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The (Will)Power to Change the World: The Influence of Lay Beliefs in the Context
of Global Social Problems

verfasst von | submitted by

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I had lots of help from people so true.

So here's to these people—this verse is for you!

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List of Publications and Manuscripts

Jankowski, J. M., Mlynski, C., & Job, V. (submitted: October 10, 2023). Just a Drop in the Ocean? How Lay Beliefs About the World Influence Efficacy, Perceptions and Intentions Regarding Pro-Environmental Behavior. *Journal of Environmental Psychology*.

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General Introduction

The current time is marked by several social problems (from poverty to rising right-wing extremism to wars). Among the most pressing ones in recent years are climate change and Covid-19 as their consequences concern the whole world. Both require fast and resolute action because otherwise critical tipping points can render negative consequences (almost) irreversible (e.g., exponential infections of Covid-19 or melting ice sheets in Greenland). However, they cannot be solved by a single person, but their resolution depends on the joint efforts of large parts of society. Thus, it is vital to understand what motivates or hinders people's participation in fighting these problems. The primary focus of this dissertation will lay on climate change as one of the most fundamental societal issues. Furthermore, part of the concepts will be applied to the Covid-19 context as an additional, timely global social problem.

The latest report of the Intergovernmental Panel on Climate Change (IPCC) illustrates that man-made climate change is a critical problem that requires fast-paced and large-scale action in several domains including individual behavior change (Lee et al., 2023). We are rapidly approaching the 1.5°C climate target with 1.1°C global warming in the period of 2011 to 2020 compared to preindustrial times. This warming has led to diverse damages to nature, people, and the economy such as loss of biodiversity, increases in mortality due to extreme heat, and damage to infrastructure due to extreme weather events. Every further increment in global warming will intensify these and other hazards. Thus, greenhouse gas emissions need to be reduced drastically and rapidly to limit global warming as much as possible. The IPCC report suggests action on multiple levels such as politics and industry, but also individual behavior change. For example, individual behaviors related to transportation (e.g., car and air travel) or food (e.g., plant-based diets) have a high potential to reduce CO₂ emissions (Wynes & Nicholas, 2017). Thus, motivating people to adopt an environmental lifestyle and make

choices in line with environmental protection, is one building block in fighting climate change.

Unfortunately, it is challenging to get people to engage in pro-environmental action. Despite overwhelming scientific evidence, there are some people who either do not believe that climate change exists or that it is man-made (Leiserowitz et al., 2023). Additionally, although most people do acknowledge that climate change is a threat (Poushter et al., 2022), many still do not act (enough). This is evident in rising numbers of air travel (except during the Covid-19 pandemic; Herre et al., 2023), stable levels of meat consumption in the US and EU (Ritchie et al., 2024), and rising numbers of passenger cars in the EU (*Passenger Cars in the EU*, 2023). Furthermore, even people who intend to act environmentally sometimes have trouble implementing these intentions into action (Bamberg & Möser, 2007; Carrington et al., 2014). Thus, environmental action remains below the necessary levels—in some cases due to skepticism about climate change but often even despite the awareness of climate change.

The Covid-19 pandemic displayed similar characteristics. The pandemic was a serious threat to both individual people and the overall economy. As of July 2024, more than 7 million people died of Covid-19 (World Health Organization, n.d.), and global economy took a hit when lockdowns and infections reduced both production and consumerism (OECD, 2020). The main mitigation responses included social distancing and vaccination—both of which heavily depend on the adherence of many citizens. However, similar to climate change, some people did not believe that Covid-19 was a serious threat (Dryhurst et al., 2020), or were hesitant to get vaccinated (Troiano & Nardi, 2021). Although the Covid-19 pandemic has passed its peak, science suggests that similar pandemics will surge in the future (Marani et al., 2021). Thus, it is still important to examine factors that foster individual action in this context.

Several factors influence if people act on issues like climate change or Covid-19. In

simplified terms, people move through two stages: first, they need to acknowledge the need to act and form an according intention (the “motivation stage”); second, they need to implement this intention into action (the “volition stage”) (Bamberg, 2013b; Heckhausen & Gollwitzer, 1987; Schwarzer, 2008). Global problems pose a particular challenge in the motivation stage because their seriousness is less visible in people’s daily experiences, and they simultaneously feel less solvable because of their global nature. This reduces people’s motivation to act (Clark et al., 2020; Doherty & Webler, 2016; Hornsey et al., 2016; Wong et al., 2021). Additionally, global social problems suffer from discrepancies between people’s intentions and their behavior in the volition stage (the so-called intention-behavior gap) just like many other behavioral domains do (Bamberg & Möser, 2007; Carrington et al., 2014; Gibson et al., 2021). Thus, global social problems entail two difficulties: first, they need to be acknowledged as serious, but solvable during the motivation stage; then, any mitigation intentions need to be successfully implemented to action during the volition stage.

Perceptions of and reactions to challenging situations have been shown to be influenced by people’s lay beliefs. Lay beliefs are core views on how certain aspects of the world function (Dweck et al., 1995). They shape people’s perceptions of and reactions to challenging situations e.g., in education (Paunesku et al., 2015), health (Burnette & Finkel, 2012), or interpersonal relationships (Schumann & Dweck, 2014). For example, they influence whether people interpret failures in academic situations as an opportunity to grow or a sign of insufficient ability and consequently whether they give up or put in more effort (Dweck et al., 1995). Additionally, they influence how well people stick to goal-directed behavior in the face of high demands (for an overview see Francis & Job, 2018). Thus, lay beliefs shape how people interpret problems and how well they enact beneficial reactions.

Similarly, they may influence how people view issues like climate change and Covid-19 as well as their ability to engage in mitigation behaviors. People’s lay beliefs about

whether the world is changeable or fixed (i.e., their *lay beliefs about the world*) relate to whether people perceive global social problems as serious and solvable (Duchi et al., 2020; Soliman & Wilson, 2017). If the world is seen as unchangeable, future negative change (due to climate change or Covid-19) may seem improbable or minor and, thus, less serious. Simultaneously, own mitigation efforts may feel both unnecessary and ineffective. Moreover, people's lay beliefs about whether self-control is a limited capacity or nonlimited (i.e., their *lay beliefs about willpower*) have been shown to influence successful implementation of behavior intentions. People that see self-control as nonlimited engage more in behaviors that serve long-term goals (e.g., academic success) especially under high demands (Job, Walton, et al., 2015). Similarly, this belief may help people implement behaviors related to climate change or Covid-19. In summary, people's lay beliefs may influence their views on global social problems like climate change and Covid-19, and their implementation of mitigation behavior.

The present dissertation investigates the influence of people's lay beliefs about the world and about willpower during the motivation and volition stage. This will provide a deeper understanding of why people often do not engage in behaviors necessary to fight climate change or Covid-19 despite the clear scientific evidence and often even awareness of these problems. As lay beliefs can be changed through interventions (e.g., Paunesku et al., 2015; Yeager et al., 2013), this may also provide a starting point to foster motivation for and implementation of action regarding global social problems.

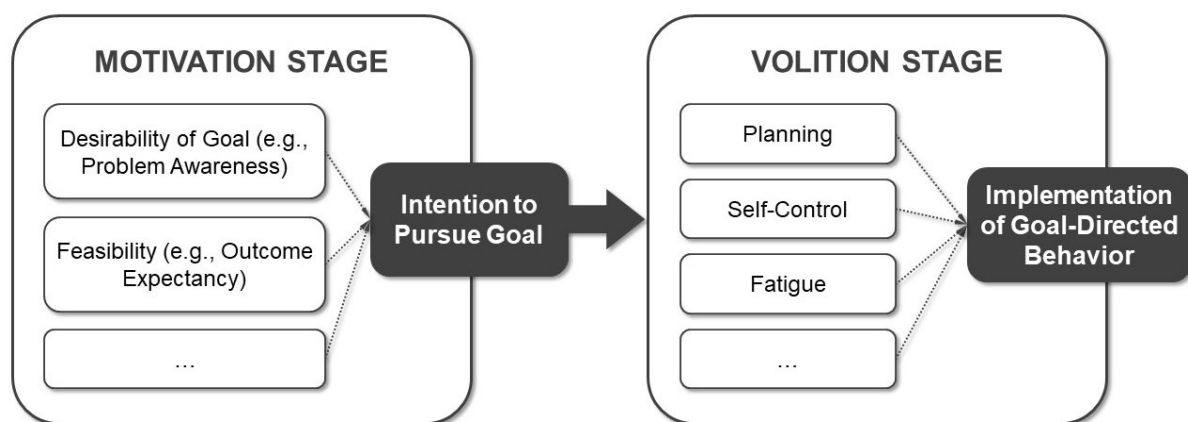
Stages of Action: Motivation and Volition

Lewin et al. (1944) first entertained the idea that goal-directed behavior can be divided into two distinct phases: a motivation stage and a volition stage (see Figure 1). During the motivation stage, people decide whether they want to pursue a certain goal or not. This stage is occupied with the question of how appealing different goals are and successfully

ends when one has committed to a goal. In the following volition stage, people implement actions to attain their chosen goal. This phase is occupied with planning and enacting behaviors suitable to attain the goal. For successful goal attainment, people need to go through both stages, i.e., they first need to form the intention to pursue the goal and then implement the adequate actions to reach the goal.

Figure 1

Overview of the Motivation and Volition Stages



Note. Overview of variables influencing the formation of the intention to pursue a goal (motivation stage) and the implementation of goal-directed behavior (volition stage). This figure integrates context-independent (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987; Inzlicht et al., 2014), pro-environmental (Bamberg, 2013b; Nielsen, 2017), and health (Prochaska & DiClemente, 1983; Schwarzer, 2008) research. The displayed influencing factors are examples, not an exhaustive list.

The idea of distinct stages of goal pursuit has been incorporated in models of goal-directed behavior in various contexts including pro-environmental behavior and health. Context-independent models such as the model of action phases (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987) or the cybernetic model of self-regulation (Inzlicht et al., 2014, 2021) have built on the idea. Furthermore, the idea has been transferred to models

specific to pro-environmental behavior (Bamberg, 2013b) or health (Prochaska & DiClemente, 1983; Schwarzer, 2008). These context-specific approaches have been applied successfully to behaviors such as car use (Bamberg, 2013a), dietary behavior (Spencer et al., 2007), and physical activity (Lippke et al., 2005; Marshall & Biddle, 2001). This indicates that it is useful to understand pro-environmental and health behavior in terms of two consecutive stages (motivation and volition).

The advantage of such a stage model is that it can map different influencing factors depending on the stage. This allows for a more fine-grained understanding and more targeted interventions. For example, adopting a certain goal (i.e., during the motivation stage) is influenced by the perceived desirability and feasibility of the goal (Heckhausen & Gollwitzer, 1987; Inzlicht et al., 2014). In the context of climate change, desirability and feasibility are based on factors such as awareness of and perceived responsibility for environmental problems and expectancies that the goal (i.e., climate protection) can be achieved (Bamberg, 2013b; Nielsen, 2017). If people are aware of the negative consequences of climate change, feel responsible for them, and think their pro-environmental behavior can alleviate the problem, they are more likely to adopt the goal of behaving environmentally friendly. In health behavior, partially similar factors play a role, e.g., knowledge about the health problem, risk perception, and expectancies that protective behavior will reduce the risk (Prochaska & DiClemente, 1983; Schwarzer, 2008). At this stage, it would not make sense to provide people with information on how to plan their health behavior and which self-regulation strategies to use, if they have not yet set the goal to engage in the health behavior at all. These more general, context-independent factors come into play during the implementation of a goal (i.e., during the volition stage). Across contexts, planning, self-control, and use of self-regulation strategies (among others) support the implementation of the necessary action to reach a goal (Bamberg, 2013b; Heckhausen & Gollwitzer, 1987;

Inzlicht et al., 2014; Nielsen, 2017; Prochaska & DiClemente, 1983; Schwarzer, 2008). This second stage is especially important because it addresses the intention-behavior gap which has been often reported in pro-environmental and health behavior (Nielsen, 2017; Schwarzer, 2008).

This stream of research shows that it makes sense to differentiate between a motivation and a volition stage when predicting pro-environmental or health behavior. This approach is useful because people are concerned with different questions at each stage (i.e., which goal to pursue vs. how to implement a certain goal). Thus, different factors influence people's choices and success at each stage. If we want to support behavior change, it is vital to know which factors are beneficial at each stage. This dissertation will investigate the role of different kinds of lay beliefs in this context.

Lay Beliefs

Lay beliefs (sometimes also called “lay theories” or “implicit theories”) are core assumptions in how people view the world (Dweck et al., 1995). They can refer to different domains such as the world in general (Chiu, Dweck, et al., 1997), groups (Halperin et al., 2011), or individual characteristics (e.g., intelligence (Dweck et al., 1995), personality (Chiu, Hong, et al., 1997), or willpower (Job et al., 2010)). They often refer to the assumption of whether the respective concept is malleable or fixed, e.g., whether one's intelligence level is inherently set and unchangeable or whether intelligence can be improved. They may, however, also refer to other features, e.g., whether willpower is a limited resource or nonlimited. Lay beliefs describe what people believe to be true, thus, they may not necessarily reflect reality. But importantly, they still shape perception and behavior.

Lay beliefs influence people's perceptions and behavior by providing a framework that guides how people see and interpret the world around them. The objectively same situation—e.g. failing a test—can have different meanings depending on one's lay belief about

intelligence. For someone who sees intelligence as fixed, it may indicate not being smart enough, while for someone who sees intelligence as malleable, it may indicate insufficient effort (Dweck et al., 1995). These different interpretations of the situation then motivate different reactions. The first may drop out of the course because of the seeming lack of the necessary ability, while the latter may increase their efforts the next time. Such different reactions can over time lead to differences in academic performance depending on students' lay beliefs (Blackwell et al., 2007; Paunesku et al., 2015; but also see Costa & Faria, 2018). Thus, lay beliefs impact important outcomes by giving rise to different interpretations of the same experiences.

Importantly, people's lay beliefs are not immutable. They can change naturally across the lifespan or be actively changed through targeted interventions. For example, people's lay beliefs about willpower have been shown to differ across age groups presumably because experiences of autonomy in willpower exertion change throughout the lifespan (Job et al., 2018). Furthermore, interventions fostering the lay belief that intelligence is malleable have been shown to increase academic performance in students (Blackwell et al., 2007; Paunesku et al., 2015). Thus, if lay beliefs play a role in people's behaviors regarding climate change or Covid-19 as well, they may provide a useful starting point for interventions to foster behavior change in these areas.

