Applying exploratory learning methods to sociopolitical beliefs and cognition.

Sarah French
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APPLYING EXPLORATORY LEARNING METHODS TO
SOCIOPOLITICAL BELIEFS AND COGNITION

By

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B.A., University of Louisville, 2016
M.S., University of Louisville, 2020

A Dissertation Submitted to Faculty of the
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April 25, 2024

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DEDICATION

This dissertation is dedicated to my family

and especially Emma Case

the first flower of spring.
ACKNOWLEDGEMENTS

I would like to thank my parents, who provided me with an appreciation for education and the means to pursue it. I would also like to thank my partner, Shadwick, for the hundreds of cups of tea (and that other thing). I could not have finished this dissertation without the love and humor of my friends, especially Lianda Velić, whose company never fails to restore my spirit. Finally, I would like to thank my mentor, Daniel DeCaro, for taking me on and consistently encouraging me to meet a higher standard.
ABSTRACT

APPLYING EXPLORATORY LEARNING METHODS TO SOCIOPOLITICAL BELIEFS AND COGNITION

Sarah French
April 25, 2024

Americans are polarized along party lines across a variety of sociopolitical issues, including climate change and sustainability issues. Sociopolitical messaging often triggers biased processing that results in defensive rejection or biased elaboration (i.e., counterarguing) of belief-incongruent information. The current research examined whether exploratory learning activities, primarily applied in STEM-education research, can foster belief updating about polarized sustainability issues. Exploratory learning encourages people to engage with learning materials and arrive at their own conclusions before receiving direct instruction/messaging. In two experiments, participants reported their beliefs about carbon taxes and electric vehicle incentives (among other issues) before and after receiving counter-attitudinal persuasive stimuli in two forms, a data table and a persuasive message. Participants in the explore-first condition (EF) were presented with the data table containing information about the counter-attitudinal topic followed by a persuasive message on the same topic. Participants in the message-first (MF) condition encountered the same materials in reverse order. In Experiment 1, the source of the persuasive message was neutral. In Experiment 2, the persuasive message was attributed to a messenger from another political party, to test whether exploratory learning
is more useful when individuals would otherwise reject the messenger. In both experiments, exploring data prior to receiving a persuasive message did not affect belief change. Participants in both experiments reported increased support for positions they had initially opposed, and to large effect. In Experiment 1, confidence in this support remained unchanged. In Experiment 2, confidence in the counter-attitudinal belief increased in the EF condition. Although effective in STEM fields, EL may not be beneficial in the context of sociopolitical decision making—at least when individuals are likely to update their beliefs anyway. However, EL might impact individuals’ metacognition when the messenger contradicts their political position.
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CHAPTER I
EXPLORATORY LEARNING IN A NEW CONTEXT:
POLARIZATION AND PERSUASION

Americans are polarized along party lines across a variety of sociopolitical issues, including climate change and climate change policy (e.g., most Democratic voters consider climate change to be a significant problem while most Republican voters do not; Pew Research Center, 2018). Increasingly, political polarization extends beyond policy and party into personal animosity. Hostility and distrust between members of political groups is on the rise (Pew Research Center, 2022). Polarization that eclipses cross-cutting social bonds to create distinct, mutually distrustful ingroups and outgroups (“us” vs. “them”) tends toward catastrophic outcomes (e.g., democratic careening, autocracy; McCoy & Somer, 2019). When polarization arises from misinformation or excessive cognitive rigidity, challenging beliefs in a relatively non-threatening way might improve outcomes.

Sociopolitical information—and misinformation—is often disseminated by party elites in order to further a political agenda (McCoy & Somer, 2019). For example, before the United States’ invasion of Iraq in 2003, a Gallup poll found that over 90% of Americans believed that Iraq had weapons of mass destruction (WMDs) and the facilities to create such weapons. These claims had been made by the U.S. government to justify the invasion but were later found to be false; 460,000 people died in the resulting conflict (Hagopian et al., 2013). Erroneous beliefs can persist long after their political impetus has
expired. Twelve years after the invasion, approximately 40% of Americans still believed Iraq had WMDs despite widely available information to the contrary (Breitman, 2015). Further, misinformed beliefs can endure even in the face of direct contradiction. Analysis of aggregate data from several studies conducted by Porter and colleagues (2019) revealed that approximately 40% of participants maintained factually inaccurate beliefs about sociopolitical issues despite explicit correction.

Persuasive messages are not uniformly effective (see Crano & Prislin, 2006, for a review) in part because of the rich complexity of information processing. People’s responses to persuasive messages depend on the depth (superficial vs. elaborative) and direction (entrenching vs. debiasing) of information processing. Many other factors also influence individuals’ willingness and ability to process and incorporate corrective information. For example, prior research on persuasion has established the influence of characteristics of the messenger (e.g., perceived credibility, ingroup/outgroup status; Clark et al., 2013; Hornsey et al., 2002), the message itself (e.g., position, perceived usefulness; Clark et al., 2008; Knobloch-Westerwick & Kleinman, 2012), and characteristics of the message receiver (e.g., interest in the issue, existing attitudes, mood, cognitive ability; Petty, Barden, et al., 2009; Zmigrod & Goldenberg, 2021). However, the influence of these factors varies, sometimes surprisingly, in magnitude and direction (Wagner & Petty, 2011). Dual-process models of information processing emerged in attempts to make sense of the various outcomes of persuasive communications.

In this dissertation, I describe relevant theory and research in the fields of cognition, persuasion, and learning before reporting the results of two experiments designed to determine the utility of exploratory learning to challenge beliefs about
sociopolitical issues. My primary aim in conducting these experiments was to investigate how problematic outcomes of traditional persuasion attempts might be improved if people independently explored issue-relevant data prior to receiving any direct persuasive messaging. The reported experiments incorporated exploratory learning phases intended to circumvent common cognitive biases while providing key information hypothesized to serve an important debiasing role in sociopolitical belief updating.

If differences in belief updating occur between indirect persuasion using exploratory learning methods versus more traditional, direct persuasion, this finding would provide initial evidence in support of exploration as a means of communicating sociopolitical information in a non-threatening, debiasing manner. Better understanding of the cognitive processes that lead to successful persuasion will help us understand how to effectively communicate important information about sociopolitical issues across partisan divides.

**The Elaboration Likelihood Model of Persuasion**

Dual process models posit two routes in information processing: a rapid, automatic, intuitive route and a slow, deliberative, analytic route. The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986) is a particularly influential dual process model conceived to explain the differential effects of persuasion across individuals. As the name suggests, the concept of cognitive elaboration is crucial in this model. For any given issue, the quantity and quality of information processing can vary continuously from very low to very high. Depth of processing is determined by a combination of internal factors (characteristics of the message receiver) and external factors (message content and characteristics of the messenger). Two major factors that
affect where people fall on this elaboration continuum are motivation and ability to process issue-relevant information. In ELM, the two processing routes are called the *peripheral* and *central* routes to persuasion. Figure 1 illustrates the two routes of processing according to ELM, including factors leading to each route and associated outcomes.

**Figure 1.**

*Elaboration Likelihood Model of Persuasion*
 Peripheral vs. Central Route Processing

When motivation and ability are low, people are more likely to process information rapidly, automatically, and superficially—the *peripheral route* of processing (see Figure 1, peripheral attitude change). Despite involving relatively little elaboration, peripherally driven persuasive communication can be effective, even if only in the short term (e.g., mere exposure effects in advertising; Olson & Thjømøe, 2003; Petty, Barden, et al., 2009). Peripheral cues can also trigger defensive rejection or avoidance of information that is incongruent with existing beliefs, as in the selective exposure effect (Knobloch-Westernwick & Meng, 2009, 2011). Selective exposure may be particularly potent in sociopolitical cognition when politically polarized individuals tune out belief-incongruent messages to protect their existing attitudes, attitudes for which they may have a high level of certainty.

In contrast, when motivation and ability to process are high, people tend to engage with information more slowly, deeply, and deliberatively. In this *central route*, people critically evaluate the content of the message, assessing the strength and rationale of each argument. Depending on the perceived strength of the arguments and factors such as the receiver’s current position on the topic (for, against), the message receiver will either incorporate the new information and update their beliefs or reject the information and maintain or strengthen their existing beliefs (Petty, Briñol, et al., 2009). Though central-route processing is more thoughtful, it is not necessarily objective, and elaboration is often biased (Wagner & Petty, 2011). For example, people sometimes
deploy cognitive resources to counterargue and invalidate new information using entrenched beliefs and biases (Eagly et al., 2000; Knobloch-Westerwick & Meng, 2009).

**ELM in a Sociopolitical Context**

Both peripheral (low elaboration) and central (high elaboration) processes can lead to belief change, but the nature of processing affects the strength and longevity of updated beliefs (Petty, Briñol, et al., 2009). Similarly, both routes can serve to maintain existing beliefs. Thus, after processing persuasive information, people commonly arrive at one of four possible belief outcomes: elaborative acceptance/rejection, or automatic acceptance/rejection (Figure 2).

ELM predicts that peripherally driven belief change is more susceptible to counter-persuasion and less predictive of behavior. During Donald Trump’s presidency, Porter et al. (2019) presented participants with false statements about climate change made by Trump. Some of the participants then received corrections (i.e., a direct persuasive message). The corrective information reduced inaccurate beliefs about climate change. However, this information had no effect on policy preferences: those who initially opposed policies designed to ameliorate climate change remained in opposition. This may be due in part to the nature of processing of the corrective information. The direct-correction strategy required little elaboration from participants, thus resulting in a peripheral belief change that did not appear to drive any changes in behavioral proxies like policy preference.
Studies have shown peripheral cues to be effective persuasive tools, specifically when motivation to engage with the relevant issue is low (e.g., Petty et al., 1983). However, people who hold strong beliefs are likely to be highly involved and motivated to maintain those beliefs. For example, Washburn and Skitka (2018) found that participants across the political divide used a simple, but incorrect, strategy to interpret provided data when this strategy led to an attitude-congruent conclusion. But when the simple strategy instead resulted in a conclusion that conflicted with their existing attitudes, both liberal and conservative participants were similarly motivated to use a
complex (and correct) strategy to reach a satisfactory answer. After participants interpreted the data for themselves, the researchers presented the correct interpretation. When the correct interpretation was incongruent with their reported attitudes, liberal and conservative participants were similarly likely to reject it.

