CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Sociological Studies

Department of Sociology

Bachelor's Thesis

2024   **Veronika Anna Černá**

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Motivated Formation of Climate-Related Beliefs

Bachelor's Thesis

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In Prague on   Veronika Anna Černá

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Abstract

Despite the consensus in the scientific community, climate change attracts considerable disagreement among people. This can be explained by the process of motivated cognition which leads to belief polarization. Motivated cognition is usually difficult to detect empirically. We use a novel experimental paradigm, recently proposed by Michael Thaler (2020), to study opinion polarization in the domain of climate change. This approach enables us to analyze how people assess the veracity of uninformative messages that are true or false with equal probability. We have conducted an online experiment on a sample ($N = 542$) representing the Czech adult population. Our results suggest that motivated cognition does not affect the formation of climatic beliefs in the Czech population and does not contribute to opinion polarization in this area. However, we were able to find evidence of theoretically expected motivated belief formation in an unrelated area of beliefs about the crime rate of immigrants. Our study partially supports the validity of Thaler's experimental paradigm but also shows that motivated cognition may play only a negligible role in climate-related belief formation in some populations.

Abstrakt

Navzdory konsenzu ve vědecké komunitě vyvolává změna klimatu značné neshody mezi lidmi. To můžeme vysvětlit procesem motivované kognice, který vede k polarizaci přesvědčení. Motivovanou kognici je obvykle obtížné empiricky detekovat. Ke studiu polarizace názorů v oblasti změny klimatu využíváme nové experimentální paradigma, které nedávno představil Michael Thaler (2020). Tento přístup nám umožňuje analyzovat, jak lidé posuzují pravdivost zpráv, které jsou pravdivé či nepravdivé se stejnou pravděpodobností. Provedli jsme online experiment na vzorku ($N = 542$) reprezentujícím českou dospělou populaci. Naše výsledky naznačují, že motivovaná kognice nemá vliv na utváření přesvědčení o klimatické změně v české populaci a nepřispívá k názorové polarizaci v této oblasti. Podařilo se nám však nalézt důkazy o teoreticky očekávaném utváření motivovaného přesvědčení v nesouvisející oblasti, konkrétně přesvědčení o kriminalitě imigrantů. Naše studie částečně podporuje platnost Thalerova experimentálního paradigmatu, ale také ukazuje, že motivovaná kognice může v některých populacích hrát při utváření přesvědčení týkajících se klimatické změny jen zanedbatelnou roli.

Keywords

climate change, public opinion, beliefs, Bayesian reasoning, motivated cognition, opinion polarization

Klíčová slova

změna klimatu, veřejné mínění, přesvědčení, bayesovské uvažování, motivovaná kognice, názorová polarizace

Title

Motivated Formation of Climate-Related Beliefs

Název práce

Motivované utváření přesvědčení týkajících se klimatu

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Introduction[1]

Human behavior is responsible for many of the environmental problems we face today. Among these, climate change stands out as particularly significant and it is, by some scholars, even considered to be the "most challenging social problem of the modern era" (Giddens, 2009 in McCright & Dunlap, 2011, p. 155). The consequences of climate change include drought, glacier melting, sea level rise, floods, and water shortages, presenting devastating impacts on our well-being (e.g., Korteling et al., 2023).

Despite the consensus in the scientific community, climate change attracts considerable disagreement among individuals revolving around its causes, impact, and strategies for mitigation and adaptation (IPCC, 2022; Hulme, 2019; Saad, 2013). The ongoing debate on climate change is becoming increasingly more polarized (Falkenberg et al., 2022). The topic of climate change constantly raises new, complex questions that tap into human psychology and social values, including people's hopes, fears, moral reasoning, perspective, personal and collective identity and values. These factors are key for understanding the disagreement on this issue (Hulme, 2019). The belief polarization is evident in public opinion, policy debates and even in the interpretation of scientific data. Extremes appear on both sides of the belief spectrum, with climate denial on one side and radical environmentalism on the other (e.g., Dunlap, 2020; Kovaka, 2021; Silke, 2022; Spadaro, 2020).

The notion that the disagreement is likely to be resolved through more scientific knowledge is false. In fact, providing people with more information on climate change typically has only a small effect on their beliefs about climate change and their support for climate policies (Rode et al. 2021; Hulme 2019). Some studies have demonstrated that providing people with information on climate change can, in fact, even backfire by strengthening people's erroneous prior beliefs and polarizing their opinions (Zhou, 2016), and undermining the credibility of the information source (Nisbet et al., 2015). One of the reasons why providing information about climate change has only a limited effect on

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[1]All information about studies including pre-registrations, analyses, power analyses and materials are available here: https://osf.io/fpr8d/?view_only=f6b750590fe0459d88e903ceaa37fddf

people's beliefs and their actions (Bayes & Druckman, 2021; Druckman & McGrath, 2019) has to do with the complex way in which people update their risk and other beliefs (e.g., Rheinberg and Hammitt, 2018). Other factors may enter this process, such as framing or motivated cognition (Bayes & Druckman, 2021; Druckman & McGrath, 2019; Zhou 2016). There is wide evidence that motivated cognition leads to polarization (Bayes & Druckman, 2021), however, there is a lack of explanation for when exactly people change their beliefs to more extreme and what is the main trigger of this change.

The objective of this thesis is to investigate the formation of beliefs in the climate change domain and how it leads to polarization through a quantitative approach. To test it we use a novel experimental paradigm introduced by Michael Thaler (2020). This allows us to measure motivated cognition on the individual level and in the whole sample, as well as belief polarization on the individual level and in the whole sample. Additionally, the study examines whether one's environmental identity or worry about the impacts of climate change can serve as the motive on which motivated cognition and belief polarization are based.

1. Theoretical Background

In this thesis, we operate with several concepts which are essential for understanding belief updating and belief polarization.

1.1 Bayes' Belief Updating

Before we delve into the issue of how people distort the reasoning process, we first briefly introduce the way people update their beliefs in general by describing the Bayes theorem.

Bayes' theorem is a theoretical model of belief updating based on new information using probability distribution. It can be defined as "a rule specifying how a prior probability distribution should be updated to a posterior distribution in the light of new information" (Okasha, 2013). This model is widely used in the social sciences and helps to explain public opinion formation, for example in the field of political science (e.g., Achen, 2005; Gerber & Green, 1999). Although individuals may occasionally deviate from the expectations of Bayes' theorem, it remains an important normative benchmark and a useful model of belief formation and updating (Bullock, 2009).

The updating process comprises the following three steps. Firstly, an individual defines the prior belief as a probability distribution regarding the true state, the best guess of the true state, and the uncertainty of this guess. In the second step, one encounters new information, which one finds more or less trustworthy. Third, one incorporates the new information in one's prior belief which creates a posterior belief. The extent to which the belief is updated is determined by the distance between the prior belief and the new piece of information, by the strength of the prior belief, and by the perceived accuracy of this new information (Bullocks, 2009; Druckman & McGrath, 2019; Lois et al., 2023).

Formally, Bayes theorem is given by a general equation:

$$p(H \vee E) = \frac{p(E \vee H) \, x \, p(H)}{p(E)}, \qquad (1)$$

where:

$p(H \mid E)$, typically the quantity of interest, is the posterior probability that some belief (in statistical inference, this would be a belief about a hypothesis but in the current reasoning context, H is a climate-related belief) is correct (credible or believable) given evidence;

$p(E \mid H)$ is the probability of observing certain evidence given that the belief (H, in our case, the climate-related belief) is correct; this part is referred to as a likelihood function, as it typically specifies the probability density function across available data points;

$p(H)$ represents the prior belief (expressed as a probability of discrete values or probability density function) about the subject matter (H);

$p(E)$ is the (marginal) probability of observing the data (across all possible combinations of beliefs); given that this part does not depend on the beliefs about the subject matter (H), it does not influence the relative posterior probabilities for different types of beliefs (H).

We can illustrate this model with the following example. Let's assume that the subject matter (H) is a belief about the anthropogenic causation of climate change. The evidence (E) is a graph capturing the correlation between anthropogenic emissions produced and the average temperature can serve as an evidence. Before observing any evidence (E), an individual can express his or her prior belief, $p(H)$, about the anthropogenic causation of climate change. After observing the evidence (E, a graph in our case), the posterior belief of the individual about the anthropogenic causation, $p(H \mid E)$, should change compared to the

prior belief, following the Baysian model, if the individual is a rational reasoner. Although the Bayesian model can be described as a model of rational information processing, nothing in the model specifies that the process is either unbiased or biased. People can perceive veracity of information heterogeneously and still process the information based on the model (Druckman & McGrath, 2019). As illustrated in Equation 1, the posterior belief is essentially determined by two factors that may work in concert or against each other: the strength of prior beliefs and the strength of the evidence. If people have strong motives and a strong prior belief, they tend to give their prior beliefs a greater weight in the belief updating process than would be rational, thus the posterior belief is influenced more by the prior belief than by the new evidence. This distortion is referred to as motivated cognition and will be further introduced in the following chapter.

1.2 The Concept of Motivated Cognition

Motivated cognition (also frequently referred to in the literature as motivated reasoning) is a phenomenon that can be defined as a conscious or unconscious tendency to deal with information motivated to arrive at a desired conclusion. This distortion affects the entire process, from the initial search for information to its processing and final implications and impact on belief formation (Kunda, 1990).

Two types of motivated cognition have been described in the past; accuracy motivation and directional motivation. While accuracy motivation is based on the assumption that the individual is motivated to believe information that comes from a trusted source and thus leads to "correct" knowledge, directional motivation, on the other hand, is based on the tendency to believe information that is in line with the individual's prior belief (Druckman & McGrath, 2019; Kunda, 1990). In other words, the conclusions at which an individual arrives after receiving new information depends on his or her goals and motives. Directional motivation overlaps with another term – confirmation bias. Confirmation bias is usually referred to as seeking out the information confirming one's prior belief, while directional motivated cognition describes the whole process from seeking the information to processing it (Druckman & McGrath, 2019). It can also be defined as one of the three main mechanisms of directional motivated cognition (Lodge & Taber, 2013 in Druckman & McGrath, 2019).

These motivated reasoners tend to filter, ignore or reject disconfirming information (e.g., Kunda, 1990; Kuklinski & Hurley 1994; Taber and Lodge 2006; Lodge and Taber 2013). The people with stronger prior beliefs are apt to reject new contradicting information more than those with weaker prior beliefs, and they approach intentionally dissonant information in fundamentally different ways than information that confirms their beliefs (Zhou, 2016).