Motivation Stage: Lay Beliefs about the World

As detailed previously, the endpoint of the motivation stage is to set and commit to a specific goal. This is influenced by perceptions of the desirability and feasibility of the goal. In the context of pro-environmental and health behavior, this requires being aware of the environmental or health problem and thinking that one's behavior can successfully reduce the problem. However, in global social problems like climate change and Covid-19, such perceptions may be impeded due to the global nature of the problem. People may easily feel

like these problems do not pertain to them because they feel abstract or intangible. Likewise, people may feel like their actions cannot contribute to the mitigation of these problems because they are so broad.

Forming Behavioral Intentions Regarding Climate Change and Covid-19

For both climate change and Covid-19 related behavior, threat belief and response efficacy have been identified as important factors. People who deny that climate change is happening or think that it is not serious engage in less pro-environmental behavior (Hornsey et al., 2016). Similarly, people who think Covid-19 is not a big threat are, for example, less willing to get vaccinated (Wong et al., 2021). *Response efficacy* refers to the conviction that one's behavior (e.g., reducing one's meat consumption) will successfully lead to a desired outcome (e.g., environmental protection) (Bandura, 1978). Higher response efficacy with regard to pro-environmental behavior is associated with higher intentions to engage in environmental protection (Bradley et al., 2020; Doherty & Webler, 2016; Lubell et al., 2007). Covid-19 related response efficacy is likewise related to a higher willingness to get vaccinated (Wong et al., 2021) and more engagement in protective behaviors (Clark et al., 2020). Thus, convincing people that climate change and Covid-19 are serious threats and that their behavior can help mitigate them are key factors to increasing climate change or Covid-19 protective behavior.

Previous studies have tried to change threat and efficacy beliefs in both contexts to foster behavior, for example by providing information. However, such interventions often show mixed or limited effects. For example, messages about the scientific consensus on climate change only have small effects on climate change attitudes (Rode et al., 2023) and the effect of knowledge on climate change belief is inconsistent across political affiliations (Hornsey et al., 2016). Similarly, messages arguing that and how people can contribute to climate protection do not consistently increase response efficacy (Hart & Feldman, 2016;

Hornsey et al., 2021) and neither do “success stories” of effective climate action (Hamann & Reese, 2020; Jugert et al., 2016). Messages designed to increase the perceived efficacy of vaccination also did not increase willingness to get vaccinated against Covid-19 (Kachurka et al., 2021). Some studies even indicate that direct persuasive messages can cause reactance and lead to adverse effects (Ball & Wozniak, 2022; Dillard et al., 2023; Ma et al., 2019; but see also Rode et al., 2023). Thus, providing people with information about climate change or Covid-19 does not seem to be enough.

Researchers have suggested that the main problem is not a lack of information, but how that information is processed. They suggest that people may reject or discard factual messages if they conflict with their underlying worldviews or ideologies (Hornsey & Fielding, 2017). This idea is supported by evidence that knowledge about climate change is related to climate change belief in Democrats (who typically acknowledge climate change), but not in Republicans (whose political ideology might be more tied to skepticism about climate change). Thus, people’s underlying beliefs may shape how facts around climate change or Covid-19 are interpreted. One of the worldviews that influence this may be lay beliefs about the world.

Lay Beliefs About the World

Lay beliefs about the world describe people’s beliefs about how changeable the (social) world is and whether it can be changed by humans (Chiu, Dweck, et al., 1997). People with a so-called *entity belief about the world* assume the world is fixed and unchangeable (although minor, short-lived trends may exist). To them, humans cannot substantially change the (social) world around them but are rather insignificant parts of the larger whole. People with an *incremental belief about the world*, on the other hand, believe that the world is changeable and specifically that human efforts can shape the world and its institutions. There is limited research on how lay beliefs about the world form. However,

differences e.g., between the US (stronger incremental belief) and India (stronger entity belief) suggest a cultural component (Kung et al., 2016). Furthermore, experiences of change in society (e.g., job mobility) seem to shape people's lay beliefs about the world as well (Chen et al., 2009).

Lay beliefs about the world influence people's perception of fundamental aspects of the world and their relationship to it. People with an entity belief see the world as unchangeable and are, thus, motivated to adapt and fit into the fixed reality. For example, they more readily adopt a new, dominant group identity (Chiu & Hong, 1999) and adjust their self-perception more to fit in-group characteristics compared to people with an incremental belief (Yang & Hong, 2010). Similarly, they also place higher importance on fitting in when evaluating others (Chen et al., 2009). Conversely, people with an incremental belief see the world as changeable and, thus, are motivated to try to shape it. In line with this, they display behaviors and attitudes that are conducive to social change. For example, they engage in more normative political action (e.g., participating in peaceful demonstrations) (Shuman et al., 2016) and favor policies that benefit groups that are perceived to be more in need (Chao et al., 2010). They are also more hopeful that social conflicts will be solved successfully (Cohen-Chen et al., 2015). Thus, overall, an entity belief orients people towards adapting to a fixed world, while an incremental belief pushes people to actively try and change the world.

Lay Beliefs About the World in the Contexts of Climate Change and Covid-19

As climate change and Covid-19 are both problems deeply connected to worldwide change, people's lay beliefs about the world may influence how people see them. First, people with an entity belief might discard future consequences of climate change as unlikely or minor because a fundamental change in the world is at odds with their core belief. Similarly, people with an entity belief might find it difficult to acknowledge changes related to the surge of Covid-19 (such as increased risks of everyday behaviors and the need for

protective measures) because they assume that the world is stable over time. Second, people with an entity belief may see any attempts to mitigate climate change or the Covid-19 pandemic as futile because they do not believe the world's course can be significantly changed by humans. This should then lead to lower intentions to engage in pro-environmental or Covid-19 protective behavior in people with an entity belief.

Initial research in the environmental domain corroborates this. People with an entity belief report lower beliefs in climate change and lower environmental response efficacy (Duchi et al., 2020; Soliman & Wilson, 2017). Consequently, they also report lower intentions to act pro-environmentally (Soliman & Wilson, 2017) and lower pro-environmental behavior (Duchi et al., 2020). Additionally, inducing an incremental belief increased preferences for sustainable hotel offerings in people with low biospheric values (Septianto et al., 2021). Lay beliefs about the world might even contribute to the commonly observed differences between conservatives and liberals concerning climate change. Conservatives report stronger entity beliefs than liberals and consequently see mitigation efforts as less effective and report lower pro-environmental behavior (Chan & Faria, 2022). Thus, overall, an entity belief about the world may promote skeptical views about climate change, Covid-19, and related mitigation efforts, thus reducing people's intentions to act. Fostering an incremental belief might then be important to motivate people to act on those issues.

Additionally, interventions targeting lay beliefs about the world may have the advantage that they do not create reactance. Lay beliefs about the world are overarching and context-independent. Existing manipulations (e.g., by Cohen-Chen et al., 2015), thus, do not refer to any concrete issue (like climate change or Covid-19). Due to this, people should feel less pressured or threatened in their freedom of choice compared to messages directly addressing climate change or Covid-19 related behavior. Thus, one aim of this dissertation is

to manipulate people's lay beliefs about the world and investigate the impact this has on their beliefs and intentions regarding climate change and Covid-19.

Volition Stage: Lay Beliefs About Willpower

As described at the beginning of the general introduction, the aim of the volition stage is to implement those behaviors that are required to attain the goal that was set during the motivation stage. Successful implementation is influenced by factors such as planning, self-control exertion, self-regulation strategies, or fatigue from other demands. These factors are relevant in many contexts where people implement intentions into action and play a role in the climate change context as well. Research has repeatedly shown a gap between people's environmental intentions or attitudes and their respective behavior (Bamberg & Möser, 2007; Carrington et al., 2014; Hornsey et al., 2016; Juvan & Dolnicar, 2014). Thus, research investigating how environmental intentions can successfully be implemented into action is vital.

Implementing Climate Change Related Behavior

There are different reasons why people may not act in line with their environmental intentions. Some reasons may be out of their control (e.g., when there is no adequate infrastructure or opportunity to act environmentally friendly), but another factor may be that pro-environmental behavior is typically effortful or otherwise costly. Pro-environmental behaviors can require different types of effort, e.g., cognitive or physical effort (e.g., when reading up on environmental issues or taking the bike instead of the car) or effortfully changing one's existing habits (Dreijerink et al., 2021). Research finds that people typically engage less in pro-environmental behaviors when they become more costly or are perceived as more effortful (Dreijerink et al., 2022; Lange & Dewitte, 2022; Wyss et al., 2022). Thus, the effort associated with pro-environmental behavior may be one barrier that hampers people's implementation of their environmental intentions.

Self-control may be helpful to overcome the barrier presented by the effortful nature of pro-environmental behavior. Self-control is the “capacity to override a dominant response tendency” (de Ridder et al., 2012, p. 77), typically when different behavioral options are mutually exclusive. In the environmental context, the dominant response tendency may be non-environmental behavior because it is often less effortful, more convenient, and less costly than pro-environmental behavior. Research corroborates that self-control helps override such non-environmental behavior tendencies. People with high trait self-control behave more environmentally friendly (for a review see Colombo et al., 2023). Additionally, people with high trait self-control align their behavior closer with their environmental intentions (Wyss et al., 2022). Thus, exerting self-control seems to support the implementation of environmental intentions. However, self-control exertion is not only influenced by people’s trait self-control ability but also by their lay beliefs about the nature of self-control.

Lay Beliefs About Willpower

Lay beliefs about willpower refer to people’s core assumptions about the nature of self-control (colloquially termed *willpower*) (Job et al., 2010). People with a *limited willpower belief* assume that self-control is a limited capacity that depletes when it is used. They believe that each time they exert self-control on an effortful behavior, they deplete some of their self-control capacity. Thus, they will have less self-control capacity left for consecutive tasks unless they replenish it by taking a break. Other people, in turn, believe that self-control is nonlimited (a *nonlimited willpower belief*). They do not see self-control as a limited capacity and, thus, do not think that exerting self-control reduces the capacity for later tasks. As mentioned previously, research on lay beliefs is not concerned with whether the beliefs people hold are true (e.g., whether willpower is truly limited or not), but rather with the effects of the beliefs people hold on their perception and behavior.

Lay beliefs about willpower have been shown to help people behave in line with their intentions in different areas such as health, academic performance, or romantic relationships. People with a nonlimited willpower belief are more physically active, snack less, and engage in more self-care activities (Bernecker & Job, 2015; Bernecker & Kramer, 2020; Di Maio et al., 2020; Job, Walton, et al., 2015). They also procrastinate less in learning contexts, engage in more self-regulated learning strategies, and have higher grades (Allen et al., 2023; Job et al., 2010, Study 4; Job, Walton, et al., 2015). Finally, they also provide more emotional and instrumental support in romantic relationships (Francis et al., 2023). This shows that a nonlimited willpower belief is associated with more engagement in (effortful) behaviors that are conducive to desired long-term goals in different areas.

The positive effect of lay beliefs about willpower is typically stronger when people experience high demands. For example, the positive effects on physical activity and a healthy diet are stronger later in the day when demands have presumably built up over the day (Francis et al., 2021). People also profit more from a nonlimited willpower belief when health behaviors are new to them and, thus, likely more difficult to implement (Bernecker & Job, 2015). Similarly, a nonlimited willpower belief shows stronger relationships to reduced procrastination and higher grades when students have a high workload (Job, Walton, et al., 2015). However, another study shows that a nonlimited willpower belief is only positively related to physical activity in patients with milder, but not severe symptoms of knee osteoarthritis indicating that a nonlimited willpower belief cannot overcome unlimited amounts of strain. Still, overall, a nonlimited willpower belief seems to help people to keep beneficial behavior up when they are faced with demands.

Different mechanisms have been discussed regarding how and why people with a limited willpower belief engage less in behaviors conducive to long-term goals. Some research indicates that lower self-efficacy mediates the relationship between a limited

willpower belief and e.g., reduced health behavior (Bernecker & Kramer, 2020; Francis et al., 2021). In line with this, a study showed that exerting self-control decreased self-efficacy, but only in people with a limited willpower belief (Chow et al., 2015). Specifically, people with a limited willpower belief felt unable to successfully exert further self-control after an initial self-control task. Other research showed that exerting self-control elicited the goal of preserving mental resources in people with a limited willpower belief (Job, Bernecker, et al., 2015). They showed an increased preference for rest-conducive objects and took longer breaks. Thus, people with a limited willpower belief may be less willing to engage in effortful self-control behavior because they either feel unable to do so successfully or prefer to conserve their resources.

Lay Beliefs About Willpower in the Context of Climate Change

Similar to supporting engagement in other effortful behaviors, a nonlimited willpower belief may also foster people's willingness to engage in effortful pro-environmental behavior. People with a limited willpower belief strive to preserve mental resources after they have engaged in an effortful task (Job, Bernecker, et al., 2015). This goal may make them less willing to exert themselves for the sake of environmental protection after having engaged in other effortful tasks, such as work-, school-, or health-related activities. But even if they have not previously exerted themselves, the basic assumption that their self-control capacity is limited might motivate them to preserve their capacity for later (e.g., more immediately relevant) tasks. In turn, a nonlimited willpower belief may increase people's willingness to invest the necessary effort for pro-environmental behavior.

A promising way to study people's willingness to exert effort for the environment is through cardiovascular measures. Past studies in the environmental domain have investigated effort exertion through self-reports (e.g., Dreijerink et al., 2022; Schultz & Oskamp, 1996) and performance in or choice to work on effortful tasks that benefit the environment (e.g.,

through an environmental donation) (Krebs et al., 2023; Lange & Dewitte, 2022). Both approaches have certain downsides: There is often a gap between actual and self-reported pro-environmental behavior (Kormos & Gifford, 2014) and while task performance overcomes this problem, it is still not a measure of actual effort exertion and e.g., depends on people's abilities. Cardiovascular measures of effort extend these approaches by providing a more direct measure of engagement. Specific cardiovascular responses (e.g., pre-ejection period of the heart and systolic blood pressure) have been associated with effort responses to performance challenges (Obrist, 1976, 1981). These responses have been shown to be good measures of effort exertion on cognitive (Mlynski et al., 2020; Richter & Gendolla, 2009) and physical tasks (Wright et al., 2012). Thus, assessing cardiovascular measures while people work on an environmental task would allow for a more detailed analysis of their willingness to exert effort for the environment and the effect of lay beliefs about willpower.

