmer climate could result in better growing conditions and lower heating costs. The ice in the Barents Sea will be pushed northwards and eastwards due to increasing south-westerly winds and warmer weather. This will expand winter fishing grounds and make it easier for the gas and oil industry to operate during the winter season.

Appendix F

Intratextual Inference Verification Task (Strømsø, Bråten, and Britt, 2010)

*Each of the following sentences consists of a statement that can reasonably be inferred from one of the texts you have now read, or of a statement that cannot reasonably be inferred from one of the four texts. If an inference can **reasonably** be drawn on the basis of one of the four texts, mark this statement as **Yes**. If it is **not reasonable** to draw an inference on the basis of one of the four texts, mark this statement as **No**. Do not turn back to the texts when you answer this task!*

		Yes	***No***
1.	Warmer climate in the Arctic can lead to some traditional trades being replaced with new industrial activity (text 4).	**x**	☐
2.	Increased evaporation from the oceans can lead to more natural disasters in the future (text 3)	**x**	☐
3.	Global warming can be due to the fact that the sun's magnetic fields draw the earth and the other planets closer to the sun (text 2)	☐	**x**
4.	Global warming may result in both cooling in Northern Europe and higher average temperature on the earth (text 3)	**x**	☐
5.	The UN's climate panel concludes that mankind's discharges of climate gases have resulted in a stronger greenhouse effect in the last decades (text 1)	**x**	☐
6.	That the earth's climate changes is to a large extent steered by astronomical conditions, although these can only lead to temperature changes at the per thousand level (text 2)	☐	**x**
7.	Discharges of CO_2 due to the consumption of fossil fuels and the deforestation of tropical regions form part of a cycle in which, for example, rotting trees release CO_2 and living trees absorb CO_2 through photosynthesis (text 1)	☐	**x**
8.	Without the manmade greenhouse effect the average temperature on earth would be many degrees colder than it is today (text 1)	☐	**x**
9.	The natural greenhouse effect is much more important for the earth's average temperature than is the manmade greenhouse effect (text 1)	**x**	☐
10.	A weakening of the Gulf Stream can create better production conditions for farming and forestry in the Nordic Region (text 3)	☐	**x**
11.	The consumption of fossil fuels and the deforestation of tropical regions are most responsible for the strengthening of the greenhouse effect (text 1)	**x**	☐
12.	The rise in temperatures around the North Pole may lead to increased extraction of oil and gas (text 4)	**x**	☐
13.	The manmade discharges of CO_2 contribute little to the strengthening of the greenhouse effect compared to the impact of naturally occurring water vapour (text 1)	☐	**x**
14.	The global climate changes may be steered from space at least as much as from the earth (text 2)	**x**	☐
15.	Because the circulation of the Atlantic is disturbed, we could have a catastrophic rise in water levels towards 2100—especially in developing countries (text 3)	☐	**x**

16.	The natural gas extracted by the oil companies contains a considerable amount of carbon dioxide (CO_2) (text 1)	**x**	☐
17.	A weakening of the Gulf Stream could negatively affect farming and forestry in the Nordic Region (text 3)	**x**	☐
18.	Warmer climate in the Arctic could reduce the need for heating so much that there will be no use for the enormous oil and gas deposits that become accessible there (text 4)	☐	**x**
19	Enormous riches can become accessible in the northerly regions due to reduced journey distance through the Northwest Passage to Asia (text 4)	☐	**x**

Appendix G

Intertextual Inference Verification Task (Strømsø, Bråten, and Britt, 2010)

*Each of the following sentences consists of a statement that can reasonably be inferred by combining information from at least two of the texts you have now read, or of a statement that cannot reasonably be inferred by combining information from at least two of the four texts. If an inference can **reasonably** be drawn on the basis of two or more of the four texts, mark this statement as **Yes**. If it is **not reasonable** to draw an inference on the basis of two or more of the four texts, mark this statement as **No**. Do not turn back to the texts when you answer this task!*

		Yes	***No***
1.	Human beings' increased consumption of fossil fuels can increase the deposits of gold, diamonds, copper, and zinc in the northerly regions	☐	**x**
2.	The large consumption of fossil fuels, which has resulted in a stronger greenhouse effect, may also give humans access to new areas for extraction of oil and gas	**x**	☐
3.	Even the seemingly insignificant increase in the earth's average temperature during the last 150 years may have very large consequences for life on earth	**x**	☐
4.	The global warming that takes place now can be due to both a manmade strengthening of the greenhouse effect and astronomical conditions	**x**	☐
5.	By removing carbon dioxide from natural gas one can get a much more environment-friendly ship traffic between the Atlantic Ocean and the Pacific Ocean when the route through the Northwest Passage becomes open	☐	**x**
6.	Global warming could have a negative impact on the economies of many countries, while it other places in the world could create new economic opportunities	**x**	☐
7.	Climate changes that have natural causes may open the Northwest Passage as a transportation route	**x**	☐
8.	When water levels are rising because the ice surrounding the poles is melting, access to the enormous resources in the northerly regions may become more difficult	☐	**x**
9.	Human activities in tropical forest areas can contribute to colder weather in the Nordic Region	**x**	☐
10.	Some causal explanations of global warming make it less relevant to implement initiatives in order to reduce the discharges of climate gases	**x**	☐
11.	Climate changes due to natural conditions could not have any importance for the possibilities of extracting oil and gas deposits in the Arctic	☐	**x**
12.	What happens in space may result in serious cooling in Northern Europe	**x**	☐
13.	The increasing concentration of carbon dioxide in the atmosphere can lead to a significantly colder Gulf Stream	☐	**x**
14.	Different types of astronomical conditions have great importance for a stronger greenhouse effect	☐	**x**
15.	The natural greenhouse effect may result in water levels rising by nearly one meter during the next 100 years	☐	**x**