There is substantial evidence for such processes in the domain of politics. The existing literature suggests people tend to dismiss information that is not in accordance with their political stances (e.g., Strickland et al., 2011 in Pennycook, 2023), while this phenomenon is equally present across the political spectrum as portrayed for example in a meta-analysis by Ditto et al. (2019). Other studies found that conditions might also be an important factor which changes people's motives underlying their cognition process. If people perceive politics primarily as a conflict where the goal is to win with strong arguments, then they also have a greater tendency to be subject to biased cognition and polarization. If, on the other hand, politics is perceived as deliberation, then people are motivated to seek consensus, which, conversely, prevents biases and polarization (Groenendyk & Krupnikov, 2021).

The issue of climate change is largely politicized (e.g., Fischer & Said, 2021; Grassle, 2021; Schmid-Petri et al., 2022). Studies have demonstrated that beliefs on climate change are to some extent predicated by political stances. This can be observed particularly in the United States where there is a considerable disagreement on environmental issues between Republican and Democratic views and these partisan differences (and polarization) have deep historical roots (e.g., Bolsen et al., 2014; Druckman, & McGrath, 2019; Lindaman & Haider-Markel, 2002).

Motivated cognition can be understood as an evolutionary adaptation that serves to protect one's (social) identity. The very identity, that can be the above-mentioned partisan identity, can serve as a motive underlying the cognitive process (Zhou, 2016). The role of personal identity is emphasized also in a study by Kahan et al. (2017), in which the authors examined *identity-protective cognition*. They describe one's climate change belief to be a symbol of membership in a certain group and therefore a part of social identity (Kahan et al., 2017). In this thesis, we operate with environmental identity as a potential motive of biased cognition.

1.3 Belief Polarization

One of the consequences of motivated cognition, often referenced in the literature, is belief polarization (Thaler, 2020). Belief polarization is defined as a phenomenon where individuals' opinions become more extreme and the disagreement between them greater (Lord et al. 1979). Belief polarization occurs when an individual is exposed to new information and when motivated cognition is present at the same time. If two individuals with different prior beliefs observe the same data, it strengthens their attitudes despite being different as a result (Batson, 1975; Lord, Ross, & Lepper, 1979). This divergence can be explained by evidence that fits with our beliefs is easily accepted, whereas counter evidence is submitted to close interrogation. As a result, individuals' beliefs can be even stronger after receiving a counterevidence. In addition, belief polarization is observed in different groups of people and regardless of the topic (Talisse, 2021).

One of the most cited evidence of belief polarization is a study by Lord et al. (1979) on capital punishment beliefs. After receiving information, the participants had an asymmetric evaluation, demonstrating conformity to sources in accordance with their attitudes and, on the contrary, greater criticism of sources contradicting their opinion. The results, based on self-report responses, showed polarization. Lord et al. also state that when people are exposed to ambiguous evidence, they both can potentially interpret it as a support for their prior beliefs, making their final disagreement more extreme and polarized (Lord et al. 1979).

A follow-up study by Kuhn and Lao (1996) outlines that belief polarization is not necessarily driven by newly received information, but rather by the fact that the information prompts participants to think about the topic. At the same time, they state that if people think about a topic, it does not necessarily mean that they also arrive at more correct results.

Studies focusing on the group polarization of opinions (Brauer et al., 1995) show that the expression of an attitude in a group has an effect on polarization. The results confirmed the reliable effect of repeated expression on the shift of opinion to a greater extreme. At the same time, however, in the second study, the authors underline that polarization occurred especially in cases where groups received feedback from other members and where opinions and arguments were repeated.

It is also important to note that polarization is debated and some scholars counter that

there is no such thing as social polarization. In the case of the United States, some authors demonstrated that it is more a case of political elites, rather than ordinary people, who are polarized (e.g., Fiorina et al., 2008).

1.4 Measuring Motivated Cognition and Polarization

Motivated cognition can be investigated through content analysis, e.g., on Twitter (see Falkenberg et al., 2022), or it can be examined by running experiments as we also do in this research. The experimental literature on motivated cognition is growing, however, most of the study designs usually stand on giving participants new information and testing for asymmetric updating. In this manner, it can be demanding to distinguish motivated biases from non-motivated biases (Benjamin, 2019 in Thaler, 2020).

1.4.1 Michael Thaler's Experimental Paradigm

Some of the problems present in the assessment of motivated belief formation were theoretically solved by Michael Thaler, who recently proposed a novel experimental paradigm that we also adopted in this thesis. This experimental paradigm introduced in his work *The Fake News Effect: Experimentally Identifying Motivated Reasoning Using Trust in News,* in which he dives into the topic of trust in fake news in the US and helps to explain this issue by the process of motivated cognition[2]. We should be able to distinguish this by giving participants signals in such a way that a Bayesian does not infer anything about the veracity of that signal, but motivated cognition manifests directional distortion. This can be achieved by giving the participants messages that are uninformative as far as source veracity is concerned.

In the case of Thaler's study, he measured motivated cognition on politicized topics where it is also expected to play a role, such as income mobility, crime rate, racial discrimination, and the scientific consensus on climate change. At the end of the study, he also measured participants' confidence in their guesses. By this approach, he proved that people are generally prone to trust fake news, when they agree with the content, more than true news, which did not support their belief (Thaler, 2020).

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[2] Thaler uses the term *motivated reasoning* in his study.

The study employs a within-subject design and involves two main steps: firstly, participants are given a factual question with a numerical answer. They are asked to estimate the true value (i.e., their median prior belief on the topic). As the second step, they receive a binary message, which is chosen randomly, saying the true value lies either above or below the median. Participants are asked to guess whether the message is true or false. A Bayesian would consider a "greater than" message to be entirely uninformative about the veracity of the message. Those who engage in motivated cognition find the message that supports what an individual is more motivated to believe as true with higher probability.

The advantage of this approach is that we do not provide people with new information, however, we still are able to test their potential reaction on receiving one.

Thaler's paradigm represents a novel approach within this field. This approach was partially adopted by Markus Eyting (2022) in his study on discrimination *Why do we Discriminate? The Role of Motivated Reasoning* to study discrimination.

1.5 Environmental Identity and Climate Worry as Potential Drivers of Motivated Formation of Beliefs About Climate Change

In our work, we assess the motivated belief formation about climate change with respect to one's pro-environmental identity and one's worry about climate change. One's beliefs, values, and attitudes reflect one's self-identity (Sparks and Shepherd, 1992). In line with this, Kahan et al. (2012) suggest that beliefs on climate change are based more on one's personal identity and values than on scientific literacy. The connection to nature can serve as part of an integral aspect of one's identity. We are using the concept of environmental identity (EID) first introduced by Susan Clayton in 2003. Environmental identity refers to "one part of an individual's self-concept that indicates a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world" (Clayton, 2003, p. 45 – 46). This concept is based on the belief that the environment is important to us and plays an important role in who we are (Clayton, 2003). The concept of EID has been used frequently in the literature, sometimes measuring only one dimension of it. The most used of these is *environmental self-identity*, which emphasizes that, unlike social identity, self-identity stems from one's own perception of oneself (e.g., Whitmarsh & O'Neill, 2010). Study by Van der Werff et al. (2014) describes self-identity as dependent on two factors;

biospheric values and past behavior. As proposed in this study, precisely because self-identity is defined by one's biospheric values, which contribute to its stability.

In our study, we use the concept of EID to test whether it can serve as a driver of motivated cognition. Thus, in our conceptualization, environmental identity refers to self-reported environmental identity, i.e., what is referred to as *self-identity* in other studies. In this thesis we measure it using a combination of three scales adopted from Truelove et al. (2016), Van der Werff et al. (2014), and Fielding et al. (2008). For more information about the scale, see chapter 5.1.4 Materials.

Another concept we operate with as a potential driver of motivated formation of beliefs is worry about the impacts of climate change. Worry can be defined as "an active emotional state that is often closely linked to adaptive behavioral responses aimed at reducing a particular threat" (van der Linden, 2017, p. 24). Worry about climate change raises personal responsibility, mitigation behavior, and often leads to stronger support for climate policies. Despite worry being similar to other related terms such as concern, risk perception, or fear, it is usually differentiated from them in the literature. In contrast to other terms, it is described as relatively personal, active, and likely to motivate mitigation behavior (Bouman et al., 2020). Articles studying climate change worry usually use a scale to measure it (e.g., Bouman et al., 2020; Verplanken, 2013), such as a ten-item CCWS (Stewart, 2021). In our case, since climate change is not our main focus, we decided to employ a single-item scale to assess it. For details of this measure, see chapter 5.1.4 Materials.

2. The Purpose of This Thesis

2.1 The Aim of This Thesis and Research Questions

The aim of this thesis is to examine the process of belief formation and potential belief polarization. By employing Michael Thaler's (2020) experimental paradigm we want to prove that people's belief on climate change (including their environmental identity and worry about its impacts) influences people's perception of messages veracity on such issues. We explore whether it is possible to use Michael Thaler's (2020) study design to measure motivated belief formation (specifically motivated cognition) and polarization in the domain of climate change in the Czech population. As a criterion validity check, we also examine

whether it is possible to measure motivated cognition in an unrelated area, namely the domain of immigrants' crime rate.

Precisely, we set following research questions for this thesis;

- RQ1: Do people perceive veracity of pro-climatic messages randomly or systematically?

- RQ2: Is environmental identity a driver for motivated cognition in the climate change domain?

- RQ3: Is worry about the impact of climate change a driver for motivated cognition in the climate change domain?

- RQ4: Do people polarize within the study?

- RQ5: Do people perceive veracity of higher-crime-rate messages randomly or systematically?

- RQ6: Is worry about the immigrants' crime rate a driver for motivated cognition in the domain of crime rate?

2.2 Sociological Relevance

Although we operate with certain social-psychological concepts, we believe this thesis is fully relevant to sociology.

This thesis focuses on the topic of beliefs on climate change in Czech society and their formation. Society is the cause of climate change and faces its consequences. Understanding the factors that lead people to their beliefs on climate change is the first step in changing their behavior. Only when we understand the underlying processes can we effectively motivate people to pro-environmental behavior.

Motives for motivated cognition (such as values, beliefs, or social identity) come from interactions with others. Motivated cognition is closely related to other sociological concepts such as conformity.

Belief polarization is the subject of many sociological studies. In this experiment, we test the mechanisms that might explain belief polarization. There is wide evidence for belief polarization in politics which can bring beneficial knowledge to the field of political sociology and help us to interpret political preferences and voting behavior.