The most robust changes to beliefs occur when individuals elaborate (i.e., elaborative acceptance; Petty, Briñol, et al., 2009). However, it is difficult to guide individuals down this path because most people appear predisposed to automatically dismiss belief-incongruent messages (i.e., automatic rejection) or elaborate in a biased manner (i.e., elaborative rejection). In terms of correcting misinformed sociopolitical beliefs, the ideal outcome is elaborative acceptance. Thus, two conditions must be met to make productive belief updating possible: First, the peripheral route must be bypassed, preventing automatic rejection. Second, the central route must be engaged in the service of belief updating rather than belief maintenance or entrenchment.

A major hurdle in decreasing pernicious polarization is the lack of reliable methods of encouraging people to engage with sociopolitical information in a debiasing, rather than entrenching, manner. Researchers informed by ELM have identified abundant factors that bear on processing across domains, but processing of messages about sociopolitical issues (e.g., gun violence, immigration, sustainability, climate change) is particularly fraught with biases. Consider the following familiar scenario: A politically liberal person recognizes a speaker as conservative and reflexively dismisses the speaker’s message. In this situation, automatic rejection of information from an outgroup messenger precludes elaborative processing of the message, ultimately resulting in preservation of existing beliefs. Or, for instance, a conservative individual might
recognize a speaker as liberal and thoughtfully counterargue the speaker’s points, maintaining or even bolstering existing beliefs. These scenarios illustrate two common avenues (peripheral route and central route, respectively) to belief maintenance or entrenchment. Devising effective methods of persuasion is further complicated by the tendency of sociopolitical counterviews to be perceived as personal criticisms or criticisms directed at one’s ingroups, prompting defensive rejection (see Esposo et al., 2013).

As ELM indicates, many internal and external factors influence the depth and direction of processing of persuasive messages. Two external factors appear especially salient in sociopolitical persuasion: the congruence of presented information with existing beliefs and messenger affiliation (i.e., ingroup vs. outgroup member).

**Belief Congruence.** According to ELM, and research on confirmation bias (Nickerson, 1998), when information is belief congruent (supports existing beliefs), rapid, automatic acceptance is likely. In contrast, belief-incongruent information is often rejected, either reflexively through the peripheral route, or contemplatively via the central route. With regard to contemplative rejection, a meta-analysis by Eagly and colleagues (2000) found that memory for belief-incongruent information was enhanced because of elaborative processing, namely counterarguing (cf. Hart et al., 1999). During counterarguing, individuals consider arguments against belief-incongruent information, leading to more negative thoughts than before, further entrenching current beliefs.

When people are not motivated to process belief-incongruent information, they may simply avoid it. People sometimes selectively expose themselves to content that is congruent with their existing views in order to prevent cognitive dissonance, an
uncomfortable state in which there exists a perceived inconsistency among one’s own thoughts, beliefs, or behaviors (Festinger, 1962). Partisan selective exposure reflects the tendency of individuals to selectively attend to political information that is in line with their existing views, a phenomenon that has been positively associated with political polarization (Knobloch-Westrick, 2012; Stroud, 2010).

**Messenger Affiliation.** ELM predicts that obvious messenger affiliation will act as a peripheral cue: information from an ingroup messenger is likely to be rapidly accepted (generally with little elaboration), whereas information from an outgroup messenger is likely to be rejected (with or without elaboration). Mackie et al. (1990) found that when presented with strong or weak arguments attributed to either an ingroup member or an outgroup member, participants were persuaded only by ingroup members. Further, ingroup members were more persuasive when delivering strong arguments, suggesting that people elaborate at least somewhat on ingroup messages when they are perceived as compelling. Outgroup members were similarly ineffective regardless of argument strength. Thus, ingroup/outgroup status appears to serve as a powerful peripheral cue, acting as a gatekeeper to elaborative processing allowing ingroup-delivered messages access to the central route via confirmation bias, and outgroup messages access primarily via contemplative counterargument (when outgroup messages are processed at all).

Motivated, biased processing of sociopolitical information reduces the effectiveness of fact-based arguments when people’s beliefs are strongly tied to their political identity (Hornsey & Fielding, 2017). That is, an individual’s political identity influences the depth and direction of information processing such that ingroup attitudes
and values are upheld. In two studies related to climate change policy, Fielding et al. (2020) found that self-identified Democrats and Republicans demonstrated greater support for and intent to engage in policy-supportive behavior when the related policy was endorsed by members of their ingroup as compared to outgroup endorsement. In contrast, people show little sign of processing of messages from outgroup members (Fielding et al., 2020; Mackie et al., 1990, 1992).

**Characteristics of the Message Receiver**

As described, characteristics of the message (belief-congruent or incongruent) and messenger (ingroup or outgroup) can influence the depth and direction of information processing. Characteristics of the message receiver also have a role. I focus on two cognitive and personality variables that potentially influence processing, and thus, the outcome of persuasion: need for cognition (NFCog) and need for closure (NFClo).

**Need for Cognition.** NFCog refers to the degree to which individuals willingly engage in and enjoy effortful thought and is a crucial component of ELM (Cacioppo & Petty, 1982). Haugtvedt and Petty (1992) demonstrate the influence of NFCog, and the persistence of beliefs formed through each route, in two studies. Participants were exposed to a persuasive message that included two important components: strong arguments, designed to appeal to individuals high in NFCog, and a credible source, designed to appeal to individuals lower in NFCog. Both high and low need for cognition individuals similarly updated their beliefs to better align with the presented position. However, differences were revealed when participants reported beliefs again two days later. Low-NFCog individuals had reverted to their original beliefs, while high-NFCog retained their updated attitudes. A second study revealed similar differences in robustness.
of belief change, even when the new attitudes were challenged just a few minutes after initial persuasion. The authors theorize that these differences in the staying power of belief change are a direct result of processing route (Figure 1). People who are relatively high in NFCog are more likely to elaborate than people who are not. The direction of elaboration (accept vs. reject) may depend on other factors like messenger affiliation and congruence with existing attitudes.

**Need for Closure.** Need for closure is a desire for “an answer on a given topic, any answer… compared to confusion and ambiguity” (Kruglanski, 1990). Kruglanski and Webster (1996) suggest that NFClo induces two distinct but related tendencies: seizing, the tendency to accept the first available answer; and freezing, the desire to maintain achieved closure. In three studies, Kruglanski et al. (1993) examined the association between NFClo and outcomes of persuasive attempts. In their initial study, they established that high-NFClo individuals were generally more resistant to persuasion. In two follow-up studies, they identified an interaction between NFClo and informational base (i.e., existing opinion), with high-NFClo being associated with resistance to persuasion only in the presence of an existing opinion. A meta-analysis conducted by Kossowska et al. (2018) paints a complex picture of the relationship between NFClo and cognitive processing. For example, these researchers note that individuals high in NFClo may engage in “effortful, open-minded” processing in order to reduce uncertainty. Whether through low- or high-effort processing, it may be that once individuals with relatively higher NFClo seize on a belief, they resist novel information that challenges that belief more so than their lower-NFClo counterparts.

**Summary**
To review, ELM posits two routes to persuasion—the rapid, intuitive peripheral route and the slow, analytical central route—distinguished primarily by the depth of processing, or elaboration, involved (Petty & Cacioppo, 1986). Dual-processing theories such as ELM are well-supported (Lavine, 1999); however, prior research has not reliably determined when a person will engage the central versus peripheral route. Additionally, it is not clear when each route will serve to weaken or reinforce existing beliefs. Thus, the factors and cognitive processes that determine depth and direction (i.e., belief updating or entrenchment) of processing remain largely unidentified (Kitchen et al., 2014; Knobloch-Westerwick & Meng, 2009). This poses a challenge for understanding how to debias people’s beliefs.

Research suggests that the ideal outcome of processing of debiasing information about polarized sociopolitical issues is elaborative acceptance via the central route, but there is a dearth of reliable means of guiding people toward this end. In theory, two conditions must be met to make productive belief updating possible. First, the peripheral route must be bypassed, preventing automatic rejection. Second, the central route must be engaged in the service of belief updating rather than belief maintenance or entrenchment. Research on exploratory learning and conceptual knowledge development to update misconceptions in STEM education provides a promising solution for meeting these conditions.

**Exploratory Learning**

With traditional education, as with traditional persuasion, the messenger’s goal is often to direct the receiver (e.g., learner) to a predetermined concept or solution. In contrast, exploration encourages individuals to process information themselves and arrive
at their own conclusions before being exposed to other perspectives. Research indicates that exploration-based learning activities can encourage richer conceptual understanding of problems and their underlying dimensions (DeCaro & Rittle-Johnson, 2012; Weaver et al., 2018).

*Exploratory learning* may refer broadly to any activities that allow people to explore and engage with new topics prior to receiving canonical solutions, or explicit instruction on how to understand given material. In contrast, direct instruction refers to traditional instructional methods in which the learner is generally the passive recipient of knowledge (e.g., lecture courses). Sociopolitical beliefs are often strongly held, which may create a heightened sense of prior topic knowledge and expertise. As a result, in traditional approaches to persuasion, a direct approach may immediately be perceived as challenging, priming one’s preexisting beliefs (i.e., knowledge) and triggering rejection by peripheral processing or more elaborative rejection via central processing. Exploratory learning approaches may be especially useful in disarming these belief-maintaining processes because exploring debiasing information firsthand, without exposure to obvious persuasive cues, may bypass these rejection processes altogether and allow individuals to engage in less biased, elaborative processing. Such exploration of debiasing information prior to explicit persuasion might increase receptivity to later persuasion, in the same or similar way that exploration prior to formal instruction improves conceptual understanding and prepares for future learning in STEM. This process is described next.