A nonlimited willpower belief may also help people stick to their environmental intentions when other demands arise. Pro-environmental behavior takes place in people's everyday lives where many other demands from work, household chores, or family duties are present. People might be quite able to make environmental choices on a relaxing weekend, but after a stressful day, people may be more tempted to go with easier, non-environmental alternatives. This is corroborated by initial research showing a negative relationship between stress and pro-environmental behavior (Kaida & Kaida, 2019; Zhang & Cai, 2022). A nonlimited willpower belief has been shown to be especially helpful when people experience high demands or when demands build up over the day (Francis et al., 2021; Job, Walton, et al., 2015). Thus, a nonlimited willpower belief may help people uphold their pro-environmental behavior during stressful, demanding times.

Aims of the Dissertation

This dissertation examines how people's lay beliefs influence their perception of and

reaction to global social problems. Lay beliefs about the world should play a role during the motivation stage when people adopt intentions to act (or not). Lay beliefs about willpower should, then, influence how well people translate their intentions into action during the volition stage. The main global social problem that is investigated is climate change, but one paper focuses on Covid-19 as an additional context (see Table 1 for an overview of each paper).

Previous studies have established positive correlations between an incremental belief about the world and climate change related variables (Duchi et al., 2020; Soliman & Wilson, 2017). Based on this, Paper 1 investigates whether inducing an incremental belief about the world increases people's climate change belief, response efficacy, and intention to act on climate change in three experiments across two cultures. Paper 2 investigates the relationship between lay beliefs about the world and Covid-19 related variables. As this has not been studied previously, the correlational relationship is tested first. Then, five experiments investigate the causal relationship between an incremental belief about the world and higher pandemic related threat belief, response efficacy, and intentions to act in the context of Covid-19 and a hypothetical pandemic scenario.

No previous studies have looked at the influence of lay beliefs about willpower in the environmental context. Thus, Paper 3 first looks at the correlational associations in a daily diary study across three timepoints. It tests whether a nonlimited willpower belief is positively related to daily pro-environmental behavior and whether this relationship is moderated by daily demands. Paper 4 looks at the more controlled setting of a lab and additionally investigates the causal effect of lay beliefs about willpower. Two studies test whether a measured or induced nonlimited willpower belief relates to stronger engagement in an environmental task as measured by task performance and cardiovascular measures of effort.

Table 1

Overview of the Four Papers of This Dissertation

Paper	N Studies	Target Lay Belief	Context	Aims	Study Design	Sample (Recruitment)
1	3	World	Climate Change	• Causal effect on climate change belief, response efficacy, and intentions	Online experiment	US American (MTurk) + German-speaking (social media)
2	6	World	Covid-19 + Pandemic Scenario	• Correlations with pandemic related threat belief, response efficacy, and intentions • Causal effects on pandemic related threat belief, response efficacy, and intentions	Online survey + online experiment	US American (Prolific)
3	1	Willpower	Climate Change	• Correlations with everyday pro-environmental behavior • Interaction with daily demands	Online daily diary	German-speaking (social media)
4	2	Willpower	Climate Change	• Correlations with engagement in environmental task (incl. cardiovascular measures) • Causal effects on engagement in environmental task (incl. cardiovascular measures)	Lab study + lab experiment	German-speaking (university participant pool)

Note. N Studies refers to the number of individual studies included in each paper. Target Lay Belief: World = Lay beliefs about the world,

Willpower = Lay beliefs about willpower.

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Paper 1: Just a Drop in the Ocean? How Lay Beliefs About the World Influence

Efficacy, Perceptions and Intentions Regarding Pro-Environmental Behavior

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Abstract

Climate change is a large-scale problem that might leave people paralyzed by feeling too small to make a difference. Indeed, low response efficacy has been shown to be related to low pro-environmental behavior. There have been some attempts to increase people's efficacy. However, these have often been less successful than hoped. In the present research we suggest that response efficacy is informed by people's more fundamental understanding of how the world functions (i.e., their lay beliefs about the world): whether they think the world is changeable or fixed. In three online experiments (on samples from Austria and the USA) we manipulated participants' lay beliefs about the world and measured their response efficacy and different indicators of intentions and perceptions related to pro-environmental behavior (such as climate change belief, perceiving norms as changing and feelings of working together in pro-environmental behavior). People who were led to adopt the belief that the world is changeable (i.e., an incremental belief) reported higher response efficacy regarding climate change. There was also some indication that they had stronger pro-environmental intentions, felt more like working together with others when engaging in pro-environmental behavior, and perceived norms around pro-environmental behavior as more dynamic. These results indicate that people's global understanding of the world plays a role in how they view and tackle large-scale social problems such as climate change. Supporting an incremental belief might foster an agentic approach to such problems and promote social change.

Keywords: lay beliefs, efficacy, pro-environmental behavior, behavior intention, dynamic norms

Introduction

Human-made climate change is one of the biggest challenges that humanity faces today. According to the latest IPCC report, climate change has caused adverse impacts to people and nature, such as increased health risks due to heat or destruction of homes and infrastructure due to extreme weather events (Lee et al., 2023). These adverse impacts will increase with every increment of global warming. Thus, greenhouse gas emissions need to be reduced drastically and rapidly to limit global warming.

Although people are generally aware of the threat of climate change, environmental action is not as pronounced as it would need to be. For example, climate change is ranked as the single most serious global problem by EU citizens (Special Eurobarometer 513- Climate Change, 2021). However, 35% report that they have not taken a single action to fight climate change and air travel—a prominent contributor to individual CO₂ emissions—is rising instead of falling (Roser & Herre, 2017).

A powerful barrier to more ambitious environmental action might be that people feel like their personal action does not have much influence on a global problem such as climate change. Low response efficacy (i.e., people's perception that their behavior can produce a certain outcome) has been repeatedly connected to reduced pro-environmental behavior and intention (e.g., Bostrom et al., 2019; Bradley et al., 2020; Doherty & Webler, 2016; Gulliver et al., 2020; Lubell et al., 2007; Rainear & Christensen, 2022). Increasing people's response efficacy, thus, seems to be a promising way to increase individuals' pro-environmental action.

However, efficacy seems to be difficult to change. For example, direct verbal instruction, e.g., providing success stories or explaining how and which behavior strategies can mitigate climate change, showed mixed effects on response efficacy (Hamann & Reese, 2020; Hart & Feldman, 2014; Hornsey et al., 2021; Xue et al., 2016).

A possible reason is that response efficacy is influenced by people's more fundamental assumptions of how the world works and whether individual behavior can change global outcomes. In the present research, we propose that if people believe that the world is largely fixed, they maintain a low response efficacy despite contrary information. If people believe that the world is changeable, on the other hand, they should adopt high response efficacy more easily. Thus, people's fundamental beliefs—their lay beliefs—about the world might be an important source of their response efficacy regarding pro-environmental behavior. We aim to manipulate these lay beliefs across three experiments to show that they shape people's response efficacy as well as other outcomes regarding pro-environmental behavior.

Response Efficacy

Bandura (1978) coined the concept response efficacy in conjunction with self-efficacy. While self-efficacy refers to the conviction that one can execute a certain behavior; response efficacy refers to the conviction that the behavior will lead to a certain outcome. For example, a person has a high response efficacy regarding climate change if they believe that personal behaviors such as following a vegan diet or joining a protest for environmental protection will contribute to the desired outcome of protecting the environment.

Environmental research further distinguishes between response efficacy at the personal and at the collective level (e.g., Bostrom et al., 2019; Doherty & Webler, 2016; Lubell et al., 2007). For example, while personal response efficacy refers to the conviction that my personal behavior can achieve a certain outcome, collective response efficacy refers to the conviction that the collective behavior of a group (e.g., a student group planting trees or activists raising awareness) can achieve an outcome.

Past literature shows that response efficacy at both the personal and collective level is important for pro-environmental behavior. People with high personal response efficacy

support environmental policies more (Lubell et al., 2007), engage and intent to engage in more private pro-environmental behavior such as recycling or driving less (Bradley et al., 2020; Hornsey et al., 2021; Lubell et al., 2007; Rainear & Christensen, 2022), and engage in more public pro-environmental behavior like protesting, voting, or volunteering (Doherty & Webler, 2016; Lubell et al., 2007). Similarly, people with high collective response efficacy show higher support for environmental policies (Bostrom et al., 2019; Lubell et al., 2007) and engage more private (Lubell et al., 2007) and public (Doherty & Webler, 2016; Lubell et al., 2007) pro-environmental behavior.

Interventions Targeting Response Efficacy

Given these previous results, researchers have tried to increase people's response efficacy in order to foster pro-environmental behavior. However, this has shown to be a difficult endeavor. Previous studies tested a direct approach to foster response efficacy by giving participants direct persuasive messages indicating that a specific personal behavior will make a difference. However, the results were mixed sometimes showing no effect on behavior or effects on some indicators but not others (Berl et al., 2022; Niemiec et al., 2021). Possibly, this is because such persuasive messages have limited effects on response efficacy itself. For example, while negative messages decreased participants' response efficacy, positive messages did not increase it compared to a control group (Hart & Feldman, 2014). This indicates that response efficacy cannot simply be increased by telling people that their behavior can make a difference.

Further studies have tried to increase people's response efficacy by presenting "success stories" about individuals or groups that successfully contributed to climate change mitigation. Results of these studies were rather mixed as well. Some found a positive effect on response efficacy (Jugert et al., 2016), while others found no effect (Hamann & Reese, 2020).

Other studies focused on providing information about concrete strategies that are effective to mitigate climate change or explaining the causal chain between causes or actions on climate change and climate change related impacts. The combination of both of these approaches has been shown to increase personal response efficacy specifically about discussing climate change with others (N. Geiger et al., 2017). Participants also retrospectively reported an increase in personal response efficacy after an extensive course program that included learning about concrete available activities (Nelson et al., 2022). In a different study, however, providing strategies only increased personal response efficacy for a specific sample, namely participants low in anthropocentrism and low to moderate in ecocentrism (Xue et al., 2016). A study testing only the effect of explaining the causal chain between climate change actions and impact initially found promising effects on personal response efficacy, but then could not replicate them (Hornsey et al., 2021).

Overall, this research shows that promoting response efficacy is not as straightforward as one might think. Results are often mixed such that a specific approach might work in one sample, but not in another one. The existence of moderating variables (Xue et al., 2016) also indicates that efficacy interventions do not work the same for everyone. A possible explanation might be that response efficacy is not only influenced by perceptions of or information on the specific problem at hand, but also by more general perceptions of how controllable and changeable the world is.

Lay Beliefs About the World

Lay beliefs are core assumptions that lay people develop to make sense of their social world (Levy et al., 2001). They can refer to different concepts such as individual characteristics (e.g., Dweck et al., 1995), groups (e.g., Halperin et al., 2011) or the world in general (e.g., Chiu, Dweck, et al., 1997). Lay beliefs about the world specifically refer to people's assumptions about how changeable the (social) world in general is (Chiu, Dweck, et

al., 1997). An entity belief of the world entails the assumption that the world is fixed and cannot be substantially changed by humans (e.g., humans are just tiny pieces with little influence on the big picture). An incremental belief, on the other hand, entails the assumption that the world is changeable and can be shaped by humans (e.g., through individual or collective actions people can permanently change core features of the world—for better or worse).

Research on lay beliefs about the world mostly focused on the effects they have on people's relationship to their social world. People with an incremental belief are more hopeful about positive social change and engage in more political action that promotes social change than people with an entity belief (Cohen-Chen et al., 2015; Shuman et al., 2016). There is limited research on the formation of people's lay beliefs about the world. However, there is some indication that experiences of change in the social world (e.g., job mobility) influence people's lay beliefs about the world (Chen et al., 2009).

Besides, lay beliefs about the world have successfully been manipulated in experimental settings. Cohen-Chen et al. (2015) had participants read an ostensible newspaper article discussing new research findings that support the changeable nature of the world. This article successfully induced an incremental belief in participants both compared to a control group (reading an unrelated text) and to a group that read about findings supporting the fixed nature of the world. Septianto et al. (2021) used the same manipulation and found similar effects on participants' lay beliefs about the world. Thus, lay beliefs about the world can at least be temporarily shifted by presenting people a direct message about the nature of the world.

Lay Beliefs About the World and Climate Change

Since the concept of global change sits at the very heart of both the problem of and the solution to climate change, lay beliefs about the world might affect people's perceptions

of several aspects of climate change.

Previous correlational studies have shown that people with an incremental belief about the world report a stronger belief in climate change and stronger response efficacy with regard to climate protection (Duchi et al., 2020; Soliman & Wilson, 2017). If a person believes that the world is fixed and unchangeable, this might lead them to view evidence of climate change as unlikely or merely a short-term trend, or they may underestimate the scope of the change. At the same time, an entity belief might lead people to regard possible mitigation strategies as futile and ineffective and their own impact as negligible. Past studies mostly looked at personal response efficacy. However, it is plausible that lay beliefs about the world would equally relate to collective response efficacy and influence what people believe about the response efficacy of larger groups of people.

As detailed above, past studies show that lay beliefs about the world are related to perceptions of future change (i.e., whether one can mitigate climate change through one's behavior). Besides, they might also relate to perceptions of change already happening now. An incremental belief might foster the perception that norms surrounding pro-environmental behavior are changing. On the one hand, an incremental belief might generally increase people's awareness of changes in the social world. On the other hand, it might lead people to interpret such changes as a sign of a meaningful shift in behavior norms (instead of random fluctuations or a short-lived trend). Perceiving that norms around pro-environmental behavior are dynamic has been shown to increase pro-environmental behavior (Sparkman & Walton, 2017).

Lay beliefs about the world might also relate to how one feels about pro-environmental behavior itself. Combatting climate change is a collective task, which poses several challenges (e.g., people's personal contributions are unclear, and people might fear free riders). However, it might also afford an opportunity. Humans generally strive to be

connected to others (Baumeister & Leary, 1995) and are motivated by working together with others (Carr & Walton, 2014). Framing pro-environmental behavior as a way of working together with others can, thus, increase interest in pro-environmental behavior (Howe et al., 2021). However, believing that humans can change the world (i.e., an incremental belief) might be an important prerequisite for seeing pro-environmental behavior as working together with others towards a shared goal. If humans cannot make a difference, there is no task to work together on. Past research has shown that believing that one's ingroup can make a change regarding a specific challenge increases identification with that group (van Zomeren, Leach, et al., 2010). Similarly, an incremental belief might foster feelings of togetherness regarding pro-environmental behavior.