As the literature suggests, people may polarize based on their repeated expression. In sociological research, we often operate with questionnaires where the repeated expression of beliefs is required. Therefore, we should know people may shift their beliefs to more extreme in this process. Exploring this kind of polarization can be thus beneficial for sociologists and other scientists collecting data using questionnaires.

3. Pilot Study 1

As mentioned above, in this thesis we study the process of motivated cognition and polarization through the lens of Michael Thaler's design introduced in chapter 1.4.1. Our original aim was to detect directional motivation from accuracy motivation in the domain of climate change. The results of the first pilot study prompted us to make certain changes in the design and to change our aims. In the second pilot study, we focused primarily on examining directionally motivated cognition and polarization within the questionnaire. We ran two pilot studies in total. The results of them and the implications of the main study are portrayed in the following chapters.

The aim of Pilot Study 1 was to test elements of Michael Thaler's (2020) experimental paradigm. As stated, our original goal was to detect directional motivation from accuracy by manipulating the veracity of messages and by asking our participants (i) to assess its veracity, and (ii) to assess whether scientists would agree with it. By employing this approach, we assumed we would be able to determine whether people are subjected to motivated cognition and to distinguish between people who trust science (i.e., their belief is in accordance with what they think science claims) and those who distrust science (i.e., their belief is in conflict with what they think science suggests). We ran five trials, in each of which we measured participants' prior belief (estimated answer for a factual question), their confidence in this estimate, their assessment of a message's veracity, and their assessment of scientific consensus on this message. All of the trials were related to the manifestations and impacts of climate change.

3.1 Methods

3.1.1 Research Questions

RQ1: Is it possible to measure motivated cognition using our design?

RQ2: Is it possible to detect directional motivation from accuracy motivation?

3.1.2 Participants

We recruited a convenience sample of mainly Czech university students via author's and supervisor's email lists and social media (Facebook Messenger). The final sample ($N = 27$ participants) was rather young ($M_{age} = 20.85$, $SD = 1.13$), highly educated (96.59% high-school education, 3.41% university or college degree) and comprised 70.37% women.

3.1.3 Materials

Manipulation of Veracity of Climatic Messages. We manipulated the veracity of messages in each of the five trials of the decision task. The message states (randomly and with an equal probability of .50) that the true quantity of interest is either lower or higher than the participant's initial guess (prior). We informed participants that the messages (i.e., lower vs. higher) are generated randomly with equal probability. Participants were asked whether this message was true or false. For example: "The average December temperature between 2012 and 2021 was [HIGHER/LOWER] than your reported [prior belief] °C. In your opinion, is this message true or false?". In the following question, we used the exact same message and asked the participants about the scientific consensus on this message (for details about this question, see variable Perceived Scientific Consensus)

Prior Beliefs About Climate Change. We measured prior beliefs by asking participants to estimate quantitative answers to four factual questions related to manifestations and impacts of climate change: (i) the average temperature in the Czech Republic between 2012 and 2021, (ii) the surface of the Arctic Ocean covered by ice sheet in 2021, (iii) number of warmest years between 1850 and 2020 that took place between 2000 and 2020, (iv) current $CO2$ concentration in the atmosphere, and (v) the sea level change since 1880. To facilitate responses, we gave participants reference values from the previous period (e.g., "The average air temperature in the Czech Republic between 1961 and 1970 was -2,8°C." (Fakta o klimatu, 2023)).

Width of the Interval on Prior Belief. To measure the participants' confidence in their prior belief about climate-related questions, we asked them to indicate the interval such that the true quantity lied in it with 90% probability (effectively 90% credible interval on the prior).

Perceived Veracity of a Pro-Climatic Message. To measure potential presence of motivated cognition, we asked participants whether each of the five climate-related

messages is true or false. The pro-climatic message is a message that indicates that the actual quantity is higher or lower in the direction that would be implied by an increased effect of climate change than implied by the participant's prior. The indicator takes the value of 1 if the participant thinks that the pro-climatic message is true or that the anti-climatic message (message indicating the opposite direction) is false (and 0 otherwise).

Perceived Scientific Consensus. We measured participant's perceived scientific consensus by asking them whether they thought that most scientists would agree on each of the messages they received. Participants indicated their responses in a binary format (yes/no).

3.1.4 Study Design

The study was a within-subject randomized experiment. We manipulated the message in each of the five trials. The message stated with equal probability, that the true quantity of interest is either higher or lower than the participant's initial guess (prior). Participants were asked to assess the veracity of the message and scientific consensus on this message. The messages were independent across trials. The flow of the task is depicted in Figure 1.

Figure 1

The Flow of Thaler's Task in Pilot Study 1
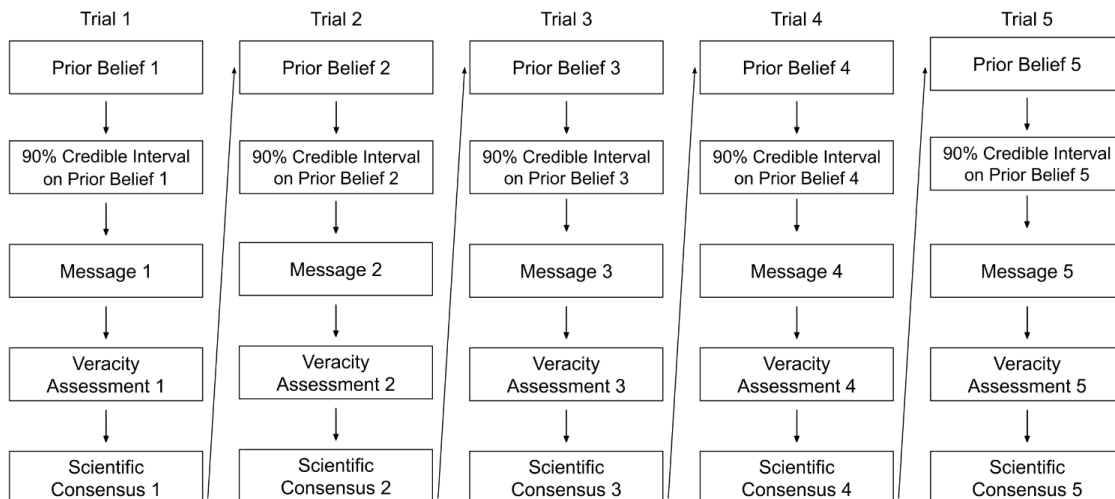
Note. The design consisted of five trials, each addressing a different topic related to climate change. Within each trial, we measured climate prior belief (participants' prior belief about

a topic related to climate change), 90% credible interval of prior belief (i.e., the lower and upper limit of their prior belief), perceived veracity of received message (i.e., whether it is true or false), and perceived scientific consensus on this message (i.e., whether most scientists would agree on the message). Received messages state that the true quantity of interest is either lower or higher than the participant's initial guess (prior), randomly and with equal probability of .50.

3.1.5 Procedure

After accessing the study online, participants provided their informed consent and proceeded to the first trial of the Thaler's task. Each trial of the task had the following structure. First, participants indicated their prior belief (concerning the average temperature in the Czech Republic between 2012 and 2021). Next, they indicated the 90% credible interval of this belief. Finally, they received a message and were asked to assess its veracity and the scientific consensus on it. This was repeated to the remaining four trials of the task, except they focused on different beliefs (the surface of the Arctic Ocean covered by ice sheet in 2021, the number of warmest years between 1850 and 2020 that took place between 2000 and 2020, current CO_2 concentration in the atmosphere, and the sea level change since 1880). After completing the five trials of the task, participants answered sociodemographic questions and received a short written debriefing about the purpose of the study. Participants received no reward for taking part in the study.

3.2 Results

We found that there were in total 86 pro-climatic veracity answers out of possible 135 data points (27 individuals x 5 trials). We used a binomial test to test whether it would be possible to reach such results randomly (i. e. with the expected probability of .5). The results of the binomial test indicate that our observations do not fit such a binomial distribution ($p = .002$) and would fit the distribution with the probability of .64. In other words, the number of the pro-climatic veracity answers deviated from the expected probability, which suggested the presence of motivated cognition in the sample.

We also found that there was a very high correlation ranging from .80 to .93 between participants' perceived scientific consensus and their perceived veracity of messages. In other words, the two factors were almost identical and people tended to equate their opinions

with prevailing scientific opinions. As such, abandoned further analysis aiming to disentangle the two facets of motivated opinion formation (i.e., direction- and precision-related) as the two are difficult to distinguish empirically.

The number of pro-climate motivated answers progressively increased through the questionnaire. A hint of polarization also appeared in the sample over the course of the study. People tend to project their pro-climatic beliefs with a higher probability in the later trials (see Figure 2).

Figure 2

Number of Pro-Climatic Answers in Each Trial
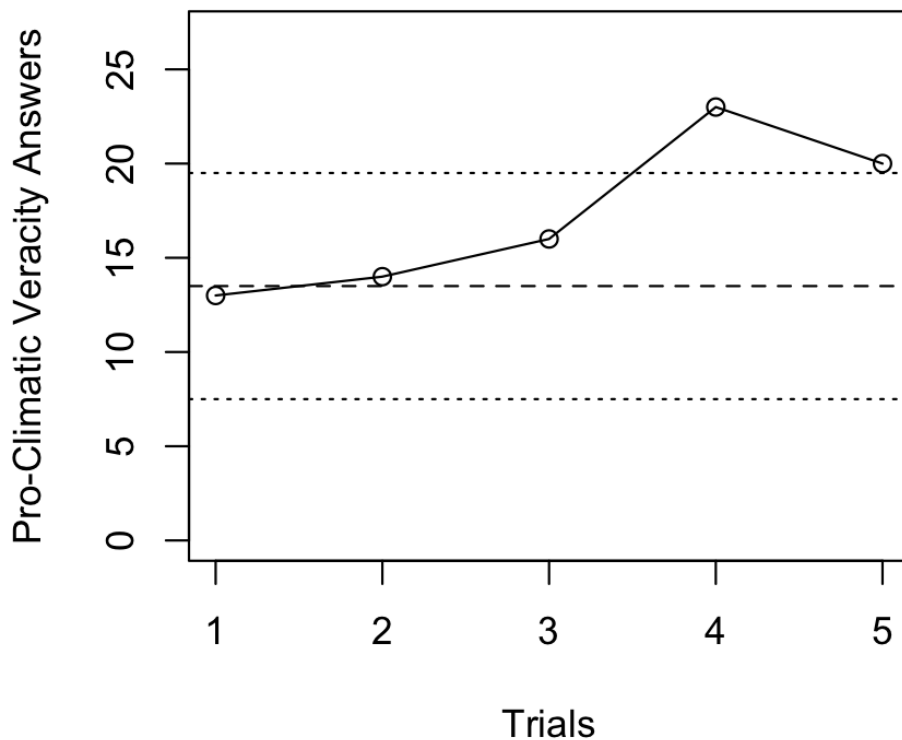
Note. The graph shows the general trend of the increasing number of pro-climatic answers while proceeding the trials in the questionnaire. The dashed line indicates the value corresponding to a probability of .50 in the binomial distribution. The dotted horizontal lines indicate the threshold values that can be reached under the probability of 0.5 in the binomial distribution.