Loibl et al. (2017) proposed three cognitive mechanisms that may underlie the benefits of exploration: activation of prior knowledge, recognition of knowledge gaps,
and identification of deep features of the problem (Figure 3). When people encounter the problem, they activate their relevant prior knowledge. In the exploratory learning phase, they explore the problem and ideally identify what gaps there are in their knowledge that they need to fill in order to successfully approach the problem. In seeking to address those gaps, they recognize deep features of the problem, or the most important aspects. Finally, bringing this acquired experience into the explicit instruction phase, prior knowledge and new information are integrated and comprehension is increased. These mechanisms are briefly described below, then the potential role of these (or similar) mechanisms in sociopolitical persuasion is discussed. There are important commonalities and differences in these processes.
Figure 3. Diagrammatic representation of knowledge acquisition in exploratory learning followed by instruction. Source: Loibl et al., 2017.
**Activating Prior Knowledge**

People draw on existing knowledge to solve novel problems, and this activation helps integrate new information into existing mental models. However, prior knowledge can be flawed or incomplete. Schwartz et al. (2007) write, “If students cannot make sense of a lesson with their pre-existing knowledge, they will not understand” (p. 8). Because the quality of prior knowledge varies, Schwartz and his colleagues differentiate between *prior knowledge*, which students already have and bring to bear on the problem, and *earlier knowledge*, which students are guided to acquire in early stages of the learning process. Earlier knowledge is precise and specifically intended to help students recognize important features of problems in order to prepare them for future learning. Activation of prior knowledge (or earlier forms of knowledge) is a precondition for recognizing knowledge gaps (Loibl et al., 2017).

**Recognizing Knowledge Gaps**

In order to identify what information is needed to solve a problem, people must recognize that they lack important knowledge. In direct instruction, knowledge gaps are often pointed out by an instructor; however, experiencing the inadequacies of one’s knowledge firsthand is more effective (Loibl et al., 2017). For example, in recognizing what they do not know, people become more curious and more interested in understanding the problem (Glogger-Frey et al., 2015). Siegler (1983, as cited in Loibl et al., 2017) highlights the importance of prediction error, suggesting that people are motivated to learn and revise their understanding when predictions based on their current understanding fail. Making errors can trigger identification of flaws in existing mental models of a problem and help prepare people to learn from subsequent instruction.
Identifying Deep Features of the Problem

A proposed benefit of productive failure is that it facilitates identification of deep features of a problem (Kapur & Bielaczyc, 2012). Identifying the key components of a problem or issue and how they relate to one another deepens understanding and aids in problem solving. Some exploratory learning approaches are more effective than others in facilitating learners’ identification of deep features.

Although these mechanisms are not explicitly designated in the literature as occurring sequentially, Loibl et al. (2017) suggest through their logic and schematic depiction of the mechanisms (see Figure 3) that they occur in a hierarchical fashion, such that activation of prior knowledge enables recognition of knowledge gaps, which in turn enables making modifications to existing mental models (e.g., correcting flaws, identifying deep features of the problem, organizing knowledge). As people advance through these mechanisms, their cognitive processing arguably becomes progressively more elaborative, and thus should resemble outcomes predicted by ELM in the realm of persuasion. The benefits to conceptual understanding that exploratory learning provides support this view. How these (or similar) mechanisms might be employed to improve sociopolitical information processing, and ultimately belief updating, merits investigation.

Both educational instruction and sociopolitical persuasion are dependent on the learner or message receiver understanding and integrating the message content into existing knowledge structures, and numerous parallels exist between the two areas, with some important differences crucial to understanding sociopolitical versus STEM belief-updating.
The Prior Knowledge Problem

Persuasion, like instruction, can take several forms, varying from direct presentation of information to more subtle delivery methods. Direct persuasion may function best when message receivers have yet to form any strong beliefs about an issue (i.e., low prior topical knowledge of an issue). When people have even a basic prior knowledge—at least sufficient to interact with the subject matter—exploration might help people create connections between ideas and integrate new information into existing schemas.

A bare minimum of prior knowledge is crucial to elaborative processing; however, it is important to note that prior knowledge can be incomplete or inaccurate. When such flaws in prior knowledge persist, they can lead to deeper misunderstanding and entrenchment of misinformed beliefs (Schwartz et al., 2007). This principle is especially relevant and concerning for sociopolitical belief updating, where prior knowledge is potentially incomplete or misinformed. Activation of such prior knowledge presumably leads to deeper misunderstanding and entrenchment, rather than serving as a basis for corrective belief updating. In STEM education, providing earlier forms of knowledge (e.g., data, examples) prior to direct instruction helps to ensure that learners have critical information necessary for future learning (Schwartz et al., 2007). Although previously untested, the same method may facilitate belief updating in sociopolitical topic areas: establishing earlier knowledge of sociopolitical issues by, for example, providing debiasing numeric data related to an issue might improve the effectiveness of corrective persuasive messages. In the context of persuasion, prior knowledge can be thought of as people’s existing beliefs. In contrast, earlier forms of knowledge are provided during the
course of learning—or, in this case, the persuasive attempt—and do not aim to correct beliefs, but rather to provide accurate foundational information and alert people to misinformed assumptions that might inform those beliefs.

**Knowledge Gaps and Prediction Error**

In order for people to update misinformed beliefs, they must become aware of the underlying misconceptions and gaps in knowledge of relevant issues. Like in direct instruction, direct persuasion techniques often involve pointing out knowledge gaps, telling people what they presumably do not know and should instead think. This approach tends to backfire in sociopolitical persuasion due to the many biases previously discussed. Indirect approaches, again, appear to offer a fruitful alternative. Siegler (1983, as cited in Loibl et al., 2017) highlights the importance of prediction error in helping bring awareness to knowledge gaps, suggesting that people are motivated to learn and revise their understanding when predictions based on their current understanding fail.

Prediction error has also been studied in the context of sociopolitical belief updating. Vlasceanu and colleagues (2021) collected self-reported beliefs about the accuracy of both neutral and politically charged statements. Some participants were then asked to make predictions about factual information associated with each statement before being provided with the correct answer. They found a positive, linear relationship between size of prediction error and magnitude of belief updating: individuals who made large predictive errors showed greater belief change at posttest compared to those who made small errors or did not make predictions (control group).

People with strong—but incomplete or misinformed—opinions about polarized issues might perceive themselves to have considerable mastery of the issue, making them
less likely to spontaneously address inconsistencies or lapses in their understanding. If belief updating requires recognizing the limits of one’s knowledge, placing people in a situation (i.e., exploratory learning paradigm) designed to induce productive failure (i.e., one in which their existing beliefs cannot account for the data, creating a predictive error) and establish earlier forms of knowledge might help people identify their own incorrect or incomplete conceptual models of sociopolitical issues. If so, this experience may prepare them to elaboratively process subsequent persuasive messages in a debiasing way.

**Identifying Deep Features of Complex Issues**

Many sociopolitical issues are complex, making them particularly vulnerable to distortion and misconception. Exploratory learning methods might provide a way to encourage people to appreciate such complexity and focus on the most important features of a sociopolitical issue. Whether achieved via self-evaluation or carefully designed instruction, identifying deep features helps learners develop a richer conceptual understanding of problems and improves ability to solve similar problems. It is possible that an inaccurate or incomplete understanding of the deep features of sociopolitical issues prevents people from updating misinformed beliefs in the face of contradictory information. If so, helping people identify these deep features (e.g., outcomes of policies) could facilitate belief updating.

In two experiments, I investigated how problematic outcomes of persuasion attempts described above might change when people independently explore issue-relevant data prior to receiving any direct persuasive messaging. Using exploratory learning phases designed to avoid activating counterproductive prior knowledge like
political identity and biases, while establishing earlier forms of knowledge that may serve an important debiasing role in sociopolitical belief updating, I examine the results through the lens of ELM and the cognitive mechanisms underlying the benefits of exploration as proposed by Loibl et al. (2017).
CHAPTER II

INVESTIGATING EFFECTS OF EXPLORATORY LEARNING ON BELIEFS ABOUT CLIMATE-RELATED ISSUES

People’s responses to persuasive messages depend on how they process the presented information. According to ELM, the depth (superficial vs. elaborative) and outcome of message processing (acceptance vs. rejection) depend on numerous factors. Two of these factors, belief congruence and messenger affiliation, are particularly salient in sociopolitical messaging, and can serve as powerful cues that prevent people from elaborating on information in a debiasing, rather than entrenching, way.

When people engage in an exploratory activity in STEM education, they often experience difficulty in solving the problem because they lack the requisite prior knowledge. Ideally, they then become aware of gaps in their understanding and notice important problem features. Schwartz & Martin (2004) describe this beneficial struggle as “preparation for future learning”. Similarly, Kapur’s (2016) concept of “productive failure” indicates that encountering difficulties and impasses in problem solving can be conducive to subsequent learning. People might be better prepared for future persuasion in much the same way. Exploratory learning activities create a situation in which individuals use elaborative cognition to make sense of a problem. If applied to sociopolitical persuasion, this elaboration in a less threatening, less politicized environment may reduce the likelihood of deliberative counterarguing, increasing receptivity to persuasive messages.
In two experiments, I apply exploratory learning techniques in the novel context of sociopolitical persuasion in order to investigate their utility as means of communicating counter-attitudinal information in a way that bypasses automatic rejection and discourages deliberative counterarguing. Participants are presented with counter-attitudinal information in two forms: numeric data tables and persuasive verbal messages. These materials were based on the earlier reported study by Washburn and Skitka (2018), with specific modifications to address my central hypotheses.

An important goal of the exploration phase in these experiments is to highlight gaps in participants’ current knowledge and draw attention to key aspects of the problem. Because the use of exploratory learning outside of STEM fields has rarely been investigated, Experiment 1 was intended to determine the feasibility of exploratory learning models in the distinctive context of sociopolitical persuasion. Because the primary purpose was to examine the simple effect of exploration, persuasive messages and data tables are not attributed to any particular source. Experiment 2 expands on Experiment 1 by attributing persuasive messages to a partisan source to introduce messenger affiliation as an independent variable.

**Experiment 1**

Experiment 1 was intended foremost to evaluate the viability of exploration as a tool for debiasing processing, specifically in the absence of strong cues like group affiliation. As such, participants were divided into two experimental conditions: explore-first (EF) and message-first (MF). Participants in the EF condition explored a data table prior to receiving a persuasive message, while MF participants viewed the persuasive message before exploring the data table. This order-based paradigm is common in the
exploratory learning literature. In addition, I measured Need for Cognition, Need for Closure, and Big Five personality traits via established surveys (Lins de Holanda Coelho et al., 2020; Roets & Van Hiel, 2011; and Rammstedt & John, 2007; respectively). Two of the Big Five traits, conscientiousness and openness to experience have been linked to conservatism and liberalism, respectively (e.g., Carney et al., 2008; Van Hiel et al., 2000). In the unlikely event that political affiliation is associated with belief updating, I will use this data to test whether differences between political parties might be better attributed to personality traits.