If an incremental belief about the world leads to favorable cognitions about climate change, they should ultimately also foster pro-environmental behavior. Past studies have looked at the relationship between lay beliefs about the world and pro-environmental behavior albeit mostly correlational. People with an incremental belief reported more intentions to engage in pro-environmental behavior (Soliman & Wilson, 2017) and more pro-environmental behavior (Duchi et al., 2020). Inducing an incremental belief also increased preferences for sustainable hotel offerings in people without strong environmental values (Septianto et al., 2021).

Overall, an incremental belief about the world might be related to several cognitions regarding climate change, most prominently response efficacy, but also climate change belief, perceptions of dynamic norms, and feelings of working together surrounding pro-environmental behavior. These cognitions are positively related to pro-environmental behavior. As such, we felt it necessary to investigate the causal influence that manipulating lay beliefs about the world could have in the climate change context. If such a causal influence is supported, interventions fostering an incremental belief about the world might be

a promising addition to existing interventions aimed at promoting e.g., response efficacy such as the ones described above.

Present Studies

Past research indicates that lay beliefs about the world might play an important role in people's perception and consequently action around climate change. However, past studies largely relied on correlational data. Thus, it is still unclear whether lay beliefs about the world exert a causal effect and can, thus, be a promising starting point to foster beneficial cognitions about climate and ultimately pro-environmental behavior.

We aim to close this gap by examining the effect of manipulating people's lay beliefs about the world on climate change related outcomes in three experiments. All experiments include measures of response efficacy. Experiment 2 and 3 also include further cognition and intention measures. The experiments look at two different populations (US Americans and Austrians).

Experiment 1

Experiment 1 aimed to test the causal effect of lay beliefs about the world on our main dependent variable: response efficacy.

Method

Participants

A power analysis was conducted with the program G*Power (Faul et al., 2007) to determine the necessary sample size based on an effect of $d = 0.3$ and an equal allocation to both experimental groups. To achieve 80% power on a one-tailed t -test ($\alpha = 0.05$) a sample of 278 was required. Participants were recruited via Amazon Mechanical Turk to take part in the study for \$1.00. Originally, $n = 352$ people completed the study, but $n = 45$ participants had to be excluded based on our preregistered criteria ($n = 20$ because they failed a reading check after the manipulation, $n = 24$ because they failed an attention check during the study and

$n = 1$ due to self-exclusion). Thus, the final sample size was $n = 307$. There were slightly more women in the sample (61%) and participants were on average 38 years old ($SD = 11$). Regarding political orientation, participants were slightly more liberal ($M = 2.7$, $SD = 1.1$; 1 = *liberal*, 5 = *conservative*). Most participants (72%) were white, 10 % were Black, 9 % Hispanic, 5 % Asian, 2 % Native American and 3 % indicated another race. The participants were distributed equally across the two randomly assigned groups ($n = 149$ in the entity belief group, $n = 158$ in the incremental belief group).

Procedure

The study was introduced as examining people's understanding and perception of two articles on scientific findings. After giving informed consent, participants were randomly assigned to one of two experimental groups (incremental belief group and entity belief group). The respective manipulation was administered along with questions on the content and style of the manipulation text to bolster the cover story. Then, participants read an informative article on climate change accompanied by similar questions on content and style. Finally, participants completed the dependent and control measures.

Ethics Statement and Materials

The study was approved by the Institutional Review Board of the Department of Work, Economy, and Social Psychology at the University X (Ref: X) [*blinded for review*] and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants. The full study material, data and data analysis scripts are available online under https://osf.io/2cs8p/?view_only=20885fdd5eab49c69a087f79baba743e. An overview of the constructs and measurements used across all three experiments is in the supplement (Table S1).

Manipulation: Lay Beliefs About the World. The manipulation of lay beliefs about

the world was based on the manipulation by Cohen-Chen et al. (2015). Participants read an article presenting ostensible research findings that either presented the world as changeable (incremental belief condition) or fixed (entity belief condition). After reading the text, participants completed four reading check items. Next, participants completed a saying-is-believing exercise. Participants received the following instruction: “Why do you think the world remains constant over time [*incremental belief: is dynamic and constantly changing*]? Describe reasons for this and explain how this relates to you personally.” The aim of this exercise was to strengthen the manipulation by asking participants to provide potential reasons and personal examples for the core statement of the manipulation text. Finally, participants completed seven items on their perception of the article (on a 5-point semantic differential scale, e.g., “boring” – “interesting”, “incomprehensible” – “understandable”). This was included to bolster the cover story.

Informative Article. The article included extracts from two newspaper articles (Doringer, 2021; Fischer, 2021). It explained findings from the 2021 IPCC report (e.g., regarding evidence for and consequences of climate change) and concluded with the message that there is still time to act. Next, participants completed four reading check items and the same seven items on their perception of the article that they had completed for the manipulation text.

Response efficacy. Response efficacy was assessed with two scales representing different types of response efficacy which were additionally aggregated into a combined measure. The first subscale assessed collective response efficacy through eight items adapted from Jugert et al. (2016) (e.g., “We humans can do something together to reduce the negative consequences of climate change”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.97$). The second subscale assessed personal response efficacy through eight items from Hornsey et al. (2021) (e.g., “It is hard to imagine that individuals like myself can make a difference with

respect to a global phenomenon such as climate change”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.88$). Both scales correlated highly ($r = .60$) and were thus additionally aggregated to form a combined response efficacy measure ($\alpha = 0.94$).

Manipulation Check. To assess whether the manipulation worked, participants reported their lay beliefs about the world on three items by Dweck et al. (1995) (e.g., “Though we can change some phenomena, it is unlikely that we can alter the core dispositions of our world.”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.89$). The scale was recoded so that high values correspond to a more incremental belief about the world.

Data Analysis

In line with our preregistration (https://aspredicted.org/MQ2_ZQW), we conducted one-sided *t*-tests to compare the two experimental groups regarding response efficacy. Welch’s *t*-test was used to account for potential differences in the variances. If the assumption of normal distribution was questionable, Wilcoxon tests were administered additionally. If the *t*-test and Wilcoxon test led to the same interpretation, only the result of the *t*-test is reported. If they differed, both results are reported. All results from the additional tests can be found in the supplement. The same procedure was used to test for initial group differences on demographics (however, *t*-tests were two-sided because we did not assume effects in any direction).

Results

Descriptive statistics on the measures in experiment 1 can be found in Table 1.

Table 1

Descriptive Statistics of Measures in Experiment 1

Variable	<i>M</i>	<i>SD</i>	α	1	2	2a
1. Incremental world belief	3.37	1.18	0.89			
2. Combined response efficacy	4.35	0.97	0.94	.47**		
2a. Personal response efficacy	3.81	1.06	0.88	.51**	.89**	

Variable	<i>M</i>	<i>SD</i>	α	1	2	2a
<i>2b. Collective response efficacy</i>	4.89	1.12	0.97	.33**	.90**	.60**

Note. Combined response efficacy refers to the average across the personal and collective response efficacy subscales. ** $p < .01$

Preliminary Results

As expected, the incremental belief group reported a stronger agreement with an incremental belief on the manipulation check ($M_{\text{Incremental}} = 3.5$ ($SD = 1.2$), $M_{\text{Entity}} = 3.2$ ($SD = 1.2$)), $t(304.3) = -2.5$, $p = .006$, $d = 0.29$. Additionally, the experimental groups differed in their political orientation, $t(303.3) = -2.4$, $p = .016$, $d = 0.28$. The incremental belief group was more conservative ($M = 2.8$, $SD = 1.1$) than the entity belief group ($M = 2.5$, $SD = 1.1$). They also slightly differed in age, $t(301.4) = -1.6$, $p = .118$, $d = 0.18$ (in this case, homoscedasticity was questionable and Wilcoxon test showed a significant difference, $W = 10,190$, $p = .042$). Thus, the analyses were repeated controlling for participants' political orientation and age. This generally strengthened the expected effects. Both sets of analyses are reported. Besides political orientation, the experimental groups did not differ in gender or ethnicity ($p > .214$).

Preregistered Analyses

As hypothesized, the incremental belief group reported higher values of response efficacy on the combined measure and the personal response efficacy subscale. They also tended to report a stronger collective response efficacy, although not significantly (see Table 2).

Table 2

Group Differences in Response efficacy in Experiment 1

	Entity Belief		Incred. Belief		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	95% <i>CI</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Combined response efficacy	4.2	1.01	4.5	0.92	-2.26	298.85	.012*	0.26	[0.03, 0.48]

	Entity Belief		Increm. Belief		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	95% <i>CI</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
<i>Personal response efficacy</i>	3.6	1.08	4.0	1.02	-2.73	300.92	.003*	0.31	[0.09, 0.54]
<i>Collective response efficacy</i>	4.8	1.18	5.0	1.05	-1.34	296.29	.090†	0.15	[-0.07, 0.38]

Note. Combined response efficacy refers to the average across the personal and collective response efficacy subscales. *CI* = Confidence intervals around Cohen's *d*. * $p < .05$, † $p < .10$

Adjusted Analyses

We conducted three multiple linear regressions to assess the manipulation's effect on response efficacy while controlling for the group differences in political orientation and age. They showed that the incremental belief manipulation significantly increased participants' response efficacy on the combined measure and both subscales (see Table 3).

Table 3

Results of Linear Regression Analyses on the Effects of the Experimental Group on Response efficacy Controlling for Political Orientation and Age

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% <i>CI</i>	Adj. <i>R</i> ²
Combined response efficacy						.14
Intercept	-0.17	0.08	-2.17	.030*	[-0.27, -0.06]	
Exp. group	0.32	0.11	3.01	.003**	[0.10, 0.52]	
Age	0.15	0.05	2.73	.007**	[0.04, 0.25]	
Pol. orientation	-0.34	0.05	-6.27	< .001***	[-0.43, -0.23]	
Personal response efficacy						.09
Intercept	-0.17	0.08	-2.14	.033*	[-0.28, -0.05]	
Exp. group	0.33	0.11	2.97	.003**	[0.10, 0.53]	
Age	0.20	0.05	3.63	< .001***	[0.09, 0.30]	
Pol. orientation	-0.19	0.06	-3.53	< .001***	[-0.30, -0.08]	
Collective response efficacy						.16
Intercept	-0.13	0.08	-1.72	.087	[-0.24, -0.02]	

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% <i>CI</i>	<i>Adj. R</i> ²
Exp. group	0.25	0.11	2.38	.018*	[0.02, 0.45]	
Age	0.07	0.05	1.26	.208	[-0.04, 0.17]	
Pol. orientation	-0.40	0.05	-7.57	< .001***	[-0.49, -0.31]	

Note. Experimental group is coded: 0 = entity belief group, 1 = incremental belief group.

Political orientation is coded such that higher values indicate stronger conservatism.

Outcomes and predictors except the experimental group are z-standardized. *CI* = BCa confidence intervals are reported because homoscedasticity was questionable in all models.

*** $p < .001$, ** $p < .01$, * $p < .05$

Discussion

As expected, the manipulation of participants' lay beliefs about the world changed participants' response efficacy. Participants that were led to endorse an incremental belief about the world reported higher response efficacy. The manipulation increased both participants' personal response efficacy and—once we accounted for group differences in political orientation—also their collective response efficacy. This indicates that its' effect is not limited to one of the two types. Next, we aimed to test the stability of this effect in a culturally different sample in experiments 2 and 3 and extent the finding to behavioral intentions and other cognitions about pro-environmental behavior.

Experiment 2

Experiment 1 showed that people's lay beliefs about the world influence their response efficacy about pro-environmental behavior. Past research indicates other positive effects on climate change related cognitions and behavior as well—most prominently on climate change belief and pro-environmental behavior intentions. Experiment 2 aimed to test the causal effect of lay beliefs about the world on these three: response efficacy, climate change belief and pro-environmental behavior intention. Additionally, a possible effect on people's perception of norms regarding pro-environmental behavior being dynamic as well as

their feelings of working together when engaging in pro-environmental behavior were assessed exploratorily.

Method

The general procedure in experiment 2 was the same as in experiment 1. However, a few changes were made, and further variables were added. All changes are described below. The full study material, data and data analysis scripts are available online under https://osf.io/2cs8p/?view_only=20885fdd5eab49c69a087f79baba743e. An overview of the constructs and measurements used across all three experiments is in the supplement (Table S1). Again, the study was approved by the Institutional Review Board of the Department of Work, Economy, and Social Psychology at the University X (Ref: X) [*blinded for review*] and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants.

Participants

As in experiment 1, a sample size of $N = 278$ was needed to detect a small to medium effect of $d = 0.3$. Participants were recruited via social media. The link and an invitation to participate in the study was posted in various German-speaking Facebook groups. The study was described as investigating the perception and understanding of two texts without giving any reference to the topic of climate change. This was done to reduce self-selection bias and priming of the topic. As incentive, participants could enter a lottery of a 200€ voucher. Overall, $N = 370$ people completed the study. However, $n = 89$ participants had to be excluded based on our preregistered criteria ($n = 80$ because they failed a reading check after the manipulation and $n = 9$ due to self-exclusion). Thus, the final sample size was $N = 281$. Most participants (84%) were women. On average participants were 25 years old ($SD = 5$) and leaned towards the political left ($M = 3.0$, $SD = 1.0$; 1 = *political left*, 7 = *political right*). The participants were distributed equally across the two randomly assigned groups ($N = 137$

in the entity belief group, $N = 144$ in the incremental belief group).

Materials

Manipulation: Lay Beliefs About the World. In experiment 2, the saying-is-believing exercise was cut and only the manipulation text by Cohen-Chen et al. (2015) was used. After reading the text, participants completed the same reading check items and questions on their perception of the article as in experiment 1.

Response efficacy. In addition to the two response efficacy scales from experiment 1, a third response efficacy scale that has been used in previous research on lay beliefs about the world in the climate change context (Soliman & Wilson, 2017) was added. This scale consisted of four items reflecting response efficacy including both personal and collective agents (e.g., “I feel that by engaging in environmentally sustainable behaviors, I can make a real difference”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.70$). Again, all three scales correlated highly ($r \geq .49$) and were thus additionally aggregated to form a combined response efficacy measure ($\alpha = 0.92$). Results are reported for the aggregate across the three scales, but the results do not change if only the two scales from experiment 1 are aggregated.