3.3 Discussion

In the Pilot Study 1, we detected motivated cognition in the direction of pro-climatic belief in our sample, as expected given the nature of the sample (i.e., students and highly educated people). This means that Thaler's (2020) paradigm effectively measured motivated cognition in our experimental settings. However, we could not distinguish directional and accuracy motivation because the correlations between perceived veracity of a message and the perceived scientific consensus were too high. We also found that the motivated opinion formation became somewhat larger as participants proceeded through the trials of the task, which would be consistent with the literature (Brauer et al., 1995). To corroborate these findings, we conducted Pilot Study 2 on a larger sample of participants.

4. Pilot study 2

In Pilot Study 2, we originally planned to extend the findings of Pilot Study 1 with an analysis of the role of environmental identity as a factor that drives motivated formation of beliefs about climate change. However, due to a technical error, we failed to measure environmental identity. Thus we used Pilot Study 2 to corroborate findings from previous pilot study. Specifically, we were interested in whether we could replicate the non-random patterns of veracity responses observed in Pilot Study 1 and whether these patterns are becoming more pronounced as participants proceed through several trials of the task.

4.1 Methods

4.1.1 Hypotheses

For our second pilot study we proposed following hypotheses:

H_1: Tendency to polarize: The sample probability of perceived veracity of pro-climatic messages deviates from the expected probability of .50.

H_1a: Given the nature of the sample (students with high pro-environmental attitudes), we expect that the sample probability of perceived veracity of pro-climatic messages will be higher than .50.

4.1.2 Participants

We recruited a convenience sample of mainly Czech university students, friends, and collaborators via author's and supervisor's email lists and,via student social networks (Instagram).

71 participants completed the study. We excluded 9 participants from our data (listwise) due to their extreme (boundary) values for prior beliefs. The final sample ($N = 62$ participants) was rather young ($M_{age} = 22.02$, $SD = 3.93$), highly educated (77.42% high-school education, 22.58% university or college degree), and comprised 59.68% women.

4.1.3 Materials

Manipulation of Veracity of Climatic Messages. We manipulated the veracity of messages in each of the trials, as in the case of Pilot Study 1.

Prior Beliefs About Climate Change. We measured prior beliefs about four climate-related topics that were also covered in Pilot Study 1 (the average temperature in the Czech Republic between 2012 and 2021, the surface of the Arctic Ocean covered by ice sheet in 2021, the number of warmest years between 1850 and 2020 that took place between 2000 and 2020, and the current CO_2 concentration in the atmosphere) in the same way as in Pilot Study 1. We did not cover one topic (the sea level change since 1880) that was in Pilot Study 1 to make the study shorter.

Posterior Belief. We asked participants to estimate their posterior beliefs related to the first factual question (i.e., the average temperature in the Czech Republic between 2012 and 2021). The format of the question was the same as for the prior belief. The posterior belief was measured either at the beginning of the questionnaire (after the first veracity question) or at the end of the questionnaire (after the last veracity question in the climate related trial). The time of the measurement was randomized with the probability of .50.

Width of the Interval on Prior Belief. We measured the confidence in the prior belief by assessing the width of its interval, similar to Pilot Study 1. This time, however, we measured the interval only in the first trial (the average temperature in the Czech Republic between 2012 and 2021).

Perceived Veracity of Pro-climatic Messages. We measured perceived veracity of pro-climatic messages in the same way as in Pilot Study 1.

4.1.4 Study design

The study had a similar within-subjects experimental design as Pilot Study 1. Specifically, in each of four trials of the Thaller's task, we manipulated the veracity of a message and we randomized when the posterior belief was measured. The flow of the task is depicted in Figure 3.

Figure 3

The Flow of Thaler's Task in Pilot Study 2
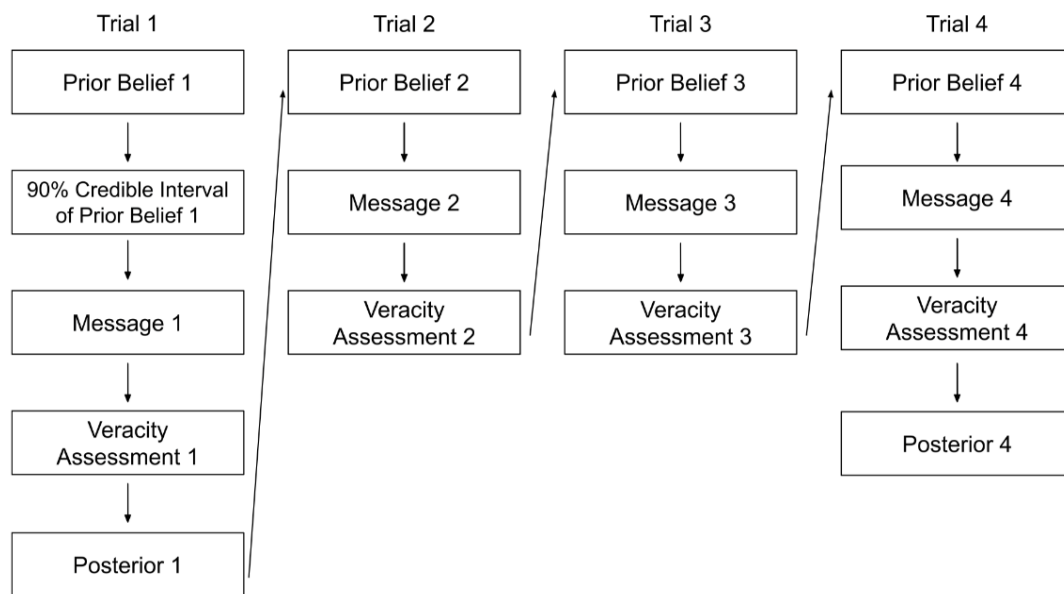
Note. The design consisted of four trials, each addressing a different topic related to climate change. Within each trial, we measured climate prior belief (participants' prior belief about a topic related to climate change), perceived veracity of received message (i.e., whether it is true or false). Received messages state that the true quantity of interest is either lower or higher than the participant's initial guess (prior), randomly and with an equal probability of .50. 90% credible interval of prior belief (i.e., the lower and upper limit of their prior belief), was measured only in the first trial. Posterior belief (i.e., same question as prior belief 1) measured at the beginning or at the end of the study (randomized).

4.1.5 Procedure

After accessing the study online, participants provided their informed consent and proceeded to Thaler's task. The task had the following structure (similar to Pilot Study 1). Firstly, participants indicated their prior beliefs, followed by interval and a veracity question. Next, they were randomly assigned to one of two groups – the first one was asked about their posterior beliefs right after the first trial, and the second group was asked about their posterior beliefs at the end of all trials. After the first trial, participants proceeded to the second trial, then the third and the fourth. Interval was measured only in the first trial. After the fourth trial, the second group was asked the posterior belief on the first question. At the end of the study, they filled in their sociodemographic characteristics.

4.2 Results

Perceive Veracity of Pro-Climatic Messages

As for the confirmatory analysis, we found that participants provided 133 out of the possible 248 (62 participants x 4 trials) pro-climatic veracity responses, for the overall probability of the pro-climatic veracity answer of .54. Such a pattern can arise randomly if the theoretical probability of the pro-climatic is .5 (binomial distribution, p = .28). In other words, random patterns in the responses do not seem to indicate motivated belief formation. As such, our results do not support H_1 nor H_{1a}.

Next, we explored how many times a pro-climatic answer appeared per each respondent to measure motivated cognition on the individual level. The result of the chi-square test showed that the frequencies of perceived veracity of pro-climatic messages did not deviate from the distribution arising from random responses (based on possible permutation of individual-level response patterns), chi (8) = 10, p = .27. Also, this result does not support motivated belief formation.

Finally, we explored the average tendency to motivated belief formation in each of the trials of Thaler's task. We examined the number of pro-climatic answers in each trial and conducted a binomial test for each of them to test whether it would be possible to reach such results randomly (i. e. with the expected probability of .5). None of them were statistically significant, with the lowest p of .559 for the last topic (the current CO_2 concentration in the

atmosphere), suggesting the number of pro-climatic answers was rather random than systematic. We did not find any polarization in the whole sample.

Posterior Belief Formation

We expected our sample to be pro-climatic (given that our participants were university students) and to manifest motivated pro-climatic belief formation. We explored the belief shift by conducting a two-sided paired *t*-test. However, we found no statistically significant shift between the prior a posterior value in the first trial (the average temperature in the Czech Republic between 2012 and 2021), $M_{prior} = 1.19$, $SD_{prior} = 2.71$, $M_{posterior} = 1.23$, $SD_{posterior} = 2.82$, $t = .53$, $p = .60$. This result suggests that participants' beliefs did not shift in one direction after assessing the veracity of climate-related message (regarding the average temperature in the Czech Republic between 2012 and 2021). There was also no difference between posterior belief measured right after the first task, $M = 1.23$, $SD = 2.82$ and after the last trial, $M = .92$, $SD = 1.83$, $t = .52$, $p = .6025$. This result suggests that participants' beliefs did not shift after finishing all four trials.

4.3 Discussion

In Pilot Study 2 we did not find any evidence of motivated belief formation neither in the whole sample nor in any of the trials. This is different from Study 1 in which we were able to detect motivated cognition. The analysis suggested, there were no unexpected extreme pro-climate veracity patterns. That supported the notion that perceived veracity was rather random than systematic. Our participants' beliefs also did not shift during the questionnaire, which is also in contrast with the results of Pilot Study 1. In conclusion, unlike in the previous study, the results did not provide us with any evidence of motivated belief formation, nor belief polarization.