**Hypothesis 1**

Participants who explore numeric data tables as an exploratory activity before receiving a corresponding verbal message (EF condition) will demonstrate greater belief updating compared to participants who view the verbal message first. This updating may manifest directly as changes in support for the experimental position, indirectly as changes in confidence in beliefs, or both. Support for the experimental policy constitutes a direct measure of beliefs. I also include an indirect measure of belief change—confidence in beliefs. Exploratory learning in STEM has been shown to help prepare students for future learning (Loibl et al., 2017). A change in confidence, even in the absence of a change in support, may amount to a similar phenomenon, indicating that participants have become more open to future persuasive arguments. Exploring debiasing numeric evidence in the absence of ideologically charged cues may alert participants to potential problems in their mental models of the issue and facilitate central-route processing. In contrast, I expect that participants who receive the verbal persuasive message first (MF condition) will identify the provided information as counter-attitudinal
and a deliberate attempt to persuade, priming defensive cognition and preventing debiased processing of the subsequent numeric data. This will result in either no change in beliefs as measured by support and confidence or negative change (belief entrenchment). Little or no change in beliefs among MF participants will suggest that they processed the counter-attitudinal information relatively superficially through the peripheral route, while negative belief change (i.e., a decrease in support) will be taken as evidence of counterarguing via the central route.

**Hypothesis 2**

People who are relatively high in NFCog are more likely to elaborate than people who are not. Thus, I hypothesize that individuals high in NFCog will demonstrate greater belief updating that their low-NFCog counterparts when encountering persuasive information with minimal biasing cues (i.e., EF condition). If high-NFClo individuals, in contrast, “seize” and “freeze” as theorized, then these individuals will demonstrate greater cognitive rigidity in the form of lesser belief change. I was unable to locate any literature to suggest that exploratory learning should affect people differently dependent on NFClo; thus, I expect individuals high in NFClo to demonstrate less change in support and confidence across order conditions,

**Method**

**Participants**

Participants were 125 undergraduate students ages 18 to 59 ($M = 19.7$, $SD = 4.73$, 83% female, 62% Democrat, 21% Republican, 17% Independent) from the University of Louisville, a public metropolitan university in the southern United States. Students were recruited from the University’s psychology student research pool, which was composed
of students enrolled in introductory psychology courses. These students participated in research studies for course credit. Students select and sign up for open studies via the Sona Systems research participation platform. The experiment reported here was listed as an online, survey-based study titled “Sociopolitical Beliefs and Cognition.”

Twelve participants were excluded for exceeding or failing to meet the minimum acceptable duration. Acceptable duration was calculated using the interquartile-range method of identifying outliers. The final sample included 112 participants.

A G*Power analysis for a repeated measures, within-between interaction, $\alpha = .05$, power = .80, number of groups = 2, number of measurements = 2, indicated that a sample size of 104 would be sufficient to observe a partial $\eta^2$ of .02 (small-medium effect).

**Design**

The experimental design was a 2 time (T1, T2) $\times$ 2 order (MF, EF) repeated-measures mixed factorial ANOVA, which allowed testing for the effect of order (MF or EF) on beliefs at T1 and T2, as measured by support for a position and confidence in beliefs. There were several judgement calls, the rationale for which I explain next. First, this design assumes no significant differences by political affiliation or experimental issue in either initial beliefs or belief change. If differences arose, the design could be expanded to include political affiliation and/or issue as a factor. Next, I designed the experiment such that participants would encounter stimuli related to a position to which they had previously indicated opposition. I do not expect participants to respond differently based on which set of stimuli (i.e., which issue) they viewed, but chose this approach in an attempt to gather data from individuals with various views. Similarly, I do not expect liberal and conservative participants to behave differently in response to the
study materials. If these expectations are confirmed, I will not distinguish between experimental issue (electric vehicle incentives or carbon taxes) or political affiliation (liberal or conservative) in statistical analyses.

After being assigned an experimental issue based on reported beliefs, participants were randomly assigned to order condition. I did not include a condition in which participants encountered stimuli that supported their current beliefs because, as described in the introduction, previous research has established that belief-congruent information is readily accepted. Thus, including a belief-congruent condition would not contribute to an understanding of how exploration might help avoid biased processing of belief-incongruent information.

The primary dependent variable in this experiment is change in support for a particular sociopolitical position. Because it is possible that underlying cognitive processes might be altered even in the absence of observable belief change, I also included a repeated-measure item intended to measure a less direct indicator: confidence in beliefs. Exploration could lead to decreased confidence in a belief that appears otherwise unchanged, suggesting a decrease in cognitive rigidity about the issue in question. This inclusion provides a broader view of potential benefits of exploration.

The two personality constructs measured, NFCog and NFClo, are included because I hypothesized that they are elements of cognitive rigidity and might have a significant relationship with belief change. If this relationship is not corroborated in preliminary analyses, they will be dropped from subsequent analyses.

This experiment included three exploratory measures intended to inform follow-up studies. First, participants reported how much time they spent thinking about the
position. Second, they reported the perceived novelty of their thoughts. Third, participants were asked to report all of the thoughts they had while exploring the data table. The rationale for subjective time and perceived novelty of thoughts is that participant responses could provide insight into both the depth (superficial vs. elaborative) and direction of processing (e.g., very little time spend thinking suggests peripheral processing; high novelty suggests more elaborative central processing). The thought-listing phase was included because participants’ self-described thought processes could help identify which biases were or were not activated by the stimuli, and perhaps reveal cognitive patterns that impede or facilitate debiasing elaboration. Analyzing these metacognitive reports—in particular, the thought-listing phase—requires careful coding, and due to time constraints, this analysis was not reported here. Nevertheless, these exploratory measures warrant description as even the incomplete information they provide may be valuable for interpreting the reported results.

Materials

Materials included two data tables and two persuasive messages constructed for an exploratory learning phase and a direct persuasion phase, respectively, as well as the short versions of the Need for Cognition Scale (Lins de Holanda Coelho et al., 2020) and the Need for Closure Scale (Roets & Van Hiel, 2011).

Data Tables

Experimental stimuli were developed for two sociopolitical issues: electric vehicle incentives and carbon taxes. I chose these issues in particular for their shared relation to climate change and sustainability, and for their relative lack of moral associations (e.g., as compared to one of the filler items, gun control policy). Further, I
thought that participants’ beliefs about these two issues as framed in the study were likely to differ (i.e., support for one of the experimental positions would likely be paired with opposition to the other), and by including both, I hoped to broaden the sample to include people of various beliefs.

Two data tables, one for each experimental issue, were constructed with identical numeric content but different axis labels and descriptions (adapted from Washburn & Skitka, 2018). Figure 4 shows the table and description for the carbon tax issue (see Appendix C for both tables).

Figure 4.

*Example Data Table (Debiasing Information): Carbon Taxes*

Carbon emissions are carbon compounds released into the atmosphere, and are produced from the burning of fossil fuels such as coal and gas. These emissions are thought to contribute to local and global climate change, among other things. A Carbon Tax is a fee paid by major producers and users of fossil fuels (e.g., energy companies, corporations). This tax is intended to pay for solutions to counteract potential side-effects of carbon emissions (e.g., planting trees, alternative energy sources).

The table below shows data compiled from several reports about the effects of Carbon Taxes on the economic prosperity of different cities. Here, economic prosperity refers to general economic growth, security, and wealth. Please examine the table carefully and come to your own conclusions about the data.

<table>
<thead>
<tr>
<th>Economic Prosperity</th>
<th>Total # of Cities</th>
<th>Improved</th>
<th>Decreased</th>
<th>Percentage Improved</th>
<th>Percentage Decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cities with carbon tax</td>
<td>128</td>
<td>107</td>
<td>21</td>
<td>83.6%</td>
<td>16.4%</td>
</tr>
<tr>
<td>Cities with no carbon tax</td>
<td>298</td>
<td>223</td>
<td>75</td>
<td>74.8%</td>
<td>25.2%</td>
</tr>
</tbody>
</table>

*Persuasive Messages*
To accompany the respective data tables, I developed two persuasive messages, one for each of the two experimental issues. The two messages were structured as similarly as possible given the distinct subject matter. The message for the carbon tax issue was displayed as follows (see Appendix C for both persuasive messages):

*People often think that carbon taxes will hurt the United States’ economy and cause economic distress for the American people. However, recent research shows that carbon taxes can be implemented with little to no economic harm. In fact, some countries have seen economic benefits from carbon taxes. In one North American community, for example, more than $1 billion generated by the carbon tax has been returned to the people’s households and businesses. Low-income families and small businesses are receiving tax credits, and their tax rates have been reduced. A one-time payment was also given to every resident. Each year, human activities release more carbon dioxide into the atmosphere than natural processes can remove, causing the amount of carbon dioxide in the atmosphere to increase. Research shows that carbon taxes work to lower greenhouse gas emissions. So, there is good evidence that it is possible to design carbon taxes that can actually contribute to a country’s economic prosperity while reducing carbon emissions. Introducing a nation-wide carbon tax in the United States is a promising direction for addressing climate change without hurting the economy.*

*Need for Cognition Scale*

The short form of the Need for Cognition Scale (Cacioppo & Petty, 1982) developed by Lins de Holanda Coelho et al., 2020 consists of six statements (e.g., *I would
prefer complex to simple problems; Thinking is not my idea of fun). For each statement, respondents rate their agreement on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scores are calculated by adding responses of all items. See Appendix A.

Need for Closure Scale

The short form of the Need for Closure Scale developed by Webster and Kruglanski (1994) and revised by Roets and Van Hiel (2011) consists of 15 statements (e.g., I don’t like situations that are uncertain; When I have made a decision, I feel relieved). For each statement, respondents rate their agreement on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scores are calculated by adding responses of all items. See Appendix B.

Big Five Personality Scale

The brief form of the Big Five Inventory developed by Rammstedt & John (2007) consists of 10 statements, two for each of the Big Five personality traits (e.g., for openness, I see myself as someone who has an active imagination; for conscientiousness, I see myself as someone who does a thorough job). For each statement, respondents rate their agreement on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scores are calculated by adding responses for each pair of items, resulting in a score for each of the Big Five traits. See Appendix XX.

Thought Listing

An open-response thought-listing phase was included to collect participants’ subjective experiences of their cognitive processes while engaging with the data table. Participants were prompted with the following text:
We are now interested in everything that went through your mind while you were viewing the data table you saw earlier in this study. Please list these thoughts, whether they were about yourself, the data, and/or the issue; whether they were positive, neutral, and/or negative. You do not need to worry about spelling, grammar, and punctuation. Please be completely honest. Simply write down your thoughts as best as you can remember them. Please ignore any new thoughts you have had since you moved on from the data table.