Climate Change Belief. Climate change belief was assessed using six items from Brick et al. (2017) (e.g., “Is it true that the average temperature on Earth has warmed over the past 50 years, regardless of the cause?”; 7-point scale with varying anchors; $\alpha = 0.76$).

Intention to Act on Climate Change. To capture participants’ intention to act on climate change, they reported on four items from Heath and Gifford (2006) (e.g., “I plan to do something that will help stop global warming”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.91$).

Perception of Dynamic Norms. To assess participants’ perception of norms regarding pro-environmental behavior being dynamic and changing, participants responded to three items (“More and more people are starting to make an effort to behave in a more

climate-friendly way.”, “In recent years, more and more people have started to make an effort to behave more environmentally friendly.”, “More and more people start to make an effort to emit less CO₂ by their behavior.”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.89$).

Feelings of Working Together. Participants rated the extent to which they experienced feelings of working together when engaging in pro-environmental behavior on three items (e.g., “If you were to engage in climate-friendly behavior, to what extent would you feel like you were working together with other people?”; 1 = *not at all*, 6 = *very much*; $\alpha = 0.90$). The items were adapted from Howe et al. (2021; experiment 6).

Initial Environmental Attitude. To assess participants’ attitude towards environmental topics at baseline in a way that would not prime the topic of climate change before the experimental manipulation we developed a novel *famous people rating task*. Participants were asked about their opinion on eight famous persons (1 = *very negative*, 7 = *very positive*, additional option to indicate *I don’t know that person*). The list of famous persons included Greta Thunberg who is well-known for her advocacy for environmental protection. Ratings regarding her person were used as a proxy for initial environmental attitudes.

Data Analysis

Data analysis was conducted in line with our preregistration (https://aspredicted.org/THP_19L) and similarly to experiment 1. Group differences on exploratory variables were analyzed in the same fashion as group differences on preregistered variables.

Results

Descriptive statistics on the measures in experiment 2 can be found in Table 4.

Table 4

Descriptive Statistics of Measures in Experiment 2

Variable	<i>M</i>	<i>SD</i>	α	1	2	2a	2b	2c	3	4	5	6
1. Incremental world belief	3.57	1.07	0.84									
2. Combined response efficacy	4.28	0.73	0.92	.44**								
2a. <i>Collective response efficacy</i>	4.96	0.86	0.92	.37**	.82**							
2b. <i>Personal response efficacy</i>	3.76	0.87	0.85	.40**	.88**	.49**						
2c. <i>General response efficacy</i>	3.98	0.85	0.70	.33**	.82**	.50**	.72**					
3. Climate change belief	5.89	0.90	0.76	.36**	.51**	.54**	.38**	.29**				
4. Intention to act	4.30	1.11	0.91	.27**	.59**	.50**	.52**	.44**	.53**			
5. Feelings of working together	3.64	1.24	0.90	.29**	.49**	.36**	.46**	.43**	.33**	.39**		
6. Perception of dynamic norms	4.47	0.86	0.89	.14*	.38**	.26**	.36**	.35**	.17**	.16**	.44**	
7. Initial environmental attitude	5.03	1.54	-	.34**	.44**	.43**	.37**	.25**	.56**	.41**	.36**	.20**

Note. Combined response efficacy refers to the average across all three response efficacy scales. General response efficacy refers to the 4-item

scale by Soliman & Wilson (2017) reflecting both personal and collective response efficacy. * $p < .05$, ** $p < .01$

Preliminary Results

As in experiment 1, the incremental belief group reported stronger agreement with an incremental belief on the manipulation check ($M_{\text{Incremental}} = 3.8$ ($SD = 1.0$), $M_{\text{Entity}} = 3.3$ ($SD = 1.1$)), $t(270.7) = -4.27$, $p < .001$, $d = 0.51$. The two groups did not significantly differ in age, gender, political orientation, or initial environmental attitude ($p > .339$).

Preregistered Analyses

As hypothesized, the incremental belief group reported higher values of response efficacy on the combined response efficacy measure as well as on all three subscales separately (see Table 5). However, there were no group differences regarding climate change belief or pro-environmental behavior intention (see Table 5).

Exploratory Analyses

The exploratory analyses showed that people in the incremental belief group perceived norms regarding pro-environmental behavior to be more dynamic. Similarly, they reported higher feelings of working together when engaging in pro-environmental behavior (see Table 5).

Table 5

Group Differences in Outcome Variables in Experiment 2

	Entity Belief		Increm. Belief		<i>df</i>	<i>t</i>	<i>p</i>	<i>d</i>	95 % <i>CI</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Combined response efficacy ¹	4.2	0.78	4.4	0.66	265.77	-2.36	.010*	0.28	[0.05, 0.52]
<i>Personal response efficacy</i>	3.7	0.91	3.9	0.82	272.94	-1.90	.029*	0.23	[-0.01, 0.46]
<i>Collective response efficacy</i>	4.8	0.95	5.1	0.76	260.22	-2.16	.016*	0.26	[0.02, 0.49]
<i>General response efficacy</i>	3.9	0.85	4.1	0.83	277.40	-1.80	.037*	0.22	[-0.02, 0.45]

	Entity Belief		Increm. Belief		<i>df</i>	<i>t</i>	<i>p</i>	<i>d</i>	95 % <i>CI</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Climate change belief ¹	5.8	1.00	5.9	0.80	261.23	-0.94	.174	0.11	[-0.12, 0.35]
Intention to act ¹	4.3	1.14	4.3	1.09	276.07	0.14	.555	-0.02	[-0.25, 0.22]
Perception of dynamic norms	4.4	0.90	4.6	0.81	272.57	-2.15	.016*	0.26	[0.02, 0.49]
Feelings of working together	3.5	1.23	3.8	1.23	278.45	-1.91	.028*	0.23	[-0.01, 0.46]

Note. Combined response efficacy refers to the average across all three response efficacy scales. General response efficacy refers to the 4-item scale by Soliman & Wilson (2017) reflecting both personal and collective response efficacy. *CI* = Confidence intervals around Cohen's *d*. ¹ Preregistered analyses. * $p < .05$

Discussion

The results from experiment 2 regarding response efficacy converge with the ones from experiment 1. They show that the positive effect of an incremental belief about the world on people's response efficacy is not exclusive to a US sample. In fact, the same effect was found in a German-speaking European sample. This strengthens the conclusion that an incremental belief of the world increases people's belief in the efficacy of mitigation efforts against climate change.

Contrary to the hypothesis, the manipulation did not affect participants' climate change beliefs. The specific climate change belief measure might have contributed to this. The measure used here differed from the one used in the two previous studies (Duchi et al., 2020; Soliman & Wilson, 2017), which focused on beliefs about two core prepositions: climate is changing, and human activities are the main cause. The measure used in experiment 2 was much broader, including e.g., aspects such as participants' worry about climate change consequences, their trust in the reliability of research and news coverage on climate change. Thus, experiment 3 used the exact measure from one of the previous studies

and tested the effect again.

The manipulation did not affect participants' intention to act either, which might also be explained by the measure. We assume that the incremental belief condition would change participants' intentions to act compared to before the manipulation. Thus, it would have been important to capture people's *changes* in intention compared to the past. Instead, we measured people's general intentions to act which might have been mostly fueled by their past intentions. Thus, the specific measure of intention to act might have been unsuitable to reveal the effect. In experiment 3, we used a measure more tuned to uncovering changes in intention to test the effect again.

The exploratory results showed that the manipulation influenced participants' perception of norms changing and their feelings of working together. Possible mechanisms behind these effects will be addressed in the main discussion. To examine these effects further, both measures were included again in experiment 3.

Experiment 3

Experiment 3 aimed to replicate the effects on response efficacy (from experiment 1 and 2) and on perception of dynamic norms (from experiment 2). For additional exploratory analyses, we changed the measure of climate change belief to match the assessment in previous research and the measure of intention to act to capture changes in intention more closely. People's feelings of working together when engaging in pro-environmental behavior were assessed exploratorily as well¹.

Method

The procedure and material in experiment 3 were the same as in experiment 1 with a

¹ An experimental effect on participants' feelings of working together was not preregistered despite the significant group differences in experiment 2 because feelings of working together are conceptually not directly connected to lay beliefs about the world (in contrast to the perception of dynamic norms). However, since this is potentially an interesting effect, we included the measure in experiment 3.

few additions. Perception of dynamic norms, feelings of working together and initial environmental attitude were assessed as in experiment 2. All further changes are described below. The full study material, data and data analysis scripts are available online under https://osf.io/2cs8p/?view_only=20885fdd5eab49c69a087f79baba743e. An overview of the constructs and measurements used across all three experiments is in the supplement (Table S1). Data analyses were conducted the same way as in experiment 1 and 2 (see also the preregistration: https://aspredicted.org/8VS_KHV). Again, the study was approved by the Institutional Review Board of the Department of Work, Economy, and Social Psychology at the University X (Ref: X) [*blinded for review*] and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants.

Participants

As in experiment 1 and 2, a sample size of $N = 278$ was needed to detect a small to medium effect of $d = 0.3$. Similar to experiment 2, participants were recruited via social media. The link and an invitation to participate in the study was posted in various German-speaking Facebook groups. Additionally, advertisements were placed through Instagram targeting a German-speaking population. The study was described as investigating the perception and understanding of two texts without giving any reference to the topic of climate change. This was done to reduce self-selection bias and priming of the topic. As incentive, participants could enter a lottery of a 150€ voucher. Originally, $n = 398$ people completed the study and $n = 126$ participants had to be excluded based on our preregistered criteria ($n = 95$ because they failed a reading check after the manipulation, $n = 14$ because they indicated that they had participated in experiment 2, and $n = 17$ due to self-exclusion). Additionally, we noticed suspicious responses that seemed to originate from a bot. They were noticeable because they provided English responses to text entry questions although the survey was in German. Most of these cases were excluded through the planned exclusion procedure

(explaining the rather high number of exclusions). Additional cases ($n = 4$) were excluded manually. Thus, the final sample size was $n = 268$. Most participants were women (82 %) and students (70 %). Participants were on average 26 years old ($SD = 10$) and leaned towards the political left ($M = 2.6$, $SD = 1.1$; 1 = *political left*, 7 = *political right*). The participants were distributed equally across the two randomly assigned groups ($n = 129$ in the entity belief group, $n = 139$ in the incremental belief group).

Materials

Climate Change Belief. Climate change belief was assessed through 12 items from Sinatra et al. (2012) (e.g., “Scientific evidence points to a warming trend in global climate.”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.83$). Item 9 from the original scale was removed because it referred to Al Gore’s documentary “An Inconvenient Truth” which might not be well-known enough in the Austrian sample especially among younger people.

Intention to Act on Climate Change. The items from experiment 2 were adapted to focus on participants’ future intentions compared to before. For example, the item “I plan to do something that will help stop global warming” was changed to “I plan to do more than I have in the past to help stop global warming”. The items were rated on the same six-point scale (1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.91$).

Goal Commitment. As an additional measure of environmental intentions, participants were asked to list three concrete environmental behaviors that they could adopt over the next four weeks. Five examples were provided (e.g., reducing meat consumption or getting informed about environmental issues). Participants were then asked to pick one of the behaviors as a goal. Subsequently, they reported their goal commitment to that behavior using five items from DeShon and Landis (1997) and two items from Brunstein et al. (1998) (e.g., “I am determined to pursue this goal”; 1 = *strongly disagree*, 6 = *strongly agree*; $\alpha = 0.81$).

Results

Descriptive statistics on the measures in experiment 3 can be found in Table 6.

Preliminary Results

As in the previous studies, the incremental belief group reported stronger agreement with an incremental belief on the manipulation check ($M_{\text{Incremental}} = 4.3$ ($SD = 1.1$), $M_{\text{Entity}} = 3.7$ ($SD = 1.1$)), $t(262.8) = -4.4$, $p < .001$, $d = 0.54$. The two groups did not significantly differ in age, gender, political orientation, or initial environmental attitude ($p > .101$).

Preregistered Analyses

In line with experiment 1 and 2, the incremental belief group reported higher values of response efficacy on the combined response efficacy measure as well as on the two subscales separately (see Table 7). However, in contrast to experiment 2, the groups did not significantly differ in their perception of norms around environmental behavior being dynamic, although a trend in the expected direction is visible (see Table 7).

Exploratory Analyses

The exploratory analyses showed that the incremental belief group also reported stronger intentions to act on climate change and higher feelings of working together when engaging in pro-environmental behavior (see Table 7). They also reported a marginal significantly stronger goal commitment regarding their chosen environmental goal behavior. However, there were again no group differences in climate change belief.

Table 6

Descriptive Statistics of the Measures in Experiment 3

Variable	<i>M</i>	<i>SD</i>	α	1	2	2a	2b	3	4	5	6	7
1. Incremental world belief	3.97	1.15	0.84									
2. Combined response efficacy	4.51	0.71	0.89	.34**								
2a. <i>Personal response efficacy</i>	4.95	0.75	0.86	.26**	.83**							
2b. <i>Collective response efficacy</i>	4.07	0.91	0.89	.32**	.89**	.47**						
3. Climate change belief	5.16	0.51	0.77	.16**	.27**	.35**	.15*					
4. Intention to act	4.22	1.14	0.91	.16*	.40**	.31**	.37**	.18**				
5. Goal commitment	4.62	0.91	0.83	.15*	.39**	.34**	.32**	.20**	.62**			
6. Feelings of working together	3.87	1.21	0.88	.16*	.43**	.35**	.39**	.24**	.49**	.37**		
7. Perception of dynamic norms	4.51	0.79	0.86	.13*	.28**	.26**	.22**	.15*	.18**	.18**	.22**	
8. Initial environmental attitude	5.25	1.49	-	.13*	.22**	.25**	.14*	.44**	.19**	.18**	.24**	.04

Note. Combined response efficacy belief refers to the average across the personal and collective response efficacy subscales. ** $p < .01$,

* $p < .05$

Table 7*Group Differences in Outcome Variables in Experiment 3*

	Entity Belief		Incremental Belief		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	95% <i>CI</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Combined response efficacy ¹	4.4	0.68	4.6	0.73	-2.23	266.00	.013*	0.27	[0.03, 0.51]
<i>Personal response efficacy</i>	4.0	0.89	4.2	0.93	-1.90	265.75	.030*	0.23	[-0.01, 0.47]
<i>Collective response efficacy</i>	4.9	0.77	5.0	0.72	-1.92	260.95	.028*	0.24	[-0.01, 0.48]
Perception of dynamic norms ¹	4.4	0.83	4.6	0.75	-1.20	258.45	.115	0.15	[-0.09, 0.39]
Climate change belief	5.1	0.49	5.2	0.52	-0.66	265.96	.255	0.08	[-0.16, 0.32]
Feelings of working together	3.7	1.26	4.0	1.15	-2.21	258.94	.014*	0.27	[0.03, 0.51]
Intention to act on climate change	4.1	1.13	4.4	1.13	-2.17	264.41	.015*	0.27	[0.03, 0.51]
Goal commitment	4.6	0.89	4.7	0.94	-1.29	264.95	.099†	0.16	[-0.08, 0.40]

Note. Combined response efficacy belief refers to the average across the personal and collective response efficacy subscales. ¹ Preregistered analyses. * $p < .05$, † $p < .10$

Discussion

Experiment 3 supports the conclusion from experiment 1 and 2 that an incremental belief of the world increases participants' response efficacy regarding environmental protection. Furthermore, it gives some indication that an incremental belief might also increase intention to act on climate change and goal commitment towards a chosen environmental behavior goal. However, the effect on goal commitment was only marginally significant. This might be because of the variability in the goals people chose. Participants created the behavior options from which they choose their goal themselves. This might have introduced considerable heterogeneity in the behaviors (e.g., regarding their feasibility or frequency). Still, both results combined indicate that an incremental belief might foster pro-environmental behavior.