5. Main study

Unlike the results of Pilot Study 1, the results of Pilot Study 2 did not provide us with evidence of motivated belief formation. In the Main Study, we aimed to extend the two pilot studies that were mostly exploratory and test a series of hypotheses concerning motivated belief formation of a larger and representative sample of participants. Specifically, we wanted to see whether we could find evidence of motivated belief formation and whether it is related to pro-environmental motivation proxied by environmental identity and climate change worry. In addition, we also included in the current study a criterion validity test focusing on belief formation in an unrelated area with known polarization potential (crime rate of immigrants) to be able to distinguish the methodological failure of Thaler's experimental paradigm from a more substantial lack of motivated belief formation.

5.1 Methods

5.1.1 Overview of the Hypotheses

In the main study, we hypothesized that motivated cognition would be manifested in departure from expected number of positive pro-climatic answers (global tendency, H_1) and in the elevated proportion of pro- or anti-climatic veracity responses (H_2 and H_3) We also hypothesize that environmental identity has a positive effect on people's prior climate change beliefs (H_4) and the probability of perceived veracity of pro-climatic messages (H_5) and the shift of people's climate change beliefs between their prior and posterior beliefs (H_6). We also expected that people's worry about the impacts of climate change would affect their prior climate change beliefs (H_7) and the probability of their perception of veracity of pro-climatic messages (H_8). We also hypothesized that people's posterior beliefs would be more polarized compared to their prior beliefs (H_9). Finally, we expected that there would be a positive monotonic relationship between people's worry about immigrants' crime rate and their prior belief about immigrants' crime rate (H_{10}) and that this worry would have an effect on perceived veracity of the higher-crime-rate message (H_{11}). Note that we included the last two hypotheses as a criterion validity check to establish the sensitivity of Thaler's experimental paradigm in an area where opinion polarization was pronounced (Čadová, 2023; Kyselá, 2023).

Technically, these hypotheses were formulated in the pre-registration as follows.

H_1: People's perception of the veracity of pro-climatic messages is systematic rather than random. (The observed distribution of perceived veracity of pro-climatic messages differs from the theoretical expectation given by the binomial distribution with the underlying probability of the positive outcome of $p = .50$).

H_2: There is a tendency in people to systematically perceive pro-climatic messages as true and anti-climatic messages as false.

H_3: There is a tendency in people to systematically perceive pro-climatic messages as false and anti-climatic messages as true.

H_4: There is a positive monotonic relationship between people's environmental identity and their prior climate change beliefs (analyzed separately for each trial).

H_5: Motivated cognition related to environmental identity: Environmental identity has a positive effect on the probability of perceived veracity of pro-climatic messages.

H_6: People's posterior beliefs become more polarized (compared to their prior beliefs) in the direction predicted by their environmental identity and this shift becomes more pronounced as they have more opportunities to express their opinions of climate-related issues (i.e., as they answer other climatic questions).

H_7: There is a positive monotonic relationship between people's climate change worry and their prior climate change beliefs (analyzed separately for each trial).

H_8: Motivated cognition related to worry about impacts of climate change: Worry about impacts of climate change has a positive effect on the probability of perceived veracity of pro-climatic messages.

H_9: People's posterior beliefs become more polarized (compared to their prior beliefs) in the direction predicted by their climate change worry and this shift becomes more pronounced as they have more opportunities to express their opinions of climate-related issues (i.e., as they answer other climatic questions).

H_{10}: There is a positive monotonic relationship between people's fear of immigrants and their prior beliefs about immigrants' crime rate.

H_{11}: Motivated cognition in a context unrelated to climate change (crime rate of immigrants).

Worry about the crime rate of immigrants has a positive effect on the perceived veracity of the higher-crime-rate message (i.e., perceiving as true a message that the true crime rate is higher than initially indicated by the participant or as false a message that the true crime rate is lower than initially indicated by the participant).

5.1.2 Sample Size Justification

We planned to collect $N = 600$ participants. The target sample size was based on available resources. However, prior to running the study, we estimated the statistical power of our study to find a small positive effect of the environmental identity on the probability of perceived veracity of pro-climatic messages (H_5) with the logistic regression. This power simulation showed that the study with $N = 600$ would have sufficient power (beta = .2) to detect a small effect size (OR = 1.326, alpha = .05) and very high power (beta = .1) to detect only marginally larger effect size (OR = 1.381) in a logistic regression analysis with only fixed parameters (using only one response per participant). In reality, the power of our analysis is probably higher given that we use a mixed logit model that benefits from repeated observation of the dependent variable.

5.1.3 Participants

Participants of the study (Czech-speaking adults) were recruited from a participant panel of an opinion poll company using quota sampling for gender, age, education, and region (NUTS2 classification) so that the sample was similar in these sociodemographics to the general Czech population aged 18 – 60. 852 participants entered the study and 611 completed it (for the drop-out rate of 28%). After the exclusion of 13 observations from participants who accessed the questionnaire two times, leaving us with valid 598 participants completed the study. As pre-registered, we have excluded 56 participants[3] who provided boundary values in Thaler's paradigm task and therefore could not answer the veracity question for the final sample of 542 participants. The sample was diverse in terms of gender

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[3] Following pre-registered criteria, we excluded participants whose responses included boundary values of the following intervals: average December temperature equalling -15°C or +15°C (climate-related trial 1); surface of the ice sheet equaling 0 or 30 mil. km2 (climate-related trial 2); number of hottest years in the 20 years between 2000 and 2020 equalling to 0 or to 20 (climate related trial 3); CO2 concentration equalling 0 or 700 ppm (climate-related trial 4).

(with 48.34% women), age (M_{age} = 45.39 SD = 14.68), education (8.12% elementary, 34.32% vocational school, 32.84% high-school, 24.72% university or college degree), and region.

5.1.4 Materials

Climate Change

Manipulation of Veracity of Climatic Messages. We manipulated the veracity of messages in each of the four climate-related trials. We used the same format of Thaler's experimental paradigm as in Pilot studies 1 and 2. For details of how the task was implemented in this study, see Figure 4.

Prior Beliefs About Climate Change. We measured prior beliefs about four climate-related topics that were also covered in Pilot Study 2 (the average temperature in the Czech Republic between 2012 and 2021, the surface of the Arctic Ocean covered by ice sheet in 2021, the number of warmest years between 1850 and 2020 that took place between 2000 and 2020, and the current CO_2 concentration in the atmosphere).

Posterior Belief About Climate Change. We measured posterior beliefs by asking participants to estimate their posterior beliefs related to the first factual question (i.e., the average temperature in the Czech Republic between 2012 and 2021). The format of the question was the same as for the prior belief. We randomized (with the equal probability, .50), whether the posterior belief was measured at the beginning (after the first veracity question) or at the end of the climate-related trials (after the fourth veracity question), in the same way as in the Pilot study 2.

Width of the Interval on Prior Belief. We measured the confidence in the prior belief by assessing the width of its interval, similar to Pilot Study 1 and Pilot Study 2. We measured the interval only in the first trial (the average temperature in the Czech Republic between 2012 and 2021).

Perceived Veracity of Pro-Climatic Messages. We measured perceived veracity of pro-climatic messages in the same way as in Pilot Studies 1 and 2.

Environmental Identity. The environmental identity is measured by a scale comprising nine items that combines the environmental self-identity scale from Truelove et al. (2016; four items; an example of an item: "I think of myself as an environmentally-

friendly consumer"), an environmental self-identity scale from Van der Werff et al. (2014; three items; an example of an item: "Acting environmental friendly is an important part of who I am") and two items from an environmental self-identity scale by Fielding et al. (2008; example of an item: "I think of myself as an environmental activist"). This scale was primarily used for the sake of another study and was translated into Czech. Participants indicated whether they agreed or disagreed with each of the statements using a five-pointed scale with labeled endpoints (1 = *strongly disagree*, 2 = *rather disagree*, 3 = *neither agree nor disagree*, 4 = *rather agree*, 5 = *strongly agree*). Three of the items (items 3, 4 and 9) were reverse-coded reversely. The final value was computed as the average score from all nine items (a higher score reflects stronger environmental identity), $M = 3.32$, $SD = .51$, alpha = .66.

Worry about the Impacts of Climate Change. We measured worry about the impacts of climate change with one item that asked participants how worried they were about the impacts of climate change. Participants indicated their answers using a seven-pointed scale (0 = *I am not at all worried*; 6 = *I am very worried*).

Crime Rate of Immigrants (Criterion Validity Check)

Manipulation of Veracity of Higher-Crime-Rate Messages Within Thaler's Experimental Paradigm. We manipulated the veracity of a message in the crime-related trial (last trial). The message states (randomly and with equal probability of .50) that the true quantity of interest is either lower or higher than the participant's initial guess (prior). We informed participants that the messages (i.e., lower vs. higher) are generated randomly with equal probability. Participants were asked whether this message is true or false, i.e., "In 2022, there were [MORE/LESS] registered crimes committed by foreigners in the Czech Republic per 1000 than [prior belief]. In your opinion, is this report true or false?".

Prior Beliefs About Crime Rate. We measured prior beliefs about an unrelated topic of immigrants' crime rate (crime rate of foreigners living in the Czech Republic for a long time). To facilitate responses, we gave participants information about the crime rate in the Czech population.

Worry about the Crime Rate of Immigrants. Similarly, as in the case of climate change, we measured worry about crime rate of foreigners living in the Czech Republic for a long time using a seven-pointed scale (0 = *I am not worried at all*; 6 = *I am very worried*).

Perceived Veracity of a Higher-Crime-Rate Message. We measured perceived veracity of a higher-crime-rate message by asking participants to estimate whether received message on crime rate is true or false. The higher-crime-rate message is a message that indicates that the immigrants' crime rate is higher than the one implied by the participant's prior. The indicator will take the value of 1 if the participant thinks that the higher-crime-rate message is true or that the lower-crime-rate message (a message in the opposite direction) is false (and 0 otherwise).

5.1.5 Study design

The flow of the task is depicted in Figure 4.