All participants had at least two minutes to write, as the button to continue did not appear until two minutes had elapsed. The thought-listing phase also included two items, both measured using a 5-point scale, presented directly after the open-response portion. The first was a measure of subjective time spent thinking about the data table before coming to a conclusion. The second was a measure of perceived novelty of thoughts while considering the data table. This thought-listing phase was included primarily to collect qualitative data to inform follow-up studies. Participant responses to these three items were not analyzed for this dissertation.

**Political Affiliation**

Political affiliation was elicited with the question, “Which major political group do you identify with the most?” Possible responses were Democrat, Republican, Independent – Democrat leaning, Independent – Republican leaning, and Independent – Non-partisan. For analyses, Democrat and Independent – Democrat leaning were collapsed, as were Republican and Independent – Republican leaning.

**Procedure**
This experiment was conducted entirely online via Qualtrics, an online survey software. Upon opening the study link, participants encountered a preamble that served as informed consent. Next, they were asked to report their beliefs about four randomly presented sociopolitical issues: carbon taxes and electric vehicles (experimental positions) and gun control and illegal immigration (included for exploratory purposes). Beliefs included general support (e.g., *How strongly do you support or oppose this position?*) as well as confidence in beliefs (*How confident are you in your beliefs about this position?*).

After reporting their beliefs, participants were presented with either a data table or a persuasive message in support of one of the two experimental positions. Which set of stimuli they encountered depended on their previous responses, with the survey flow directing each participant to an issue to which they had expressed opposition. Thus, all participants viewed counter-attitudinal stimuli. The order in which they viewed the stimuli was randomized. Participants in the explore-first condition (EF) first viewed the data table, were asked to report any conclusions they may have drawn from it, and report their confidence in those conclusions. Next, they were presented with the corresponding persuasive message. Participants in the message-first condition (MF) encountered stimuli in the reverse order, first viewing the persuasive message, then viewing the data table and reporting conclusions and confidence. Next, all participants were asked to report their beliefs about all of the sociopolitical positions a second time.

Participants were then prompted to list the thoughts they had while viewing the data table using an open-response format (thought-listing phase described above). To prevent participants from immediately skipping this portion of the study, participants
were informed that they had two minutes to write and that the button to proceed would appear after this time had elapsed. Directly after the thought-listing item, participants were asked to indicate how long they spent thinking about the data table before coming to a conclusion and the extent to which their thoughts about the issue were similar or different from any they may have had in the past. These three items—thought listing, subjective time spent, and subjective novelty of thought—were exploratory items and will not be described here.

Next, participants completed the short version of the Need for Cognition Scale (NFCog; Lins de Holanda Coelho et al., 2020), the short version of the Need for Closure Scale (NFClo; Roets & Van Hiel, 2011), and the 10-item Big Five Inventory (Rammstedt & John, 2007). Participants were also asked to provide demographic information (i.e., race, sex, political affiliation). Finally, they were debriefed, thanked, and presented with a brief message about misinformation and disinformation.

Results

Preliminary Analyses

Mean support ratings for each position are reported in Table 1, organized by time and political party. Democrat and Republican categories include participants who identified as Democrat or Democrat-leaning and Republican or Republican-leaning, respectively.

Table 1.

Mean Support Ratings for Sociopolitical Positions by Political Affiliation
As anticipated, liberal and conservative participants did not show differences in initial support for experimental positions (carbon tax or EV incentives) or in belief change \( (F(2, 109) = .02, p = .985) \), so I collapsed across political affiliation, resulting in a 2 order (EF, MF) \( \times \) 2 time (T1, T2) design for further analyses (Figure 5).

**Figure 5.**

*Support for Position by Political Party*

<table>
<thead>
<tr>
<th></th>
<th>Democrat ((N = 70))</th>
<th>Republican ((N = 23))</th>
<th>Independent ((N = 19))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Tax</td>
<td>Time 1: 3.99(.87)</td>
<td>Time 2: 3.93(.80)</td>
<td>Time 1: 3.04(.92)</td>
</tr>
<tr>
<td>EV Incentives</td>
<td>Time 1: 2.33(.59)</td>
<td>Time 2: 3.04(.83)</td>
<td>Time 1: 2.96(.122)</td>
</tr>
<tr>
<td>Gun Control</td>
<td>Time 1: 4.48(.62)</td>
<td>Time 2: 4.37(.70)</td>
<td>Time 1: 2.86(.46)</td>
</tr>
<tr>
<td>Immigration</td>
<td>Time 1: 1.93(.81)</td>
<td>Time 2: 1.99(.93)</td>
<td>Time 1: 3.18(1.15)</td>
</tr>
</tbody>
</table>

*Note.* Support was measured using a 5-point scale.

As anticipated, liberal and conservative participants did not show differences in initial support for experimental positions (carbon tax or EV incentives) or in belief change \( (F(2, 109) = .02, p = .985) \), so I collapsed across political affiliation, resulting in a 2 order (EF, MF) \( \times \) 2 time (T1, T2) design for further analyses (Figure 5).

Initially, I expected NFCog and NFClo to be related to both each other and the primary dependent variable of belief change. Descriptive statistics and correlations among the dependent variables are reported in Table 2. Preliminary analyses revealed no
significant correlations of interest for NFCog, NFClo, conscientiousness, or openness to experience. Conscientiousness was weakly related to confidence at T2, but not support for position.

Table 2.

Correlation Matrix and Descriptives

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Support T1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.57 (.53)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Support T2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.11 (.69)</td>
<td>.356**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Confidence T1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.52 (.85)</td>
<td>-.365**</td>
<td>-.094</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Confidence T2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.25 (.88)</td>
<td>-.082</td>
<td>.014</td>
<td>.188*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Need for Cognition&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.67 (2.15)</td>
<td>.058</td>
<td>.158</td>
<td>-.068</td>
<td>.083</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Need for Closure&lt;sup&gt;c&lt;/sup&gt;</td>
<td>52.39 (7.95)</td>
<td>-.076</td>
<td>-.028</td>
<td>.047</td>
<td>-.071</td>
<td>-.076</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Conscientiousness&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.36 (1.40)</td>
<td>-.234*</td>
<td>-.066</td>
<td>.123</td>
<td>.228*</td>
<td>.126</td>
<td>-.031</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Openness&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.23 (1.72)</td>
<td>.065</td>
<td>.027</td>
<td>.133</td>
<td>.039</td>
<td>.001</td>
<td>-.119</td>
<td>.130</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>9. Response Time</td>
<td>2.23 (.28)</td>
<td>-.066</td>
<td>-.110</td>
<td>.178</td>
<td>.101</td>
<td>-.222*</td>
<td>.033</td>
<td>-.086</td>
<td>.101</td>
<td>-</td>
</tr>
<tr>
<td>10. Conclusion Confidence&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.41 (.94)</td>
<td>-.015</td>
<td>-.015</td>
<td>.081</td>
<td>-.017</td>
<td>.041</td>
<td>.113</td>
<td>.018</td>
<td>-.054</td>
<td>-.015</td>
</tr>
</tbody>
</table>

*<sup>p</sup> < .05, **<sup>p</sup> < .01.

<sup>a</sup>Score range of 1-5.

<sup>b</sup>Score range of 6-30.

<sup>c</sup>Score range of 15-75.

<sup>d</sup>Score range of 2-10.

A one-way ANCOVA with a DV of Support at T2, IV of Order, and covariates Support at T1, NFCog, NFClo, conscientiousness, and openness indicated only a significant influence of Support at T1 after controlling for the other variables (Table 3).

Further analyses of these covariates are not reported here in order to simplify the research design.
Table 3.

One-Way ANCOVA with Support at Time 2 as Dependent Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>.51</td>
<td>1</td>
<td>.51</td>
<td>1.22</td>
<td>.271</td>
<td>.01</td>
</tr>
<tr>
<td>Support at T1</td>
<td>6.09</td>
<td>1</td>
<td>6.09</td>
<td>14.55</td>
<td>&lt;.001</td>
<td>.12</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.978</td>
<td>1</td>
<td>.978</td>
<td>2.34</td>
<td>.129</td>
<td>.02</td>
</tr>
<tr>
<td>Need for Closure</td>
<td>.018</td>
<td>1</td>
<td>.018</td>
<td>.04</td>
<td>.835</td>
<td>.00</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.002</td>
<td>1</td>
<td>.002</td>
<td>.00</td>
<td>.948</td>
<td>.00</td>
</tr>
<tr>
<td>Openness</td>
<td>.001</td>
<td>1</td>
<td>.001</td>
<td>.00</td>
<td>.960</td>
<td>.00</td>
</tr>
<tr>
<td>Order (MF or EF)</td>
<td>.543</td>
<td>1</td>
<td>.543</td>
<td>1.30</td>
<td>.257</td>
<td>.01</td>
</tr>
<tr>
<td>Error</td>
<td>43.94</td>
<td>105</td>
<td>.418</td>
<td>1.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Next, I conducted a series of repeated-measures ANOVAs to address my research questions. Means and standard deviations for all DVs are presented in Table 2. There was homogeneity of variances for support scores between conditions, as assessed by Levene’s test for equality of variances ($ps > .49$).

Support for Position

There was a main effect of time, $F(1, 110) = 61.03, p < .001$, partial $\eta^2 = .355$, indicating that support was significantly higher at Time 2 ($M = 3.10$, $SD = .07$, 95% CI [2.97, 3.23]) than at Time 1 ($M = 2.57$, $SD = .05$, 95% CI [2.47, 2.67]; Figure 6). The effect of order on support was not significant, $F(1, 110) = .03, p = .858$, partial $\eta^2 = 0$. The interaction of order and time was also not significant, $F(1, 110) = 1.35, p = .247$, partial $\eta^2 = .012$.

Figure 6.

Support for Position at Time 1 and Time 2 by Order
Note. Support for position was measured using a 5-point scale. Error bars represent 95% CI.

Planned comparisons revealed no significant difference in support at Time 2 for MF (M = 3.16, SD = .71) and EF (M = 3.05, SD = .65), t(110) = .82, one-tailed p = .207, 95% CI [-.15, .37], Cohen’s d = .16).