Results regarding the additional cognitive variables were as follows: The incremental belief manipulation also increased people's feeling of working together when engaging in

pro-environmental behavior. As this effect also emerged in experiment 2, it seems to be somewhat robust. In experiment 2, participants in the incremental belief group reported a stronger perception of environmental behavior norms being dynamic. This was not replicated in experiment 3, although a trend in the expected direction emerged. Thus, the robustness and strength of the effect need further testing. Consistent with experiment 2, experiment 3 did not reveal any differences between the two experimental groups regarding climate change belief although a different measure was used. Possible reasons for and implications of this result will be addressed in the main discussion.

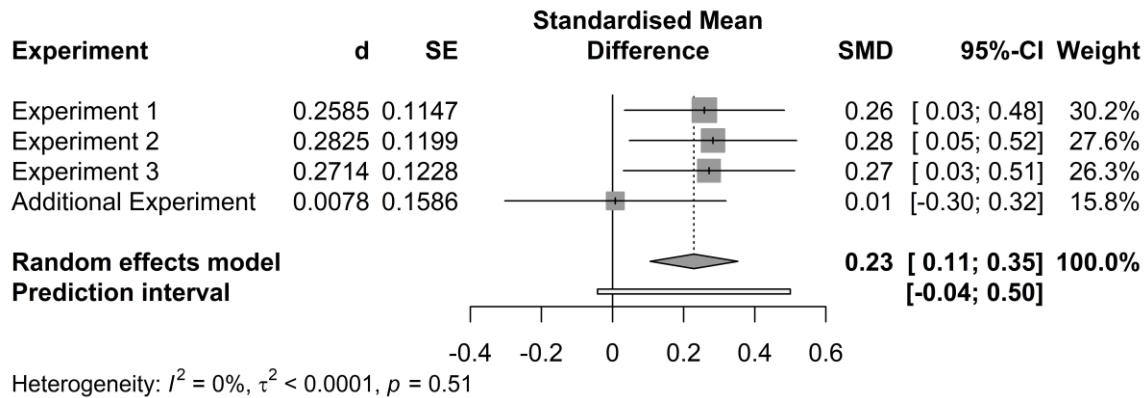
Meta-Analysis on Response efficacy

We ran another experiment that used the same manipulation as part of a different project focusing on cardiovascular measures of effort for the environment. That project is mainly reported elsewhere (Jankowski et al., 2023; manuscript is in preparation). However, as some of the results are important to this work, we want to be transparent about them. Details on the experiment and all results regarding group differences between the two experimental groups are in the supplement (see Table S6 and Table S7). Most importantly for this work is that we did not find group differences regarding response efficacy. We assume that this might be due to the sample (largely psychology students) where the manipulation in general did not work as well.

To assess the estimated effect on response efficacy while also accounting for this non-significant study, we conducted meta-analyses on the overall effect on combined response efficacy and both subscales across all four experiments. They showed a significant positive effect on the combined response efficacy scale, $d = 0.23$, 95% CI [0.11, 0.35], $z = 3.63$, $p < 0.001$ (Figure 1), the personal response efficacy subscale, $d = 0.22$, 95% CI [0.09, 0.34], $z = 3.46$, $p < 0.001$, and the collective response efficacy subscale, $d = 0.18$, 95% CI [0.06, 0.31], $z = 2.89$, $p = 0.004$.

Figure 1

Meta-Analysis of Differences in Combined Response Efficacy in Experiments 1 to 3 and an Additional Experiment from Jankowski et al. (2023)



Note. Positive effects indicate higher response efficacy in the incremental belief group.

General Discussion

In three experiments, we show that inducing an incremental belief about the world enhances important climate change related cognitions and outcomes. Most prominently, it increased participants' response efficacy both on the personal and collective level. Response efficacy has been shown to be positively related to different kinds of pro-environmental behaviors (e.g., Bradley et al., 2020; Doherty & Webler, 2016; Lubell et al., 2007; Rainear & Christensen, 2022). Our experiments offer robust evidence that response efficacy in the context of climate change is formed based on people's lay beliefs about the world.

We also found some evidence that an incremental belief about the world fosters pro-environmental behavior inclinations. This was true for pro-environmental behavior intention and goal commitment to an environmental behavior goal. Although they point in the same direction, further research is recommended as these results were only found in one study.

An incremental belief about the world also changed participants' perception of norms regarding pro-environmental behavior in study 2 (and on trend-level in study 3). People in the incremental belief group were more inclined to perceive norms regarding pro-environmental

behavior as dynamic, i.e., perceived that more and more people were trying to act more environmentally. Possibly, an incremental belief made examples of change more salient and simultaneously led people to interpret them as indicators of meaningful change. Perceptions of changing norms have been shown before to motivate pro-environmental behavior (Sparkman & Walton, 2017). Thus, they might contribute to a positive effect of an incremental belief about the world on environmental intentions.

An incremental belief about the world also showed positive effects on perceiving pro-environmental behavior as a form of working together with others. Interestingly, feelings of working together are not a direct part of an incremental belief (as opposed to e.g., perceptions of dynamic norms). However, an incremental belief might be a prerequisite for viewing climate action as a shared task towards a common goal because an entity belief entails that human action is generally not effective to achieve large-scale change. Possibly, believing that humans can change the world also fosters a sense of “we” that is reflected in a feeling of working together on the shared goal of climate protection. This is in line with past research showing that believing that one’s ingroup can make a change increases identification with that group (van Zomeren, Leach, et al., 2010). Similarly, an incremental belief might foster feelings of togetherness regarding pro-environmental behavior. Humans generally strive to be connected to others (Baumeister & Leary, 1995) and feelings of working together on tasks can increase motivation (Howe et al., 2021). Thus, feelings of working together might be another mechanism how an incremental belief impacts intentions for climate action.

Interestingly, we found no effect of manipulated lay beliefs about the world on climate change belief contrary to previous correlational studies. This result was consistent across two studies with different measures of climate change belief. Thus, it seems like this effect is either very small or does not exist in the present sample. The relatively high means in both groups indicate that all participants strongly believed in climate change regardless of

the experimental condition. Thus, the effect of an incremental belief on climate change belief might be specific to the US (where previous studies took place) simply because in Europe the existence of climate change is less debated.

Worldviews and Climate Change

Past research has investigated people's views of the present and future world as antecedents of environmental attitudes and behavior, specifically in terms of the belief in a just world and cognitive alternatives to the status quo. A just world belief (i.e., believing that the world in general is a just place) has been shown to be detrimental to problem awareness and willingness to act in the climate change context (Feinberg & Willer, 2011). This belief differs from lay beliefs about the world because it focuses on the perceived fairness of the world (i.e., whether it *should* change) and not on its stability (i.e., whether it *can* change). Perceiving the world as fair might obstruct people's belief in climate change and their willingness to engage in pro-environmental behavior because it is at odds with the inherent unfairness of climate change (i.e., it disproportionately affects those least responsible for it (e.g., future generations or the global south)). This research indicates that people's fundamental understanding of the world should be considered when dealing with large-scale social problems.

Other research has investigated the influence of people's ability to access cognitive alternatives to the status quo (i.e., their ability to imagine an alternative world that is more sustainable) on pro-environmental behavior. People that were better able to imagine such an alternative world reported stronger pro-environmental intentions and showed more activist pro-environmental behavior when given the opportunity (J. D. Wright et al., 2020, 2022). The concept of cognitive alternatives is related, but distinct from lay beliefs about the world because they focus on the ability to imagine *how* a changed world might look and not on the perception *if* such change is possible. Both, however, indicate that cognitions about if and

how the world can change are important precursors to climate action.

In face of the positive effects of an incremental belief about the world, one may wonder why some people still hold an entity belief about the world. An incremental belief is related to higher response efficacy which is generally positive as people strive to feel in control. It is also related to actions to support change which should relate to the desirable outcome of actual change. Thus, the question arises what could perpetuate an entity belief about the world, nonetheless. Believing that the world is largely stable reduces uncertainty and makes the future more predictable. As such it can reduce worries about the future. Believing that the world is stable can also serve as a justification for a lack of behavior change. If one's behavior cannot make a difference, there is no need to go through the hustle of changing it. There is some evidence that people do change their lay beliefs to fit a desired conclusion (e.g., justify a behavior or support a certain reasoning) (Leith et al., 2014). Thus, for the individual an entity belief can be adaptive by proving security and justification of the status quo.

Limitations and Future Research

The experiments did not include a neutral control group. Thus, we cannot determine the direction in which the manipulation worked (i.e., whether the entity belief condition increased an entity belief, the incremental belief condition increased an incremental belief or both simultaneously). Future research should design and test interventions specifically to foster an incremental belief about the world.

The samples in this study were not representative of the general US-American and German-speaking populations. For example, the samples of experiment 2 and 3 were rather young and had a large proportion of women. These demographics typically care more about climate change (Hornsey et al., 2016). It is possible that lay beliefs about the world have a stronger effect on response efficacy for people who care about climate change and less so for

climate change sceptics who do not see the need to combat climate change to begin with. Besides, education level has been shown to relate to environmental beliefs and behaviors (Hornsey et al., 2016; Meyer, 2015), but was not consistently assessed in the present studies. Future research should investigate the effect of lay beliefs about the world in more representative samples and research possible moderating effects of demographics.

Besides, future research could complement the present results by investigating a possible bi-directional relationship between lay beliefs about the world and response efficacy. The present studies tested the effect of people's general lay beliefs about the world on their efficacy in a specific context—namely climate change, but similar effects might emerge in other contexts. In turn, it is also plausible that strong experiences of efficacy (or the lack thereof) in one or several contexts might inform people's general lay beliefs about the world. Thus, it would be interesting to research whether and to what extent changes in people's efficacy perception in one context might feedback to changes in their lay beliefs about the world.

Future research could also look at other climate change related outcomes. It is becoming increasingly clear that people's individual behavior alone is not enough to combat climate change and there have been calls for research focusing on the system-level (Chater & Loewenstein, 2022). Support for system-wide policies might as well depend on beliefs about whether humans can elicit change in the world, thus, lay beliefs about the world might play an important role here too.

Practical Implications

Our results show that it would be beneficial for climate protection to foster an incremental belief in the population. This could be achieved by highlighting how the world has changed compared to the past and possibly communicating the processes behind such change. Making ongoing changes salient might also be a way of increasing an incremental

belief, as direct experiences of e.g., job mobility have been shown to influence lay beliefs about the world (Chen et al., 2009). Besides, direct interventions (e.g., in schools) might boost a general sense of control regarding social change already early on. This might not only have positive effects on climate protection, but might also foster a positive, agentic approach to other social problems.

Conclusion

We show that promoting an incremental belief about the world in people increases their response efficacy regarding pro-environmental behavior. Additionally, we show further positive effects on other climate change related cognitions that might foster pro-environmental behavior. Finally, we show first evidence that an incremental belief also fosters pro-environmental behavioral inclinations (although this finding must be interpreted cautiously because it was only found in one study). Taken together, we show that people's general understanding of the world in form of their lay beliefs about the world influences how they tackle important large-scale social problems. Next steps include creating interventions that foster an incremental belief to support beneficial cognitions and action regarding social change, e.g., in context of climate change.

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Paper 2: The Relationship Between Lay Beliefs About the World and Pandemic-Related Beliefs, Attitudes, and Behaviors

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Abstract

The Covid-19 pandemic created a strong need to understand how people can be motivated to engage in protective health behaviors (such as vaccination). Past research suggests that perceiving a health threat as serious and protective behaviors as beneficial increases people's motivation to engage in protective behavior. However, perceptions of the seriousness of the threat and the effectiveness of protective behavior can be ambiguous in the context of a novel, global pandemic. Research on climate change suggests that people's core understanding of the world (as either stable and unchangeable or dynamic and influenced by humans) influence whether people perceive such abstract threats to be serious and protective behaviors to be effective on a large scale. Across five online studies ($N = 1663$), we investigated the correlational relationship and causal effect of these lay beliefs about the world on beliefs, attitudes, and behavioral inclinations regarding both Covid-19 and a hypothetical pandemic scenario. The results did not support a causal effect of lay beliefs about the world, but consistently showed correlational relationships. A sixth online study ($N = 410$) tested a possible reversed causal effect of pandemic-related behavior inclinations being justified by shifting one's lay beliefs about the world accordingly. However, we did not find evidence for this effect either. These results indicate that lay beliefs about the world are associated with perceptions of pandemic health threats, but their causal role is unclear.