Figure 4

The Flow of Thaler's Task in the Main Study
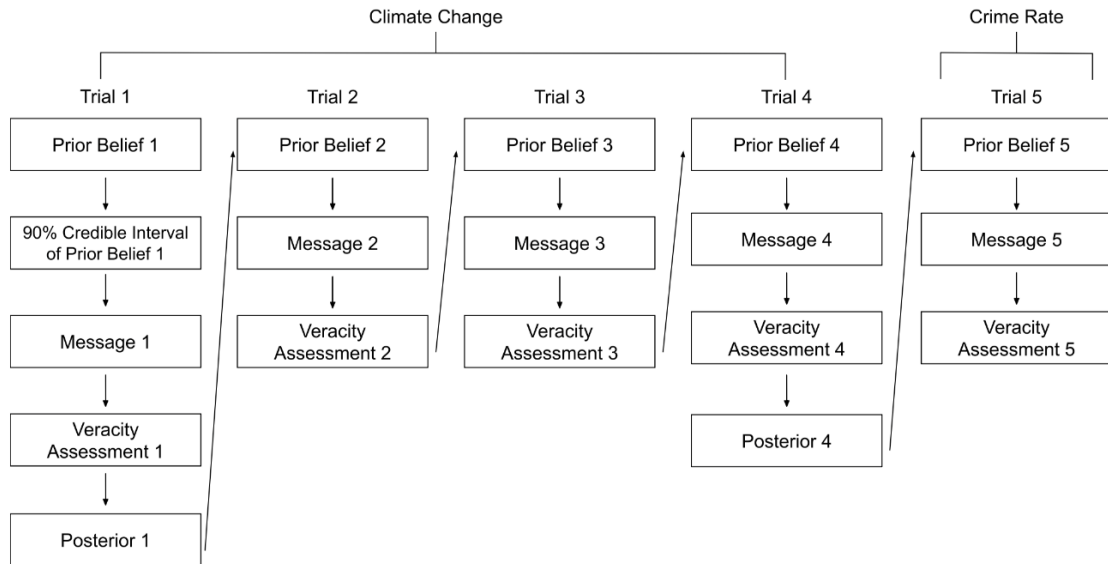
Note. The study design consists of five trials, four trials on topics related to climate change and one, the fifth trial, on an unrelated topic of immigrants' crime rate. Within each trial we measured the participant's prior belief about each topic and perceived veracity of received message (i.e., whether it is true or false). Received messages state that the true quantity of interest is either lower or higher than the participant's initial guess (prior), randomly and with equal probability of .50. 90% credible interval of prior belief (i.e., the lower and upper limit of their prior belief), was measured only in the first trial. Posterior belief (i.e., same question as prior belief 1) measured at the beginning or at the end of the study (randomized).

5.1.6 Procedure

Participants who accessed the study online were screened for socio-demographics. Eligible participants provided their informed consent and entered the study. Participants first completed an unrelated study on Consideration of Future Consequences on pro-environmental intention. Next, participants completed the nine items measuring their environmental identity and a measure of worry about climate change and worry about crime rate of immigrants. Next, participants completed the four climate-related trials of the Thaler

paradigm task. The task consisted of the following steps (see also Figure 4 for details). First, participants indicated their prior belief, followed by 90% credible interval. Second, they received a randomly generated message (that the true quantity is either higher or lower than their prior belief) and were asked to assess its veracity. Next, participants were randomly assigned to one of two groups – the first group received a question about their posterior beliefs (concerning the average temperature in the Czech Republic between 2012 and 2021) right after the first trial, and the second group received the question after the fourth (last) climate-related trial. Next, participants completed the remaining three trials (the surface of the Arctic Ocean covered by ice sheet in 2021, the number of warmest years between 1850 and 2020 that took place between 2000 and 2020, and the current CO_2 concentration in the atmosphere). These trials were similar to the first trial except we did not measure 90% credible interval of the prior belief. Next, participants proceeded to the one trial of Thaler's task focusing on the crime rate of immigrants (the criterion validity check). Next, participants proceeded to another unrelated part of the study (not reported here) focusing on other aspects of environmental identity. Finally, participants were directed to the opinion poll company's landing page to access debriefing with contact information and receive rewards for their participation in the study (20 CZK, an equivalent of .80 USD).

5.2 Analysis

For the analysis we used binomial test (H_1, H_2, H_3), Spearman rank-order correlation (H_4, H_7, H_{10}) point-biserial correlation (H_{11}), linear regression analysis (H_6, H_9), and, mixed logit models (H_5, H_8). All statistical tests were conducted in R.

5.2.1 Data Exclusion and Missing Data

1. We excluded participants who repeatedly accessed the questionnaire (duplicated participants).

2. We excluded participants with an incomplete answer in one or more of the climate-related veracity questions.

3. We excluded participants providing boundary values that were allowed in the questionnaire (subsequent veracity question cannot be asked).

We also coded as missing implausible values in the crime rate prior equaling or

smaller than 1 and larger than 180 (per 1000; i.e., 10 times larger than the true value). These are not used to exclude participants, however they were excluded pairwise for the analysis of H_{10} and H_{11}.

5.2.2 Statistical Models to Test the Hypotheses

H_1

To test H_1 we used indicators of perceived veracity of a pro-climatic message. To test whether perceived veracity of pro-climatic messages was rather systematic than random in our sample, we counted the total number of answers in the direction implying a belief in the increased process of climate change (1) in all four climate-related trials in the whole sample. To test whether it would be possible to reach such results randomly (i.e., with the probability of .5) we used a binomial test.

We chose this approach because it allows us to determine the likelihood of observed values reached under the probability of .5 which is the probability of the actual veracity of each of the messages that participants received. The results indicated whether the pro-climatic veracity patterns are rather systematic than random or otherwise.

H_2

To test H_2, we counted the frequency of pro-climatic veracity answers for each of the participants in all four climate-related trials, obtaining a pattern corresponding to the binomial distribution. In order to test extreme pro-climatic patterns (four out of four pro-climatic responses in the respondent), we used a binomial test. We know that the probability of such extreme patterns is .0625. To estimate the probability that the observed number of extreme responses can arise in this model, we used a binomial test with a baseline of $p = .0625$. If this probability is less than $p < .05$ and also the total frequency of extreme pro-climatic veracity patterns is higher than the expected value, then we can accept H_2.

We are using a binomial test because it fits the nature of our data (binomial distribution) and effectively measures the probability of extremes which helps us to detect possible polarization in our sample.

H₃

Similar to H_2, we also test H_3 with a binomial test. Like in the previous case, the probability of extreme anti-climatic veracity patterns (four out of four answers are anti-climatic) is equal to $p = .0625$. With the binomial test with baseline $p = .0625$, we estimate the probability with which the observed values arise based on this model. We accept H_3 when the estimated probability of observed data arising from the binomial distribution is $p < .05$ and the observed frequency of extreme anti-climatic veracity answers is higher than the expected value.

H₄

To measure whether there is a positive monotonic relationship between environmental identity and prior climate beliefs in each trial we used Spearman rank-order correlation. After recoding the answers for each item, we computed the average environmental identity value for each participant which we correlated with every prior belief (standardized using scale function) in each of the climate-related trials. If all four correlations are positive and significant, the hypothesis is supported fully, when two or three correlations are positive and significant then the hypothesis is supported partially. Less is considered as not supported.

We used Spearman rank-order correlation to measure a monotonic relationship between variables environmental identity and prior climate beliefs in each trial.

H₅

To test H_5 we ran a mixed logit model, where we examined the effect of environmental identity on the probability of perceived veracity of pro-climatic messages. For each climate-related question we used our indices of perceived veracity of pro-climatic messages. The logit model entered: perceived veracity of pro-climatic messages as the dependent variable and the following predictors:

- random intercept for persons,
- random intercepts for questions,
- environmental identity (fixed effect),
- and trial order (fixed effect).

This allowed us to test how EID predicts the perceived veracity of pro-climatic messages and therefore to detect the potential source of motivation. We employed a mixed logit model with random intercept for persons and random intercept for questions so it reflects the hierarchical nature of our data and prevents error. Using a logistic regression model would not consider correlations in observations within id and within question.

H_6

In order to test H_6 we analyze the shift between prior and posterior belief as predicted by other variables, we conduct a regression analysis with the standardized difference between prior and posterior belief as DV and the following predictors:

- environmental identity,

- time (i.e., dummy indicator of whether the posterior belief was measured at the beginning or the end of the questionnaire),

- interaction time x identity.

This enables us to measure the shift between the prior and the posterior, whether this shift is predicted by environmental identity and whether it is more pronounced over time (when they have the opportunity to express their belief, when they respond to multiple trials) which indicates potential belief polarization within the study. We will conclude that identity affects posterior belief polarization if the effect of environmental identity is positive (corroborating H_{6a}).

H_7

Similarly to H_4, we use a correlation to measure the relationship between worry about climate change impacts and standardized prior beliefs in climate-related trials to see how strong this association is. We are using Spearman rank-order correlation. If all four correlations are positive and significant, we conclude that the hypothesis is fully supported, if two or three correlations are positive and significant, we conclude the hypothesis is partially supported and if less the hypothesis is not supported.

H_8

For testing H_8 we are using a mixed logit model similar to the one used for testing H_5. This time, the climate worry scale is used as the independent variable.

This analysis determines whether the worry about impacts of climate change has a positive effect on the probability of perceived veracity of pro-climatic messages.

H_9

We are testing H_9 similarly to H_6 except that we use climate change worry as the dependent variable in this model.

H_{10}

In order to measure the association between people's worry about immigrants' crime rate and their prior beliefs about immigrants' crime rate, we use Spearman rank-order correlation. If a positive significant correlation is measured, we conclude that H_{10} is supported.

This allows us to detect whether participants' prior beliefs are associated with their worry as we expect.

H_{11}

And finally, we use a point-biserial correlation to test for the positive association between perceived veracity of higher-crime-rate messages and worry about immigrant's crime rate. This hypothesis is supported if we find a positive significant correlation.

By this approach we measure potential motivated cognition in a context unrelated to climate change (crime rate of immigrants).

5.3 Results

Non-Random Patterns in Pro-Climatic Veracity Responses

We found that there were 1110 out of the possible 2168 (542 participants x 4 trials) pro-climatic veracity responses (resulting in the probability of veracity responses of .51). Such a count of pro-climatic veracity responses can arise even when response patterns are random (rather than systematic), $p = .27$, binomial distribution with probability of success of .5. This result does not support H_1 and we conclude that the response patterns are random, rather than formed systematically in one direction.

Next, we conducted a binomial test to examine the observed proportion of extreme anti-climatic and pro-climatic veracity answers (i.e., either all anti-climatic or all pro-climatic). Each should represent 6.25% of all observations under the assumption that responses are random; this proportion follows from the number of all possible permutations. We observed counts of 30 and 30 pro- and anti-climatic veracity responses. A binomial test revealed that the share of extreme anti-climatic fitted the expected probability of .0625 and therefore is rather likely under the assumption that the responses are generated randomly, $p = .86$). Therefore, we conclude that there is no evidence of a systematic climate-related belief formation and thus we reject both H_2 and H_3.