Confidence

There was a main effect of time, with confidence dropping significantly from T1 (M = 3.51, SD = .08, 95%CI [3.35, 3.67]) to T2 (M = 3.23, SD = .08, 95%CI [3.07, 3.40], F(1, 110) = 6.76, p = .01, partial $\eta^2 = .057$ (Figure 7). The effect of order on confidence in beliefs was not significant at the .05 level, F(1, 110) = 2.52, p = .115, partial $\eta^2 = .022$. The interaction of order and time was also not significant, F(1, 110) = .97, p = .328, partial $\eta^2 = .009$.

Figure 7.

Confidence in Beliefs at Time 1 and Time 2 by Order
Note. Confidence was measured using a 5-point scale. Error bars represent 95% CI.

Planned comparisons revealed a significant difference in confidence at Time 2 between MF ($M = 3.38$, $SD = .90$) and EF ($M = 3.08$, $SD = .82$), $t(110) = 1.76$, one-tailed $p = .040$, 95% CI [-.04, .62], Cohen’s $d = .34$.

Time Spent

I performed a logarithmic transformation of time spent on the table to correct for skew. Then, using a median split, I computed a dichotomous variable from time spent viewing the data table, creating low ($\leq 2.22$) and high ($>2.22$) response time groups. I then conducted a $2 \times 2 \times 2$ mixed ANOVA. Time was the only significant effect, $F(1, 108) = 60.50$, $p < .001$, partial $\eta^2 = .359$, with no other main effects or interactions.

Confidence in Conclusion

Similarly, I computed a dichotomous variable from confidence in conclusion ratings, creating low and high confidence groups. I then conducted a $2 \times 2 \times 2$ mixed ANOVA. Again, time was the only significant effect, $F(1, 108) = 62.37$, $p < .001$, with no other main effects or interactions.
Discussion

Participants significantly updated their beliefs, demonstrating increased support for experimental policies. Contrary to hypotheses, the magnitude of change in support did not depend on the order of persuasive stimuli. Further, although confidence in beliefs dropped significantly from time 1 to time 2, this decrease did not depend on order. In short, there was no observed benefit of exploring data prior to reading a persuasive message.

Conscientiousness and openness to experience were not related to belief change, except for a weak positive correlation between conscientiousness and post-persuasion confidence. These null effects are not surprising given that belief change did not differ by political affiliation, which has consistently been linked to these traits (Gerber et al., 2011). Although the experimental issues were designed to be somewhat partisan, they were likely much less polarizing than sociopolitical issues like gun control or immigration (evidenced by differences in support ratings for positions in these domains, Table 1). Perhaps conscientiousness and openness would have significant effects in a study of more politically polarizing issues.

Contrary to initial hypotheses, NFCog and NFClo were neither related to each other nor to post-persuasion beliefs. NFCog is an important element of the ELM, as it is related to an individual’s tendency to elaborate on information they encounter (Petty & Cacioppo, 1986). If high-NFCog individuals elaborate more, perhaps they were elaborating positively and negatively (counter-arguing), masking the influence of NFCog on belief change. Later analysis of the thought-listing data may provide insight into the depth and direction of elaboration as it relates to NFCog. NFClo is a construct
representing, among other things, individuals’ tolerance for ambiguity and preference for
predictability and order (Webster & Kruglanski, 1994). Individuals who are
dispositionally high in NFClo or placed into a situation which increases NFClo are
thought to “seize” and “freeze” on a position, reducing processing of further information
in order to avoid ambiguity (Kruglanski & Webster, 1996). If this is true, it may be that
the stimuli used in the current study did not create significant ambiguity as to cause
discomfort and avoidant changes in processing. As mentioned regarding
conscientiousness and openness, an effect of NFClo might emerge in a study of more
polarizing issues.

Overall, the stimuli were effective in persuading participants to update their
beliefs, at least in the absence of strong peripheral cues. Participants indicated opposition
to the experimental issues, but not strongly, suggesting they may have come into the
study with a greater degree of flexibility than anticipated. Further, these stimuli were
relatively neutral compared to counter-attitudinal information from an obvious outgroup
source. It may be that attempts to discover effects of exploration in the context of biased
cognitive processing are rendered ineffective if the materials do not cue sufficient bias.
Experiment 2 is designed to test this assumption.

**Experiment 2**

In Experiment 1, participants updated their beliefs significantly, and the
magnitude of change was not affected by order condition (EF or MF). Notably, the data
table and persuasive message were presented without any attribution to a particular
source. Next, I conducted a follow-up study that attributed the persuasive message to a
partisan source to allow for testing order effects in the context of peripheral cues (i.e.,
political affiliation) that lead to automatic rejection and/or counterarguing. It may be that EF is only beneficial when encountering information that meets a certain bias threshold (i.e., a counter-attitudinal message from an outgroup messenger).

Participants were again divided into two experimental conditions: explore-first (EF) and message-first (MF). Participants in the EF condition explore a data table prior to receiving a persuasive message, while MF participants view the persuasive message before exploring the data table. The data table is unchanged from Experiment 1; however, the persuasive message is attributed to either a liberal or conservative research center.

**Hypothesis 1**

Participants who explore numeric data tables before receiving a corresponding verbal message from a partisan source will demonstrate greater belief updating (as measured by support for a position and confidence in beliefs) compared to participants who view the verbal message first. Participants who explore data independently prior to receiving the persuasive message will have identified gaps in their knowledge of the issue, making them more receptive to persuasion, even from an outgroup messenger. In contrast, I expect that participants who receive the verbal persuasive message first will flag the source as an outgroup messenger, which prior research indicates will lead to automatic rejection or counterarguing, preventing debiasing elaboration when presented with the subsequent data table.

**Method**

**Participants**

Participants were 162 undergraduate students ages 18 to 76 ($M = 22.02$, $SD = 9.84$, 77.5% female, 61% Democrat, 22% Republican, 17% Independent) recruited from
the University of Louisville student research pool. Eleven participants were excluded for exceeding or failing to meet the minimum acceptable duration. Acceptable duration was calculated using the interquartile-range method of identifying outliers. The final sample included 151 participants.

A G*Power analysis for a repeated measures, within-between interaction, $\alpha = .05$, power = .80, number of groups = 4, number of measurements = 2, indicated that a sample size of 144 would be sufficient to observe a partial $\eta^2$ of .02 (small-medium effect).

Materials and Procedure

Materials and procedure were identical to those of Experiment 1, with one exception: the persuasive messages were attributed to a partisan source. Where the persuasive message in Experiment 1 read, “However, recent research shows…”, the message in Experiment 2 read, “However, research from a [liberal, conservative] political research group shows…” depending on the participants’ initial support ratings.

Results

Preliminary Analyses

Mean support ratings for each position are reported in Table 4, organized by time and political party. Democrat and Republican categories include participants who identified as Democrat or Democrat-leaning and Republican or Republican-leaning, respectively.

Table 4.

Mean Support Ratings for Sociopolitical Positions by Political Affiliation
As in Experiment 1, Democrat, Republican, and Independent participants did not show differences in initial support for experimental policies or in belief change ($F(2,148) = .21, p = .811$), so I collapsed across political party (Figure 8). Following null effects in Experiment 1, NFCog, NFClo, and Big Five were analyzed in Experiment 2 to simplify the design and reduce potential for error.

**Figure 8.**

*Support for Position by Political Party*

<table>
<thead>
<tr>
<th></th>
<th>Democrat ($N = 92$)</th>
<th>Republican ($N = 34$)</th>
<th>Independent ($N = 25$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Tax</td>
<td>3.90(.83)</td>
<td>3.90(.75)</td>
<td>3.96(1.00)</td>
</tr>
<tr>
<td>EV Incentives</td>
<td>2.46(.70)</td>
<td>2.89(.77)</td>
<td>2.96(1.01)</td>
</tr>
<tr>
<td>Gun Control</td>
<td>4.22(.92)</td>
<td>4.22(.89)</td>
<td>3.21(1.09)</td>
</tr>
<tr>
<td>Immigration</td>
<td>2.29(.98)</td>
<td>2.36(.99)</td>
<td>2.76(1.05)</td>
</tr>
</tbody>
</table>

*Note.* Support was measured using a 5-point scale.

*Note.* Error bars represent 95% CI.
Next, I conducted a series of repeated-measures ANOVAs to address my research questions. Correlations, means, and standard deviations for all DVs are presented in Table 5.

**Table 5.**

*Correlation Matrix and Descriptives*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Support T1</td>
<td>2.35 (.63)</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Support T2</td>
<td>2.97 (.83)</td>
<td>.379**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Confidence T1</td>
<td>3.28 (.94)</td>
<td>-.540**</td>
<td>-.357**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Confidence T2</td>
<td>3.30 (.94)</td>
<td>-.314**</td>
<td>-.035</td>
<td>.545**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5. Response Time</td>
<td>2.16 (.31)</td>
<td>-.032</td>
<td>.007</td>
<td>.092</td>
<td>.093</td>
<td>-</td>
</tr>
<tr>
<td>6. Conclusion Confidence</td>
<td>3.39 (1.04)</td>
<td>-.178*</td>
<td>-.033</td>
<td>.216**</td>
<td>.261**</td>
<td>.074</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01.

*Note.* All variables were calculated using a 5-point scale, except Response Time, which was logarithmically transformed from duration in seconds.

**Support for Position**

There was a main effect of time, $F(1, 149) = 86.99, p < .001,$ partial $\eta^2 = .369$ (large effect), indicating that support was significantly higher at Time 2 ($M = 2.98, SD = .07, 95\% CI [2.85, 3.12]$) than at Time 1 ($M = 2.35, SD = .05, 95\% CI [2.24, 2.45]$), Figure 9. The effect of order on support was not significant, $F(1, 149) = .69, p = .407,$ partial $\eta^2 = .005.$ The interaction of order and time was also not significant, $F(1, 149) = 1.75, p = .188,$ partial $\eta^2 = .012.$

**Figure 9.**

*Support for Position at Time 1 and Time 2 by Order*
Note. Support for position was measured using a 5-point scale. Error bars represent 95% CI.

Planned comparisons revealed no significant difference in support at Time 2 for MF ($M = 2.90, SD = .77$) and EF ($M = 3.07, SD = .89$), $t(149) = -1.28$, one-tailed $p = .102$, 95% CI [-.44, .10], Cohen’s $d = -.21$).