Introduction

The outbreak of the Covid-19 pandemic has put extreme demands on medical systems, intensive care units, and global health (Acter et al., 2020; Möhlenkamp & Thiele, 2020). According to the WHO, the coronavirus has infected over 774 million people and caused over 7 million people's death as of February 2024 (World Health Organization, n.d.). Research suggests a high probability of observing similar pandemics in the coming decades (Marani et al., 2021). Thus, there is a clear need to understand how to motivate people to take steps to mitigate such pandemics. There are several ways through which people can influence the course of a pandemic—e.g., by following rules and regulations that are implemented to “flatten the curve” of the pandemic or by getting vaccinated to achieve herd immunity (WHO, 2020). However, the Covid-19 pandemic showed that several people would not follow the regulations, refrain from getting vaccinated or even deny the pandemic threat altogether (Clark et al., 2020; Troiano & Nardi, 2021; Vogel et al., 2021). Thus, it is vital to understand the factors that motivate people or prevent them from engaging in behavior that helps the fight against pandemics such as Covid-19. In this paper, we are interested in how people's core understanding of the world (i.e., whether they believe that the world at a large scale is changeable and specifically shaped by humans or not) influences people's beliefs, attitudes and behaviors related to a surging pandemic. Believing that the world is rather stable and unchangeable might lead people to underestimate the threats of a new situation such as the Covid-19 pandemic. Furthermore, believing that humans have little impact on the world at large might additionally lead people to feel like their protective behavior is ineffective. Both would likely discourage people from engaging in protective behaviors.

Health-related behavior

One of the most frequently used frameworks to understand health and illness behaviors is the Health Belief Model (Champion & Skinner, 2008). The Health Belief Model

states that individuals' beliefs (e.g., about the seriousness of the disease and benefits of protective behaviors) influence health behavior. Multiple studies have supported the validity of the model in the context of the Covid-19 pandemic regarding protective behavior (Clark et al., 2020; Sarwar et al., 2020; Shahnazi et al., 2020; Shmueli, 2021; Wong et al., 2021). In this paper, we are particularly interested in two constructs of the Health Belief Model: perceived severity and perceived benefits. Perceived severity refers to the seriousness of the consequences of getting Covid-19. Studies have shown that higher perceived seriousness was related to more protective behaviors, such as higher willingness to get vaccinated (Wong et al., 2021). Perceived benefits refer to people's beliefs about the benefits of engaging in preventive behaviors to minimize health risks during the pandemic. Studies have shown that increased perceived benefits were related to more protective behavior such as following the regulations or taking health precautions (Clark et al., 2020).

Perceived benefits include benefits for the individual (e.g., protecting oneself from getting infected), but also benefits for others or the general society (e.g., protecting more vulnerable people or contributing to herd immunity by getting vaccinated). Even though previous studies mostly focused on individual benefits (e.g., Clark et al., 2020), the social benefits might be especially important in a large health crisis like a pandemic. In a pandemic, one's own actions do not only impact one's own health, but also have implications for society-wide outcomes such as the health of others and the general course of the pandemic. Such social benefits of vaccination and mitigation efforts might thus be an as important motivator as individual benefits. Importantly, social benefits are independent of one's personal susceptibility to the disease. For many people (i.e., young, and healthy ones), the individual threat of Covid-19 and thus the individual benefit of protective behavior was rather low (e.g., the infection fatality rate was below 0.1% for people under 39 years (O'Driscoll et al., 2021)). These people might rather be motivated by the social benefits (i.e., protecting

vulnerable groups or mitigating the pandemic in general).

Overall, increasing the perception of a pandemic (e.g., Covid-19) as serious and the belief in the efficacy of one's behavior to not only protect oneself but also alleviate the strain on society seems to be a viable way to increase pandemic-related protective behavior. In our studies, we thus focused on how people's core understanding of the world affected the perception of the seriousness of a pandemic (such as Covid-19) and the efficacy of mitigation efforts and hence protective behavior.

Insights from climate change research

Both factors – belief in the seriousness of the issue and belief in the efficacy of one's own behavior – are key factors in climate change mitigation. Indeed, both issues share common characteristics. Just like climate change, a pandemic represents a rather abstract, distant threat. People do not usually perceive the negative effects of climate change in their daily lives, just like most people did not experience the severe health consequences of Covid-19 firsthand during the pandemic. In the US, there have been about 460,000 hospitalizations (as of June 2, 2023) corresponding to ca. 0.1% of the population, so most people did not personally know one of them (Centers for Disease Control and Prevention, 2021). As with climate change, the threat of Covid-19 was mostly conveyed in the news. This made it seem far away and not personally relevant, making it easy to ignore (Gifford, 2011). Additionally, in both issues, collective action is needed. Climate change and a global pandemic can both only be addressed if a substantial number of people engage in protective behavior. Thus, one's personal behavior can seem irrelevant on the broad scale. Both – the abstract threat and unclear impact of the individual – might reduce the perceived relevance of protective behavior, especially since it is also connected to negative, short-term consequences (e.g., not seeing one's family, wearing an annoying mask).

Climate change research provides us with some insights on how to still motivate

protective behavior. First, it indicates that educating people and trying to convince them with scientific information has limited effects. Knowledge about climate change is only weakly connected to climate change belief (Hornsey et al., 2016). Furthermore, confronting skeptic people with facts is often met with reactance (Ma et al., 2019). A similar dynamic could be observed regarding Covid-19: providing facts about Covid-19 and protective measures did not seem to be effective (Kachurka et al., 2021). Some researchers argue that instead, underlying worldviews and interests are crucial as they shape how people interpret facts around climate change (2017). This might as well be true for perceptions about a pandemic such as Covid-19.

Lay beliefs about the world

An underlying worldview that has been identified to influence beliefs and behavior regarding climate change are lay beliefs about the world. Lay beliefs about the world concern the belief as to whether the world has a “fundamental, uncontrollable nature [or whether] people, through their efforts, can shape society and its institutions” (Levy et al., 2001, p. 162). An entity belief about the world refers to the conviction that the world and its institutions are fundamentally immutable and uncontrollable (although transient societal trends might exist temporarily) (Levy et al., 2001). An incremental belief about the world refers to the belief that people have an impact on the world and its institutions and can change them (Levy et al., 2001). These beliefs fundamentally shape one’s perception of and relation to the world. For people with an entity belief, the world is fixed. Such a view would motivate to accept the world as it is and adjust to it. For people with an incremental belief, the world is malleable. This should motivate them to change the world actively where they feel the need.

Lay beliefs about the world have been shown to be related to distinct beliefs, emotions and behavioral patterns regarding climate change and other social issues. Incremental theorists believe more strongly that climate change is happening, man-made and

a relevant threat (Duchi et al., 2020; Soliman & Wilson, 2017). Additionally, incremental theorists have more favorable beliefs and emotions about the solvability of social issues. They have stronger efficacy beliefs, i.e., they believe that their own actions can contribute to mitigating climate change (Duchi et al., 2020; Soliman & Wilson, 2017). They also feel more hopeful that social injustices and conflicts will be solved peacefully (Cohen-Chen et al., 2015; Shuman et al., 2016). Finally, the differences in efficacy belief and hope promote distinct behavioral patterns to target the problem. Incremental theorists engage in more collective action (e.g., demonstrations) and engage in more behavior to target the problem (e.g., more pro-environmental behavior in the context of climate change) (Duchi et al., 2020; Shuman et al., 2016; Soliman & Wilson, 2017). Entity theorists instead turn to more non-normative action (i.e., violent behavior) (Shuman et al., 2016).

Because climate change and global pandemics (e.g., Covid-19) share core features, we assume that lay beliefs about the world also play a role in the perception of pandemics. Pandemics entail a fundamental change in people's social world (e.g., actions that were previously normal are suddenly considered risky, and a previously safe environment now holds an invisible threat). Lay beliefs about the world might matter in whether one acknowledges or is skeptical about this drastic, global change. Since the rise of the pandemic, some people have downplayed the risk of Covid-19, despite clear evidence of the virus being serious (Vogel et al., 2021). An entity belief about the world might have contributed to that, since believing in a fixed world is at odds with this drastic change. Furthermore, entity theorists might not believe that their personal behavior is relevant to combat the pandemic. According to the Health Belief Model, these differences in perceived severity and benefits should lead to differences in behavior. Entity theorists might, thus, not engage as much in behaviors to combat the pandemic (e.g., wearing masks, getting vaccinated) as their incremental counterparts. Likewise, entity theorists should also see restrictions to combat

Covid-19 (e.g., closing shops) as less effective and thus disapprove of them.

Out of several important behavioral tendencies and intentions regarding Covid-19, one of the most important aspects was people's willingness to get vaccinated. By getting vaccinated, one cannot only protect oneself, but also other people by decreasing virus transmission and the risk of new mutations to arise. In 2019, the World Health Organization (WHO) announced vaccine hesitancy as one of the ten threats to global health (WHO, 2019). Future pandemic situations might face similar vaccine hesitancy as did the Covid-19 pandemic (Hrynich et al., 2020). Therefore, vaccine willingness was a key dependent variable in our studies (next to other behavioral intentions and attitudes).

Present research

The present research was conducted from March 2021 to August 2023. In Study 1, we analyzed the association of lay beliefs about the world with Covid-19-related beliefs, behaviors, and attitudes. In Study 2, we experimentally manipulated lay beliefs about the world to test their causal effect on Covid-19-related outcomes. Study 3a-c repeated the experimental manipulation and tested its effect on key outcomes related to a novel, hypothetical pandemic scenario. Finally, Study 4 tested the reversed causal effect of pandemic-related behavior on a shift in participants' lay beliefs about the world to justify their behavior. All studies were approved by the Departmental Review Board of *[university name blinded for review]* (project numbers: 2021/M/003, 2021/M/010, 2022/M/002, 2023/M/005). Studies 2, 3a-c and 4 were pre-registered (https://aspredicted.org/L5Z_RS8, https://aspredicted.org/F7X_3Q2, https://aspredicted.org/2QL_QFG, https://aspredicted.org/HKF_RCD, https://aspredicted.org/9B4_X2B).

Study 1

Study 1 explored the association of lay beliefs about the world with Covid-19-related beliefs, attitudes, and behaviors. We focused on Covid-19-related behavior change,

willingness to get vaccinated against Covid-19, persistence behavior to support a Covid-19 relief fund, attitudes towards Covid-19 measures, perceived severity of the disease (Covid-19 belief) and perceived benefits of mitigation efforts (Covid-19 efficacy belief).

Method

Participants

208 US Americans completed an online study via Amazon Mechanical Turk (recruiting period: 12/03/2021–31/03/2021). After excluding participants that failed an attention check ($N = 22$) or experienced technical problems ($N = 5$), the final sample size was $N = 181$ (51% female, 48% male, 1% non-binary; mean age 42 years, $SD = 12.3$). Most participants (78%) were White; the others were Asian (9%), Black (6%), Hispanic (4%), Native American (1%) or indicated another ethnicity (2%). Overall, participants slightly tended to be politically liberal ($M = 2.61$, $SD = 1.28$ on a scale from *Very liberal* (1) to *Very conservative* (5)).

Procedure and measures

After participants gave written consent to the participation information and the data protection form, they completed different questionnaires (e.g., on their lay beliefs about the world and personality), Covid-19-related measures, and participated in a persistence task. Lastly, they completed some general demographic questions, and they were thanked and debriefed. The main variables of interest will be described in the following sections (the full material is available under the following link:

https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcfb).

Lay beliefs about the world. The Lay Beliefs about the World Scale (Chiu, Hong, et al., 1997) included 3 items (e.g., “Our world has its basic or ingrained dispositions, and you really can’t do much to change them”) and participants responded on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). Responses to all items were averaged ($\alpha =$

0.93), higher scores indicate a stronger entity belief about the world.

Covid-19-related behavior change. Participants reported on their behavior over the past seven days regarding nine Covid-19 guidelines (e.g., “Wash your hands regularly with soap and water for at least 20 seconds or clean them with alcohol-based hand rub”). Participants indicated how different their behavior regarding these guidelines had been relative to before the pandemic on a 4-point Likert scale from *Exactly the same* (1) to *Very different* (4). Responses to all guidelines were averaged, with higher scores reflecting larger behavior change to conform with Covid-19 guidelines. To assess the internal consistency ($\alpha = 0.81$), one item (“Stay home if you feel unwell”) was removed, as most participants had missing data (because they had stated that they had not been unwell in the past seven days).

Vaccination intention. Intention to get vaccinated against Covid-19 was measured by two questions. The first one asked whether participants had already registered or tried to get the Covid-19 vaccine (*yes* or *no*). If participants hadn’t done so yet, they were asked if they would get vaccinated (once a vaccine was approved by the FDA and available) (*yes* or *no*). The answers on both questions were summarized as *yes* if any of the two questions were answered with *yes* and as *no* if both questions were answered with *no*.

1-back persistence task. Participants completed a very easy, rather boring N(1)-back letter memory task (Jaeggi et al., 2010). They were told that they could complete as many trials as they wanted (i.e., they could quit the task and proceed to the next study part whenever they wanted). They were informed that the number of correctly solved trials would translate into a donation to a Covid-19 relief fund (specifically the nonprofit, nonpartisan organization Direct Relief). A few sentences described the organization’s mission and measures. It was clarified that participants’ personal compensation was not dependent on their performance on this task (however, they were also not paid extra for the time they spent on the task). We used the number of correctly solved items as an index of persistence. Higher

values reflect longer persistence on the task.

Covid-19 threat belief. Perceived threat of Covid-19 was measured with a 10-item scale (e.g., “Covid-19 is a real threat”, “Negative consequences of Covid-19 are minor”) similar to an existing questionnaire on the pandemic swine flu (2011). Participants responded on a Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). Responses to all items were averaged ($\alpha = 0.96$), with higher scores representing stronger belief in the pandemic being a real threat.

Covid-19 efficacy belief. For each Covid-19 guideline used to assess Covid-19 related behavior change, participants indicated their efficacy belief regarding that guideline (“I feel that by adhering to this guideline, I can make a real difference in the fight against the pandemic.”). Participants responded on a 5-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (5). Responses on all guidelines were averaged, with higher scores reflecting higher efficacy beliefs regarding Covid-19 protective behavior. To assess the internal consistency ($\alpha = 0.95$), again one item (“Stay home if you feel unwell”) was removed as most participants had missing data (because they had not been unwell in the past seven days).

Covid-19 attitudes. In order to assess attitudes towards Covid-19 measures, we used a scale on the support of specific governmental measures (e.g., “Closing daycares, schools and universities”) (Blais et al., 2021). Participants responded how much they agreed with each initiative on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). Responses to all items were averaged ($\alpha = 0.94$), with higher scores indicating stronger support for the measures.