Effect of Environmental Identity and Climate Change Worry on Motivated Beliefs

Next, we tested whether people's prior beliefs reflected their environmental identity and their worry about climate change. We estimated Spearman's rank-order correlation to test for a monotonic relationship between environmental identity and (standardized) prior climate beliefs in each of four climate-related trials. The result was significant only for the second belief (i.e., the surface of the Arctic Ocean covered by ice sheet in 2021), $r(540) = .09$, $p = .03$, indicating a very weak correlation, and not for other trials (rs = -.05, .02, -.09, $p > .05$). Based on these results, we rejected H_4. Likewise, we only found a monotonic relationship between climate change worry and the second belief (i.e., the surface of the Arctic Ocean covered by ice sheet in 2021), $r(540) = .12$, $p = .004$, where the remaining three beliefs were essentially unrelated to climate change worry (rs = .05, .04, .08, ps > .05). Thus we also rejected H_7.

Effect of Environmental Identity and Climate Change Worry on Perceived Pro-Climatic Veracity

The results of a mixed model revealed no statistically significant effect of environmental identity on veracity, $OR = 1.11$, 95% CI [0.94 – 1.31], $p = .22$). We rejected H_5.

We employed a mixed logit model also in the case of worry about the impacts of climate change on veracity. Results suggested positive but not statistically significant effects of worry about the impacts of climate change on veracity ($OR = .98$, 95% CI [$0.93 - 1.03$], $p = .48$). We reject H_8. For detailed results of the models, see Appendix 1.

Effect of Environmental Identity and Climate Change Worry on the Shift Between Prior and Posterior Beliefs About the Average Temperature

Based on the linear model, there is no significant association between the predictors (environmental identity, time, and their interaction with the dependent variable (standardized difference between posterior and prior belief about the average temperature in the Czech Republic between 2012 and 2021). The results of the regression analysis did not provide us with support for H_6 and therefore we reject it.

H_9 was tested the same way as H_6 except that instead of the independent variable environmental identity, variable worry about the impacts of climate change was used. The results suggest that the overall fit of the model is not statistically significant, and the independent variables do not predict the belief shift (i.e., the standardized difference between posterior and prior). A low R-squared value ($< .01$) suggests that the model explains only a small share of the variation within our dependent variable.

For details, see Table 1.

Table 1

Model of Prior Belief Shift Between Prior and Posterior Beliefs

	β	SE	p
Constant	-.10	.16	.54
WorryCC[a]	.03	.04	.38
Time[b]	-.14	.21	.52
WorryCC:Time	.02	.05	.68
R^2	< .01		
Constant	.46	.43	.28
EID[c]	-.13	.13	.31
Time[b]	-.77	.57	.18
EID:Time	.21	.17	.21
R^2	< .01		

Note. $N = 542$. The upper part of the table presents the effects of climate change worry, the lower part of the table presents the effects of environmental identity.

[a]WoryyCC is measured by a scale ranging from 0 (no worry) to 6 (strong worry).

[b]Posterior belief was measured after the first veracity question (0) or after the last veracity question in the climate-related trial (1).

[c]EID indicates environmental identity; measured by a 9 item scale with values ranging from 1 to 5 (the higher the score, the stronger EID).

Criterion Validity of Thaler Paradigm in Unrelated Context of Crime Rate of Immigrants

We used a Spearman rank-order correlation to assess the relationship between participant's worry about the crime rate of immigrants and their prior belief on this issue. The results revealed significant, albeit weak, positive correlation, $r(488) = .24$, $p < .001$, confirming H_{10}.

To measure potential motivated cognition in a context unrelated to climate change (crime rate of immigrants), we used a Spearman rank-order correlation to assess the relationship between perceived veracity of higher-crime-rate messages and worry about immigrant's crime rate. The result of the point-biserial correlation showed significant, albeit weak, positive correlation ($r(488) = .11$, $p = .01$), therefore we confirmed H_{11}.

Tests of Validity and Reliability

We also tested the internal validity of the study design by correlation worry about the impacts of climate change (*WorryCC*) and environmental identity (*EID*). The results show there is the theoretically expected, albeit small, correlation, $r(488) = .42$, $p < .001$, between these two variables, which suggests strong internal validity.

6. Discussion

The aim of this study was to gain a better understanding of motivated belief formation and polarization related to climate change. We adopted Michael Thaler's (2020) experimental paradigm which allows to detect motivated cognition from unbiased belief formation. We conducted three studies in total; two pilot studies and one main study. Despite the fact that the first pilot study suggested motivated belief formation in the climate change domain, the second pilot study and the main study did not support that. This also contradicts what other studies have found (e.g., Bayes & Druckman, 2021; Thaler, 2020). However, the results of the main study indicate partial support for the study design for the unrelated area of immigrant's crime rate. Next, our data did not suggest an effect of environmental identity nor worry about climate change to be the drivers of motivated cognition or polarizations in the climate change domain, however suggested worry about immigrants' crime rate to be a

driver of motivated cognition in this area. Our results contribute to other experiment-based studies investigating the process of motivated cognition.

6.1 Vague Prior Beliefs on Climate Change

The results suggest a prevalence of vague prior belief about climate change among our participants. We found no association with their environmental identity and their worry about the impacts of climate change as we expected. Notably, participants' responses did not vary according to their motivations. This convergence in observed responses may suggest that (a) there is a consensus on the issue of climate change, (b) the questions are not sensitive enough to capture nuance differences, or (c) individuals possess limited knowledge of the topic.

6.2 Non-Systematic Patterns in Veracity Responses

In our experiment, participants exhibited rational behavior: (a) they refrained from altering their beliefs based on null information, and (b) their perception of veracity accurately reflected the non-informative nature of the message. One of the possible interpretations of these findings is that our participants responded purely randomly, regardless of the content. However, this explanation seems implausible, given the meaningful response patterns observed in the data, such as the positive relationship between environmental identity and worry about the impacts of climate change and the relationship between different facets of environmental identity. In addition, the criterion validity check revealed meaningful results, suggesting systematic responses in this domain.

6.3 Criterion Validity of Thaler's Paradigm: Crime Rate of Immigrants

We observed compelling evidence that Thaler's experimental paradigm detects motivated belief formation with respect to immigrants' crime rate. These findings suggest that the immigrants' crime rate is probably more politicized and also more polarized in the Czech population than the topic of climate change, which aligns with public opinion polls (Čadová, 2023; Kyselá, 2023). In line with this, our participants exhibited a stronger motivation with regard to this issue which served to drive motivated cognition and thus motivated belief formation. This indicates the selective influence of motivations on belief formation.

6.4 Limitations

There are several limitations of this research that warrant consideration. First, participants were recruited online using a web-based survey platform. They received a small financial reward for participating, however, unlike in the original study by Thaler (2020), they were not financially incentivized to provide as accurate responses as possible (i.e., they did not receive extra reward for being closer to the true answers). This difference could have, technically, contributed to more random rather than systematic responses. On the other hand, financial incentives are not usually used in sociological research and it is still possible to reach valid results. In addition, other parts of the study do not suggest random responses, as mentioned in chapter 6.2. Another limitation may lie in the web-based format itself, as it lacks controlled settings. However, Thaler's (2020) study (and also plenty of other studies) were also conducted online.

Next, the original study (Thaler, 2020) also measured motivated cognition and belief formation in different topics and in a different country. It seems the Czech population may polarize on climate change, but not necessarily on the question whether it exists or not (see Čadová, 2023).

6.5 Implications

Although our studies provide partial support for the paradigm, their important contribution is that they raise a variety of questions to be answered in future studies. Our findings indicate no motivated belief formation concerning the existence of climate change. However, it would be advisable to shed light on other dimensions of the topic of climate change such as humans' responsibility for this issue or climate policies.

Our results also show that motivated belief formation is a complex mechanism, revealing findings that diverge from our initial assumptions. Hence, further research could be concerned with corroborating prevailing assumptions regarding the underlying mechanism of this phenomenon.

6.6 Ethical Considerations

This study was conducted in accordance with ethical standards. Several steps were taken to prevent unethical research;

- The research did not involve a particularly sensitive group (such as children or people with limited decision-making capacity).

- The research did not aim to obtain sensitive data and posed little or no risk to participants that is comparable to the risk they may encounter in a regular office work or school.

- As part of the experiment, manipulation was used (we manipulated the veracity of messages in each of the five trials of the motivated cognition task), with which the participants were familiar, therefore it was not a matter of deception.

- The data collection and processing were in accordance with the Czech law and the EU Regulation 2016/679 of the European Parliament and of the Council (General Data Protection Regulation) and Law 101/2000 Coll. (Data Protection Act).

- We have published anonymized data with the consent of the participants, which they have expressed in their informed consent.

- Our study was approved by the ethics committee (see Appendix 3).

Conclusion

This thesis examines the process of the motivated formation of climate-related beliefs using a novel experimental paradigm proposed by Michael Thaler (2020). The process of motivated cognition, which can be defined as distortion of the information processing in order to arrive at desired conclusions, plays a pivotal role in the formation of motivated beliefs. This phenomenon affects the way new information is perceived and the way it influences one's beliefs. Furthermore, it helps us to explain belief polarization in society.

Previous research has demonstrated that Thaler's (2020) paradigm effectively detects motivated cognition. In our studies, we adopted this paradigm to examine motivated belief formation and belief polarization in the climate change domain. The first pilot study found evidence for motivated belief formation and also indicated belief polarization within the questionnaire. The second pilot study, however, did not provide us with any evidence of motivated belief formation nor polarization.

The results of the main study, similar to those of the second pilot study, indicated there was no motivated cognition in the Czech population with regard to climate change. The perception of veracity of pro-climatic messages was not systematic, in the sense that individuals did not tend to make pro- or anti-climatic inferences from non-informative messages. Additionally, no evidence was found indicating that environmental identity or worry about climate change predicts people's prior beliefs and climate-related belief formation.

However, we were able to find evidence of the criterion validity of Thaler's paradigm, specifically, we were able to identify evidence of theoretically expected motivated belief formation in an unrelated area of beliefs about the crime rate of immigrants. Worry about immigrants' crime rate was significantly associated with prior belief on immigrants' crime rate and also the perceived veracity of higher-crime-rate messages. Unlike the question of the existence of climate change, the issue of immigrant crime rates seems to be polarizing in the Czech population.

In summary, this thesis partially supports the validity of Thaler's (2020) while highlighting the limited role of motivated cognition in climate-related belief formation in some populations. This contributes to other experimental studies investigating these processes.