Confidence

A 2 (Time) × 2 (Order) repeated-measures mixed ANOVA was conducted to test for effects of order on confidence in beliefs about the experimental position at Time 1 and Time 2. There were no main effects of time ($F(1,149) = .40, p = .527$) or order ($F(1,149) = .50, p = .480$), but a significant interaction between the two emerged, $F(1,149) = 5.62, p = .019$, partial $\eta^2 = .036$. Participants in the MF condition demonstrated a decrease in confidence from T1 to T2, but participants in the EF condition demonstrated an increase (Figure 10).

Figure 10.

Confidence in Beliefs at Time 1 and Time 2 by Order
Note. Confidence was measured using a 5-point scale. Error bars represent 95% CI.

To disentangle the interaction, I conducted two post-hoc paired-samples *t* tests with Bonferroni corrected $\alpha = .025$. The effect of time was stronger for EF ($M_{\text{change}} = .22$ $SD_{\text{change}} = 1.00$, 95% CI [-.03, .47], $t(63) = 1.75, p = .042, d = .22$) than for MF ($M_{\text{change}} = -.13$ $SD_{\text{change}} = .79, t(86) = -1.49, p = .069, d = -.16$), but neither test was significant after correction.

**Time Spent**

Using a median split, I computed a dichotomous variable from time spent viewing the data table, creating low ($\leq 2.19$) and high ($>2.19$) response time groups. I then conducted a 2 (time) $\times$ 2 (order) $\times$ 2 (response time) mixed ANOVA. Time was the only significant effect, $F(1, 149) = 86.02, p < .001$, with no other main effects or interactions.

**Confidence in Conclusion**

Similarly, I computed a dichotomous variable from confidence in conclusion ratings, creating low and high confidence groups. I then conducted a 2 (time) $\times$ 2 (order) $\times$ 2 (confidence) mixed ANOVA. Again, time was the only significant effect, $F(1, 149) = 90.50, p < .001$, with no other main effects or interactions.
Discussion

As in Experiment 1, participants significantly updated their beliefs about experimental positions, demonstrating increased support for positions to which they initially indicated opposition. Contrary to my hypothesis, the magnitude of change in support did not depend on the order of persuasive stimuli, even with the addition of partisan attribution. There was an interaction of time and order on confidence in beliefs, with EF participants demonstrating increased confidence in their beliefs from time 1 to time 2 and MF participants demonstrating a decrease.

The divergent pattern in confidence from time 1 to time 2 by order is pleasantly puzzling. If participants who explore first are more likely to recognize gaps in their knowledge and realize prediction errors, we might expect to see a decrease in confidence in beliefs over time. Instead, participants who explored first demonstrated an increase in confidence over time, while their message-first counterparts’ confidence fell slightly. It may be that all participants updated their beliefs similarly, but those who explored first experienced a “now I have it” moment, resulting in not only a deeper understanding of the issue, but also a metacognitive awareness of that understanding. If so, this experience could explain why EF participants felt more confident afterward than did MF participants. Examining the content of the thought-listing phase could illuminate differences in metacognitive processes between EF and MF conditions.

General Discussion

Sociopolitical information processing—especially about contentious issues—is influenced by many factors, and often fraught with biases. The peripheral route generally fails to deliver meaningful change, but cues in messaging (e.g., congruence with current
beliefs, messenger affiliation) often trigger peripheral processes, leading to belief maintenance. Similar cues can initiate biased central-route processing, leading to counterarguing and belief entrenchment. The reported experiments tested the utility of an exploratory learning paradigm as a method of bypassing problematic cues.

In two experiments, exploring data prior to receiving a persuasive message did not affect belief change, regardless of message source. Nevertheless, belief updating occurred, and to large effect. Given the multitude of biases that inhibit flexible thinking, these results are somewhat surprising. On the other hand, participants encountered two types of compelling arguments. If they came in to the study with weak or non-existent opinions about the experimental issues, it is reasonable that the stimuli would be highly persuasive. Because participants were undergraduates and primarily freshmen, they may have lacked deeply held pre-existing views about carbon taxes and electric vehicle incentives. The mean support ratings at time 1 support this view, indicating general, but not strong, opposition.

The null effects of exploring first present the possibility that, although effective in STEM fields, exploratory learning is simply not beneficial in the context of sociopolitical decision making. It is reasonable to suspect some differences in cognitive processing of physics concepts (see Weaver et al., 2018) versus sociopolitical arguments, particularly with regard to motivation and affect, factors crucial in ELM (Petty & Cacioppo, 1986). Still, the interaction of time and order on confidence levels in Experiment 2 hints at potential metacognitive differences between participants who explored first and those who did not. Given the low observed power for many of the analyses here, it is entirely possible that exploration has beneficial effects that are masked by an underpowered
sample. In either case, more research is needed in order to determine the utility of exploratory learning in a sociopolitical context.

An important question at this point is what factors contributed to participants’ belief change and if they are accounted for by the theories described, namely, exploratory learning and ELM. At a basic level, the results perhaps encourage skepticism about the applicability of exploratory learning, and even ELM, to sociopolitical processing of the kind examined in these experiments. Much of the foundational research into ELM occurred prior to widespread access to the Internet and the proliferation of social media. Some researchers point out that cognitive mechanisms underlying elaboration and belief updating may have been influenced by profound changes in the way information is consumed. It is possible that established paradigms and assumptions are no longer applicable, or no longer functioning as they did pre-Internet (Kitchen et al., 2014). Indeed, an attempt to replicate historical ELM findings failed to support 24 of 27 key findings, a result the authors attribute, in part, to pitfalls of applying theory originally developed in a very different context (Kerr et al., 2015). Yet, a theory may be outdated insofar as it is not updated. Future studies of exploratory learning that involve ELM should be designed with these criticisms in mind. At this stage, it would be unwise to draw firm conclusions about the effectiveness of exploratory learning or the applicability of ELM in this topic domain. Instead, I focus on directions for future research.

Although the order-based paradigm employed in these experiments is common in exploratory learning studies, exploratory learning activities can take many forms. Future research should test various exploratory learning activities. An interesting avenue, particularly for climate-related issues, may be to introduce an exploratory simulation
activity in which participants can interact with data or explore the effects of policy manipulations (e.g., a simulation in which they can enact different forms of a carbon tax and explore outcomes). Computer simulations are capable of modeling complex systems and processes that might otherwise be difficult or impossible to present (e.g., simulated effects of different carbon tax plans), and have demonstrated benefits in STEM education (Jimoyiannis & Komis, 2001; Sarabando et al., 2014). Issue involvement is a prime determinant of whether attitude change is induced via the central or peripheral route (Petty and Cacioppo, 1981). ELM posits that higher involvement leads to more central processing. The exploratory learning paradigm used in these experiments might have failed to engage participants with issues they were not initially heavily involved in, but an interactive approach that provides dynamic feedback could be more effective in fostering debiasing elaboration of issue-relevant material.

Another method of increasing involvement might be to tailor issues to the participant pool. If undergraduate participants do not hold strong views on carbon taxes or electric vehicle incentives, focusing on more personally relevant issues might prove more insightful. For example, when sampling college students, experimental positions could be derived from relevant issues like student loan forgiveness and free college initiatives.

Tversky and Kahneman (1981) initially introduced the now well-supported idea that decisions are influenced not only by informational content, but how that content is framed (i.e., whether presentation highlights positive or negative aspects). Framing—specifically goal framing, like what occurs in the message phase—affects the impact of persuasion. In general, negative frames (i.e., focusing on possible losses) are more
effective than positive frames (i.e., focusing on gains; Levin et al., 1998). The carbon tax issue initially describes a loss (People often think that carbon taxes will hurt the United States’ economy and cause economic distress for the American people), but the bulk of the message focuses on potential gains. In contrast, the electric vehicle issue is presented first as a gain (People often think that personal electric vehicles can fix the United States’ carbon emissions problems, helping to address climate change), followed by information highlighting possible losses. Although this difference in framing might have affected outcomes, it seems unlikely. Preliminary analyses revealed no differences in belief change between the two issues, rather than greater updating among participants who encountered the negatively framed electric vehicle issue. Nevertheless, follow-up studies should ensure that persuasive messages are framed similarly to avoid unnecessary error.

Prior research in ELM suggests that when persuasion occurs primarily through the peripheral route, updated beliefs are less stable and more likely to revert over time. In the reported experiments, it is difficult to parse whether belief change was more peripherally or centrally driven. A study design that includes a follow-up session would illuminate longer-term effects of exploration. To illustrate, imagine a follow-up study in which participants responded to a survey of their beliefs about the same sociopolitical issues two weeks after the initial experiment. Some of the participants would presumably revert to support levels like those at time 1, while others would maintain their updated support from time 2. If exploring first increases elaboration, and consequently central-route processing, we might see an effect of order materialize. A more direct (and perhaps more plausible) approach might be to ask participants to produce arguments for or against a
position at the end of the study. If those who had explored first produced more numerous or better-quality arguments, we could take that as evidence for central-route processing.

Information processing can be a profoundly complex event, undoubtedly involving many factors not addressed in the reported experiments. Future research should examine alternative individual differences in conjunction with order of presentation (MF or EF). Degree, rather than direction, of political affiliation might also play a role. It is possible that exploring first has differential effects depending on how strongly identified one is with one’s political party, and thus how strongly opposed to an outgroup messenger they are likely to be. Researchers interested in this possibility should endeavor to collect a sufficiently large sample to examine degree of polarization as a factor in exploratory learning paradigms.

Larger sample size would also address the statistical limitations that might in part explain the null effects of exploration in the reported experiments. Observed power was generally very low across analyses. The interaction between order and support at time 1 and time 2 was not significant, but observed power was a mere .28. As mentioned above, it remains possible that I did not have sufficient power to detect a real benefit of exploring first, particularly considering that effect sizes in exploratory learning studies tend to be small to moderate.

By continuing to investigate the cognitive mechanisms underlying successful persuasion through novel means, we create and refine models of sociopolitical cognition and decision making that can be implemented in service of cooperation, a social behavior crucial in democratic society. For anyone concerned that people are set in their beliefs to the detriment of social cooperation, the changes in attitudes achieved here through a very
brief intervention may, at best, provide hope for the future of public discourse. Overall, this dissertation provides an important starting point for the empirical investigation of exploratory learning outside of STEM, and the results provide guidance for future applications of exploration to effective, debiasing public messaging in diverse settings.
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Appendix A

Need for Cognition Scale (Short Version)

Here are a number of characteristics that may or may not apply to you. Please use the scale below to indicate the extent to which you agree or disagree with each statement.

<table>
<thead>
<tr>
<th>Disagree strongly</th>
<th>Disagree moderately</th>
<th>Disagree a little</th>
<th>Neither agree nor disagree</th>
<th>Agree a little</th>
<th>Agree moderately</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

1. I would prefer complex to simple problems.

2. I like to have the responsibility of handling a situation that requires a lot of thinking.

3. Thinking is not my idea of fun.**

4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.**

5. I really enjoy a task that involves coming up with new solutions to problems.

6. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.

**reverse coded items
Appendix B

Need for Closure Scale (Short Version)

Read each of the following statements and decide how much you agree with each according to your beliefs and experiences. Please respond according to the following scale.

<table>
<thead>
<tr>
<th>Disagree strongly</th>
<th>Disagree moderately</th>
<th>Disagree a little</th>
<th>Neither agree nor disagree</th>
<th>Agree a little</th>
<th>Agree moderately</th>
<th>Agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

1. I don't like situations that are uncertain.
2. I dislike questions which could be answered in many different ways.
3. I find that a well-ordered life with regular hours suits my temperament.
4. I feel uncomfortable when I don't understand the reason why an event occurred in my life.
5. I feel irritated when one person disagrees with what everyone else in a group believes.
6. I don't like to go into a situation without knowing what I can expect from it.
7. When I have made a decision, I feel relieved.
8. When I am confronted with a problem, I’m dying to reach a solution very quickly.
9. I would quickly become impatient and irritated if I would not find a solution to a problem immediately.
10. I don't like to be with people who are capable of unexpected actions.
11. I dislike it when a person's statement could mean many different things.
12. I find that establishing a consistent routine enables me to enjoy life more.

13. I enjoy having a clear and structured mode of life.

14. I do not usually consult many different opinions before forming my own view.

15. I dislike unpredictable situations.
Appendix C

Study Materials

Data Table – Electric Vehicles

Carbon emissions are carbon compounds released into the atmosphere, and are produced from the burning of fossil fuels such as coal and gas. These emissions are thought to contribute to local and global climate change, among other things. Electric Vehicle Incentives are government programs designed to encourage people to buy electric cars instead of conventional gas-powered vehicles. Incentives often include rebates (money back after purchase) and/or tax credits, which are used to lower the amount of tax someone owes.

The table below shows data compiled from several reports about the effects of Electric Vehicle Incentives on the carbon emissions of different cities. Please examine the table carefully and come to your own conclusions about the data.

<table>
<thead>
<tr>
<th></th>
<th>Total # of Cities</th>
<th>Carbon Emissions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Increased</td>
<td>Decreased</td>
<td>Percentage Increased</td>
</tr>
<tr>
<td>Cities with electric vehicle incentives</td>
<td>128</td>
<td>107</td>
<td>21</td>
<td>83.6%</td>
</tr>
<tr>
<td>Cities with no electric vehicle incentives</td>
<td>298</td>
<td>223</td>
<td>75</td>
<td>74.8%</td>
</tr>
</tbody>
</table>
Data Table – Carbon Taxes

Carbon emissions are carbon compounds released into the atmosphere, and are produced from the burning of fossil fuels such as coal and gas. These emissions are thought to contribute to local and global climate change, among other things. A Carbon Tax is a fee paid by major producers and users of fossil fuels (e.g., energy companies, corporations). This tax is intended to pay for solutions to counteract potential side-effects of carbon emissions (e.g., planting trees, alternative energy sources).

The table below shows data compiled from several reports about the effects of Carbon Taxes on the economic prosperity of different cities. Here, economic prosperity refers to general economic growth, security, and wealth. Please examine the table carefully and come to your own conclusions about the data.

<table>
<thead>
<tr>
<th>Cities with carbon tax</th>
<th>Total # of Cities</th>
<th>Economic Prosperity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Improved</td>
</tr>
<tr>
<td>Cities with carbon tax</td>
<td>128</td>
<td>107</td>
</tr>
<tr>
<td>Cities with no carbon tax</td>
<td>298</td>
<td>223</td>
</tr>
</tbody>
</table>
Persuasive Message – Electric Vehicles

People often think that personal electric vehicles can fix the United States’ carbon emissions problems, helping to address climate change. However, recent research shows that it is not possible to reach our emissions goals by simply replacing gas-powered cars with electric vehicles. Electric vehicles must still be powered, often by existing coal or natural gas power plants. About 300 million (90%) of the existing vehicles on the road today would need to be replaced with electric vehicles by 2050; this would require energy equal to about half of our nation’s current electricity production. Finally, replacing existing cars and installing new charging stations for EVs will require substantial amounts of critical materials (e.g., to build vehicles and charging stations), which all contribute to increased local and global carbon emissions.

So, there is a need for a wider range of policies that focus on reducing vehicle ownership and use, regardless of fuel type. Traveling less and relying more on mass transit, like buses and passenger trains, are promising directions for addressing climate change.
Persuasive Message – Carbon Taxes

People often think that carbon taxes will hurt the United States’ economy and cause economic distress for the American people. However, recent research shows that carbon taxes can be implemented with little to no economic harm. In fact, some countries have seen economic benefits from carbon taxes. In one North American community, for example, more than $1 billion generated by the carbon tax has been returned to the people’s households and businesses. Low-income families and small businesses are receiving tax credits, and their tax rates have been reduced. A one-time payment was also given to every resident. Each year, human activities release more carbon dioxide into the atmosphere than natural processes can remove, causing the amount of carbon dioxide in the atmosphere to increase. Research shows that carbon taxes work to lower greenhouse gas emissions.

So, there is good evidence that it is possible to design carbon taxes that can actually contribute to a country’s economic prosperity while reducing carbon emissions. Introducing a nation-wide carbon tax in the United States is a promising direction for addressing climate change without hurting the economy.
CURRICULUM VITA

Sarah Elisabeth French

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Education

2024  Ph.D. in Experimental Psychology
      Advisor: Daniel A. DeCaro
      University of Louisville, Louisville, KY

2020  M.S. in Experimental Psychology
      Advisor: Keith B. Lyle
      University of Louisville, Louisville, KY

2017  B.A. in Psychology, Minor in Sociology
      Cum Laude
      University of Louisville, Louisville, KY

Research Interests

Belief Updating
My research aims to identify factors that influence the relative ease or
difficulty with which individuals update existing beliefs when presented
with new information. My goals are to develop methods for encouraging
people to process novel information in a debiasing, rather than
entrenching, manner.

Mental Models
I am interested in methods of promoting shared mental models of
complex social-ecological systems, as well as repairing mental models
that are based on erroneous information, in order to help communities
remove obstacles to collaborative problem solving in sociopolitical
dilemmas.
Research Experience

2020-present  **Graduate Research Fellow**  
Social Decision Making & Sustainability Lab  
University of Louisville, Louisville, KY  
Principal Investigator: Daniel A. DeCaro

2020-2021  **Graduate Research Assistant**  
Department of Engineering Fundamentals  
University of Louisville, Louisville, KY  
Principal Investigator: Patricia A. Ralston

2018-present  **Graduate Research Fellow**  
Memory & Cognition Lab  
University of Louisville, Louisville, KY  
Principal Investigator: Keith B. Lyle

2017-2018  **Post-Baccalaureate Research Assistant**  
Memory & Cognition Lab  
University of Louisville, Louisville, KY  
Principal Investigator: Keith B. Lyle

2016-2017  **Undergraduate Research Assistant**  
Memory & Cognition Lab  
University of Louisville, Louisville, KY  
Principal Investigator: Keith B. Lyle

Teaching Experience

Spring 2024  **Teaching Assistant**  
PSYC 301 – Statistics for Psychology

Fall 2023  **Teaching Assistant**  
PSYC 307 – Cognitive Processes

Fall 2023  **Teaching Assistant**  
PSYC 331 – Sensation and Perception

Spring 2022  **Teaching Assistant**  
PSYC 382 – Cognitive Neuroscience

Fall 2021  **Instructor**  
PSYC 301 – Statistics for Psychology

Spring 2021  **Teaching Assistant**  
PSYC 302 – Research Methods
Papers


Conference Posters


Mentoring Experience

2019 **Early Undergraduate Research Mentor**
Student: Alexandra DuCloux
Project Title: *The face of a criminal: Developing stimuli for show-up and line-up research.*
Poster presented at Summer Research Symposium at the University of Louisville.

2019 **Culminating Undergraduate Experience Research Mentor**
Student: Kaylyn Tyree
Project Title: *Attitudes about childlessness in women and men: The role of expected fecundity and other factors.*
Poster presented at Undergraduate Research Symposium at the University of Louisville.

Service to the Community and University

2023-2024 **University of Louisville DEI Committee Assessments and Reports Subcommittee**
*Co-Chair*

2021-2023 **University of Louisville DEI Committee**
*Graduate Student Representative*

2021-2024 **United Campus Workers of Kentucky**
*Organizer*
Labor union

2021 **Kentucky Psychological Association Undergraduate Academic Conference**
*Judge*

2020 **University of Louisville Undergraduate Research Symposium**
*Judge*

2018-2019 **Ulster Project Youth Advisory Board**
*Member*
Peace and justice organization for mediating sectarian conflict among Northern Irish youth

2016-2020 **University of Louisville Women’s Center**
*Volunteer*

Honors and Distinctions

2022-2023 **University Graduate Research Fellowship**
University of Louisville, Louisville, KY
2018-2020  University Graduate Research Fellowship  
University of Louisville, Louisville, KY

Awards

2019-2020  Graduate Student Council Travel Grant Award  
Dept. of Psychological & Brain Sciences  
University of Louisville, Louisville, KY  
Amount Awarded: $350

2019  Research Grant for Undergraduate Mentoring Experience  
College of Arts & Sciences  
University of Louisville, Louisville, KY  
Amount Awarded: $1,000

2018-2019  Graduate Student Council Travel Grant Award  
Dept. of Psychological & Brain Sciences  
University of Louisville, Louisville, KY  
Amount Awarded: $350

2019  APSSC Travel Grant Award  
Thirty-first annual APS Meeting in Washington D.C.  
Association for Psychological Science  
Amount Awarded: $500

Professional Memberships

Psychonomic Society
Society for Judgment and Decision Making
Association for Psychological Science
American Psychological Association
Psi Chi Honor Society
Midwest Political Science Association