Summary

Tato práce zkoumá proces motivovaného utváření přesvědčení o klimatu pomocí nového experimentálního paradigmatu, které navrhl Michael Thaler (2020). Proces motivované kognice, který lze definovat jako zkreslené zpracování informací s cílem dospět k požadovaným závěrům, hraje při utváření motivovaných přesvědčení klíčovou roli. Tento jev ovlivňuje způsob, jakým jsou nové informace vnímány a jakým ovlivňují přesvědčení člověka. Mimo to nám pomáhá vysvětlit názorovou polarizaci ve společnosti.

Předchozí výzkum ukázal, že Thalerovo paradigma (2020) účinně detekuje motivovanou kognici. V našich studiích jsme toto paradigma přejali ke zkoumání motivovaného utváření přesvědčení a polarizace přesvědčení v oblasti změny klimatu. První pilotní studie přinesla důkazy o motivovaném utváření přesvědčení a také naznačila polarizaci v rámci dotazníku. Druhá pilotní studie nám však neposkytla žádné důkazy o motivovaném utváření přesvědčení ani o polarizaci.

Výsledky hlavní studie, podobně jako výsledky druhé pilotní studie, ukázaly, že v české populaci neexistuje motivovaná kognice v souvislosti se změnou klimatu. Vnímání pravdivosti pro-klimatických sdělení nebylo systematické v tom smyslu, že jedinci neměli tendenci vyvozovat z neinformativních sdělení pro- nebo antiklimatické závěry. Kromě toho nebyly nalezeny žádné důkazy naznačující, že environmentální identita nebo obavy ze změny klimatu predikují apriorní přesvědčení lidí a utváření přesvědčení souvisejících s klimatem.

Podařilo se nám však nalézt důkazy kriteriální platnosti Thalerova paradigmatu, konkrétně jsme byli schopni identifikovat důkazy teoreticky očekávaného motivovaného utváření přesvědčení v nesouvisející oblasti přesvědčení – o kriminalitě přistěhovalců. Obavy z míry kriminality přistěhovalců byly, v tomto případě, významně spojeny s apriorním přesvědčením o kriminalitě přistěhovalců a také s vnímanou pravdivostí zpráv o vyšší kriminalitě. Narozdíl od otázky existence změny klimatu, se téma kriminality přistěhovalců zdá být v české populaci polarizující.

Souhrnně lze říci, že tato práce částečně podporuje platnost Thalerova (2020) a zároveň upozorňuje na omezenou roli motivované kognice při utváření přesvědčení týkajících se klimatu v některých populacích. Tím přispívá k dalším experimentálním studím zkoumající tyto procesy.

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Appendices

Appendix 1: Results of Mixed Logit Models

Appendix 2: Bachelor's Thesis Project

Appendix 3: Approval by the Ethical Committee

Appendix 1: Results of Mixed Logit Models

Table A1

Model of Perceived Veracity of Pro-Climatic Messages (Mixed Logistic Regression)

Predictors	Odds Ratios	*95% CI*	*p*
(Intercept)	0.54	0.30 – 0.97	.041
Environmental Identity	1.11	0.94 – 1.31	.224
Trial	1.14	1.05 – 1.23	.001

Random Intercepts

σ^2	3.29
$\tau_{00\ id}$	0.00
$\tau_{00\ trial}$	0.00
N_{id}	542
N_{trial}	4
Observations	2168
Marginal R^2	0.007

Table A2

Model of the Perceived Veracity of Pro-Climatic Messages (Mixed Logistic Regression)

Predictors	*Odds Ratios*	*95% CI*	*p*
(Intercept)	0.82	0.61 – 1.08	.155
Worry CC	0.98	0.93 – 1.03	.477
trial	1.14	1.05 – 1.23	.001

Random Effects

σ^2	3.29
$\tau_{00\ id}$	0.00
$\tau_{00\ trial}$	0.00
N_{id}	542
N_{trial}	4
Observations	2168
Marginal R^2	0.007

Appendix 2: Bachelor's Thesis Project

Name of the student: Veronika Anna Černá

Study programme: Sociologie a sociální politika

Expected thesis title: **Why do people (dis)trust science on climate change: accuracy motivation or directional motivation?**

Keywords: belief updating, motivated cognition, climate change, prior belief, directional motivation, accuracy motivation, asymmetric search

Thesis supervisor: Mgr. Jan Urban, Ph.D.

Topic of the thesis

While exposure of ordinary people to information about impacts of climate change and its severity has increased over the last 20 years and uncertainties inherent in such information has generally decreased (IPCC, 2022), people's concern with climate change stagnates or increases only slowly (2022; Saad, 2013). Providing people with information on climate change typically has only a small effect on their beliefs about climate change and their support for climate policies (Rode et al., 2021) and information interventions have typically a lower effect on climate attitude and behavior than other approaches (Whitmarsh et al., 2021). Some studies even show that providing people with information on climate change can even backfire by strengthening people's erroneous prior beliefs and polarizing their opinions (Zhou, 2016), and undermining credibility of the information source (Nisbet et al., 2015). One of the reasons why providing information about climate change has only a limited effect on people's beliefs and their actions (Bayes & Druckman, 2021; Druckman & McGrath, 2019) has to do with the complex way people update their risk and other beliefs (e.g., Rheinberh and Hammit, 2018).

Studies of risk perception have revealed that people systematically misjudge risks (Slovic et al., 2000), they fail to adjust their behavior to risk information (O'Donoghue and Rabin 2001) and use different rationalization strategies to justify their failure to reflect risk information in behavior (Wisdom et al., 2010; Adda and Cornaglia, 2006). In the climate

change domain, such risk updates are influenced by motivated reasoning processes (Bayes & Druckman, 2021; Druckman & McGrath, 2019). Different processes of motivated cognition often lead to similar outcomes in terms of posterior risk beliefs, which makes it difficult to differentiate underlying mechanisms of risk perception and risk belief formation (Druckman and McGrath, 2019).

While directional motivation makes people put higher weight on information that is consistent with their prior beliefs, accuracy motivation makes people favor information sources that they think are more accurate (Druckman and McGrath, 2019). The difference between the two processes of motivated belief and attitude formation is that prior beliefs about climate change should affect directionally motivated belief and attitude formation but not accuracy-motivated belief and attitude formation (Druckman and McGrath, 2019). However, since one's beliefs about accuracy of the source are typically correlated with how close is the source to oneself in terms of beliefs, the two processes would frequently result in the same outcome (information is processed in the way that is congruent with one's prior beliefs; Druckman and McGrath, 2019). As such, it may be difficult to differentiate the two processes of motivated cognition.

In my thesis I will be using a novel paradigm adopted from Thaler's work (Thaler, 2020) to investigate these processes. By employing this approach, it apparently becomes possible to differentiate between the two motivational processes and study them experimentally.

In this thesis, following hypotheses are proposed and tested:

H1: It is possible to distinguish directional- and accuracy-motivated formation of beliefs about climate change empirically using Thaler's (Thaler, 2020) belief formation paradigm.

H2: Directional motivation of belief formation is linked to people's prior attitude to climate change.

H3: Accuracy motivation of belief formation is linked to people's prior trust in science.

H4: Directional- and accuracy-motivated formation of beliefs about climate change lead to polarization of attitude to climate change.

The aim of my thesis is to explain what underlying mechanisms lead to the formation of these beliefs by using a combination of already-existing paradigms and procedures in the field of climate change. Society is the cause of climate change and faces its consequences. Understanding the factors that lead people to their attitudes about climate change is the first step in changing their behavior. Only when we understand the processes can we effectively motivate people to pro-environmental behavior.

Methods of data production and analysis

This work will consist of a pilot study (currently underway) and 2 empirical studies as follows.

Pilot study tests Thaler's (Thaler, 2020) experimental paradigm and its ability to distinguish directional motivation from accuracy motivation at the individual level. The aim of pilot study is to test internal consistency and reliability of the paradigm.

Study 2 will **assess the** criterion validity of Thaler's (Thaler, 2020) paradigm. Specifically, we will look at whether directional- and accuracy-motivated formation of beliefs about climate change are linked to attitude to climate change and trust in science, respectively.

Study 3 will manipulate directional and accuracy-motivated formation of beliefs about climate change experimentally. This study will look at whether the two processes of climate change belief formation lead to polarization of attitude to climate change.

Data collection for the Pilot study and the two other studies will be done in collaboration with the supervisor who will cover the financial costs of participant recruitment. Studies will be conducted on non-representative but variable samples of Czech-speaking adults using CAWI method. The sample sizes for the two main studies will be determined using power simulation. I will analyze the data using statistical environment R. Most of the substantial analyses will be conducted using linear and non-linear regression analyses.

Ethical considerations

Informed consent from each participant will be obtained. The study has a negligible risk for participants comparable to Internet browsing and office work. The manipulation has only a short-term effect. No personal or sensitive data will be collected. All data will be anonymous. The study will be reviewed by the Institutional review board of the Charles University Environment Center.

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Appendix 3: Approval by the Ethics Committee

Centrum pro otázky
životního prostředí
Univerzita Karlova v Praze

Schválení návrhu výzkumného projektu *Etickou komisí pro výzkum při Centru pro otázky životního prostředí Univerzity Karlovy* / Approval of the Research Project Proposal by *Institutional Review Board of Charles University Environment Centre*

Název projektu / Title of the project:

Časové perspektivy, motivovaná kognice a proenvironmentální chování / Time perspectives, motivated cognition and pro-environmental behaviour

Navrhovatel/ Applicant: Jan Urban

Číslo návrhu projektu / Project proposal number: 2/2024

Datum podání žádosti / Date of project proposal submission: March 7, 2024

Jménem *Etické komise pro výzkum při Centru pro otázky životního prostředí Univerzity Karlovy* (IRB) potvrzujeme schválení výše zmíněné studie IRB. Tento výzkum musí být realizován v souladu s předloženým návrhem projektu, tedy v souladu s předloženým výzkumným plánem a materiály popsanými v návrhu. Jakékoli podstatné změny ve studii vyžadují dodatečné schválení IRB před tím, než budou v této studii realizovány.

On behalf of *Institutional Review Board of Charles University Environment Centre* (IRB), we hereby certify that the abovementioned study has been approved by IRB. All research must be conducted in accordance with the approved submission, meaning that the study must be carried out using the research plan and materials outlined in the submitted proposal. Any substantial changes to the study require additional approval from IRB before they can be implemented.

Za Etickou komisi pro výzkum při Centru pro otázky životního prostředí Univerzity Karlovy,

For Institutional Review Board of Charles University Environment Centre,

Jméno / Name: Vojtěch Máca

Datum / Date: April 4, 2024   *Podpis / Signature:*