Political ideology. Participants were asked to indicate their political ideology (“In general, do you think of yourself as...”) on a scale from *Very liberal* (1) to *Very conservative* (5).

Results

Lay beliefs about the world were associated with all Covid-19-related outcomes (see Table 1). First, lay beliefs about the world were related to Covid-19-related behavior change and intention. Participants holding more of an entity belief changed their behavior less to follow Covid-19 guidelines ($r_{Pearson} = -.20$) and were less willing to get vaccinated ($r_{Point-biserial} = -.28$). To assess the relationship with persistence on the N-back task, we conducted a negative binomial regression to account for zero-inflation in the data. It showed that holding an entity belief was related to less persistence on the task, $IRR = 0.78$, $CI[0.60, 1.01]$, $p = .036$. Specifically, a shift of one standard deviation towards an entity belief was associated to a 22% decrease in solved trials. Second, lay beliefs about the world were related to beliefs regarding Covid-19. Namely, participants holding an entity belief believed to a lesser extent that Covid-19 is a real threat ($r_{Pearson} = -.25$), and that their behavior could make a difference regarding the pandemic ($r_{Pearson} = -.26$). Third, lay beliefs about the world were related to attitudes regarding Covid-19 measures. Specifically, participants holding an entity belief were less supportive of governmental measures to combat Covid-19 ($r_{Pearson} = -.21$).

Table 1. Correlation Matrix of the Main Variables in Study 1.

Variable	<i>M</i>	<i>SD</i>	<i>α</i>	1	2	3	4	5	6	7
1. Entity world belief	3.70	1.30	.93							
2. Covid-19 related behavior change	2.72	0.59	.81	-.20**						
3. Vaccination intention ¹	0.75	0.44		-.28**	.41**					
4. N-back persistence for donation ²	71.82	132.75		-.11	-.03	.12				
5. Covid-19 threat belief	5.09	1.14	.96	-.25***	.39***	.65***	.07			
6. Covid-19 efficacy belief	4.09	0.99	.95	-.26***	.40***	.53***	-.04	.79***		
7. Attitude towards Covid-19 related measures	3.82	1.28	.94	-.21**	.29***	.38***	-.04	.70***	.68***	
8. Political ideology	2.61	1.28		.24**	-.15*	-.31***	.07	-.49***	-.36***	-.40***

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N = 181. Pearson correlations were conducted unless otherwise indicated. Higher values of political ideology represent a stronger conservative (vs. liberal) view. ¹Point-biserial correlations due to vaccination intention being binary. ²*N* = 150 due to a technical error in the data collection of *n* = 31 participants. * *p* < .05, ** *p* < .01, *** *p* < .001

Past studies have shown that lay beliefs about the world are related to political ideology, with conservatives holding more of an entity belief than liberals (Cohen-Chen et al., 2015; Duchi et al., 2020; Soliman & Wilson, 2017) and the same emerged in our study (see Table 1). Since political ideology was also associated with the Covid-19 related outcomes (see Table 1), we conducted multiple regression analyses for each outcome, including political ideology as a control variable. Table 2 shows that the same patterns hold when political ideology is included as a control variable. Thus, lay beliefs about the world seem to be connected to the Covid-19 related outcomes independently of political ideology.

Table 2. Results of Multiple Regression Analyses of Relationship of Lay Beliefs About the World with Covid-19 Related Behavior, Beliefs, and Attitudes Controlling for Political Ideology.

Outcome variable	Estimate (β , <i>OR</i> , or <i>IRR</i>)	<i>df</i>	<i>t</i> / <i>z</i>	<i>p</i>
Covid-19 related behavior change	-0.17	178	-2.30	.022*
Vaccination intention ¹	0.64	178	-2.22	.027*
N-back performance for donation ²	0.75	147	-2.33	.020*
Covid-19 threat belief	-0.14	178	-2.18	.031*
Covid-19 efficacy belief	-0.18	178	-2.55	.012*
Attitude towards Covid-19 related measures	-0.12	178	-1.74	.084 [†]

N = 181. Linear regressions were conducted and standardized β reported unless otherwise

indicated. Higher values of lay beliefs about the world represent a stronger entity belief.

¹Binomial regression due to binary outcome variable. *Odds Ratio* is reported. ²*N* = 150 due to a technical error in the data collection of *n* = 31 participants; Negative binomial regression due to count data with a zero-inflation; *Incidence Rate Ratio* is reported. * *p* < .05, [†] *p* < .1

Discussion

In the first study, we found consistent associations between lay beliefs about the world and Covid-19 related behaviors, beliefs, and attitudes. First, participants with an

incremental belief – i.e., the belief that the world is changeable – showed more behavior inclinations to mitigate Covid-19. They persisted longer on a boring task to financially support a Covid-19 relief fund. They also changed their behavior more to follow Covid-19 guidelines and reported higher willingness to get vaccinated. Second, a higher incremental belief was related to higher threat belief and higher efficacy beliefs about their mitigation efforts. Last, people with more of an incremental belief also showed more positive attitudes towards Covid-19 rules and regulations to support the mitigation of the pandemic. Thus, lay beliefs of the world seem to be associated with Covid-19 related beliefs, attitudes, and behaviors.

Study 2

The aim of study 2 was to explore the causal effect of lay beliefs about the world. We focused on willingness to get vaccinated against Covid-19 among people who had not yet been vaccinated as the main outcome variable. Getting vaccinated was an essential step to mitigate the Covid-19 pandemic (Hrynck et al., 2020). We expected that those who would be exposed to the incremental belief about the world condition, would be more willing to get vaccinated than those who were exposed to the entity belief about the world condition. In addition to the manipulation's effect on vaccination willingness, in further exploratory analyses, we assessed the effects on beliefs in the threat of Covid-19 and the efficacy of protective behaviors as well as Covid-19 policy support.

Method

Participants

A power analysis determined that we need 118 participants to obtain a power of 80% with a standard significance level of $\alpha = 0.05$ to detect the effect on vaccination willingness from a pilot study (more detailed explanation of the sample size rationale is presented in the preregistration: https://aspredicted.org/L5Z_RS8). The data collection was conducted

25/06/2021 – 26/06/2021 via Amazon Mechanical Turk. 478 participants from the US completed the study. 80 participants were excluded because they failed an attention check, and another participant was excluded because they indicated that their data should not be used. Thus, 397 participants were included in the secondary analyses (58% female, 41% male, 1% non-binary; mean age 43 years, $SD = 13$). Participants were mostly White (87%) with others being Black (5%), Asian (4%), Hispanic (2%) or another ethnicity (2%). The sample slightly tended to be politically liberal ($M = 2.71$, $SD = 1.22$ on a scale from *Very liberal* (1) to *Very conservative* (5)). The sample was evenly distributed across the randomly assigned experimental groups ($N_{\text{incremental}} = 204$, $N_{\text{entity}} = 193$).

To test our main hypothesis, we only included people who were not vaccinated yet. This was 29% of the overall sample ($N = 114$; 61% female, 39% male; mean age 40 years, $SD = 11.2$). Again, most participants were White (88%) with others being Black (6%), Hispanic (3%), Asian (1%), Native American (1%) or another ethnicity (2%). This subsample slightly tended to be politically conservative ($M = 3.37$, $SD = 1.23$ on a scale from *Very liberal* (1) to *Very conservative* (5)). The subsample was also evenly spread across the incremental belief ($N = 60$) and entity belief group ($N = 54$).

Procedure and measures

After participants gave written consent to the participation information and the data protection form, they read a passage about whether the world was rather dynamic or fixed (lay beliefs about the world manipulation) and answered questions on the text. Following this, participants reported their vaccination status and vaccination intention in case they were not vaccinated yet. Subsequently, participants completed further measures on Covid-19 related beliefs and attitudes, a manipulation check, and additional questionnaires and demographic questions (the full material can be found under https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcbb).

Lay beliefs about the world manipulation. Participants read a short article about whether the world around them is known to be fixed or malleable based on scientific evidence (Cohen-Chen et al., 2015). After the manipulation, we presented four reading check questions to ensure that the participants read and understood the article. If people failed any of these items, they could read the text again once. If they gave a wrong answer again, they could not participate in the study.

Manipulation check. The same lay beliefs about the world scale ($\alpha = 0.94$) was used as in Study 1 to confirm whether the manipulation had worked.

Vaccination intention. Participants who had indicated that they had not been vaccinated yet (neither completely nor the first shot) answered one item on their vaccination intention (“Do you intend to get vaccinated against Covid-19 (once it is available to you)?”, *yes* or *no*).

Covid-19 belief. The same Covid-19 belief scale was used as in Study 1 ($\alpha = 0.95$).

Covid-19 efficacy belief. As the efficacy belief measure in the Study 1 was rather long and repetitive, with similar responses across all guidelines, we used a shorter measure in Study 2. We adapted a scale on beliefs about the effectiveness of sustainable behavior (Soliman & Wilson, 2017) to the Covid-19 context. The final scale included 5 items on the efficacy of protective behavior in general (e.g., “I feel like any action I take to mitigate the Covid-19 pandemic is only a ‘drop in the bucket’ and won’t make a difference.”). Participants responded on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). An additional item focused specifically on the perceived efficacy of getting vaccinated (“I feel that by getting vaccinated, I can make a real difference in the fight against the pandemic.”). People responded on a 5-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (5). This last item was rescaled before aggregating the 6 items ($\alpha = 0.90$). Higher scores on this measure reflect higher efficacy beliefs.

Covid-19 policy support. We adapted a measure on attitudes towards refugee support (Madan et al., 2019) to assess attitudes towards a policy to provide vaccines to poorer countries. Participants read a short description of a recent proposal by the WHO to mitigate the pandemic (namely, the necessity of providing 11 billion Covid-19 vaccine doses to poorer countries). We further informed participants that the US had already announced a policy to provide 500 million vaccine doses, but the country could further support this case. Then, we asked two questions on participants' attitudes of the US providing further support (e.g., "How much do you agree that the US should further support vaccination in poorer countries beyond the agreed 500 million vaccine doses?"). Participants responded to these questions on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). We aggregated these scores ($\alpha = 0.97$) in a way that higher scores reflect stronger support towards providing vaccines to poorer countries. Two additional exploratory items were assessed (see supplement).

Statistical analysis

We performed the pre-registered statistical analyses with R 4.3.2 (R Core Team, 2023). First, we used a *t*-test to confirm that the manipulation had worked. Then, we conducted a logistic regression to investigate the effect of the lay beliefs about the world manipulation on vaccination intention. Additionally, we conducted *t*-tests to investigate the effect of the lay beliefs about the world manipulation on the other Covid-19 related outcomes.

Results

Preliminary results

Overall, participants in the entity belief group reported a significantly stronger entity belief ($M = 3.59$, $SD = 1.28$) than participants in the incremental belief group ($M = 2.97$, $SD = 1.26$). The effect was of medium size, $t(395) = -4.85$, $p < .001$, $d = -0.49$. Among non-

vaccinated participants, those in the entity belief group reported a stronger entity belief ($M = 3.87$, $SD = 1.32$) than non-vaccinated participants in the incremental belief group ($M = 3.41$, $SD = 1.22$). However, the difference was only marginally significant and the effect was small, $t(112) = -1.94$, $p = .055$, $d = -0.36$. Besides, the groups did not differ in gender, ethnicity, age, or political orientation neither when looking at the whole sample ($p > .24$) nor at the non-vaccinated participants only ($p > .068$).

All Covid-19 related variables were significantly correlated among each other (Table 3). Besides, lay beliefs about the world related to all Covid-19 related variables: a stronger entity belief about the world correlated with lower vaccination intention, Covid-19 threat and efficacy beliefs, Covid-19 policy support, and lower likelihood of being vaccinated (Table 3).

Table 3. Correlation Matrix of the Main Variables in Study 2.

Variable	<i>M</i>	<i>SD</i>	<i>α</i>	1	2	3	4	5	6
1. Entity world belief	3.27	1.31	.94						
2. Vaccination intention ¹	0.19	0.40	-	-.27**					
3. Covid-19 threat belief	4.82	1.21	.95	-.30**	.73**				
4. Covid-19 efficacy belief	4.33	1.24	.90	-.29**	.69**	.78**			
5. Covid-19 policy support	4.21	1.64	.97	-.26**	.54**	.63**	.65**		
6. Political ideology	2.71	1.22	-	.27**	-.52**	-.55**	-.45**	-.49**	
7. Vaccination status ²	0.71	0.45	-	-.23**	-	.75**	.78**	.63**	-.45**

$N = 397$. Pearson correlations were conducted unless otherwise indicated. Higher values of political ideology represent a stronger conservative (vs. liberal) view. ¹ $N = 114$ (only non-vaccinated participants); point-biserial correlations due to vaccination intention being binary. ²Point-biserial correlations due to vaccination status being binary (0 = non-vaccinated, 1 = (partially) vaccinated). ** $p < .01$

Covid-19-related outcomes

Contrary to our prediction, there was no significant difference between the two experimental groups with regard to the intention to get vaccinated against Covid-19

(incremental belief group: 21.6%; entity belief group: 16.6%), $OR = 0.72$, $CI[0.27, 1.84]$, $p = .500$.

There were no differences between the two experimental groups regarding any of the other Covid-19 related variables either (Table 4).

Table 4. Tests of Differences Between the Experimental Groups Regarding the Covid-19 Related Outcomes.

Outcome variable	<i>M (SD)</i>		<i>df</i>	<i>t</i>	<i>p</i>	<i>d</i>
	Incremental	Entity				
Covid-19 threat belief	4.79 (1.22)	4.85 (1.19)	394.6	-0.47	.641	-0.05
Covid-19 efficacy belief	4.29 (1.25)	4.38 (1.22)	394.7	-0.71	.479	-0.07
Covid-19 policy support	4.21 (1.52)	4.21 (1.77)	379.7	-0.01	.993	-0.00

$N = 397$. Two-sided t -tests were conducted.

Discussion

Contrary to the predictions, Study 2 did not find a causal effect of the manipulation of lay beliefs of the world on vaccine intention or any other Covid-19 related outcomes. The manipulation successfully changed people's lay beliefs about the world (albeit only marginally significantly among non-vaccinated participants), but these changes did not translate to changes in the outcomes. However, as in Study 1, we found correlational relationships between lay beliefs about the world and Covid-19 related outcomes.

A possible explanation for these results is that beliefs and attitudes around Covid-19 were already very fixed at the time of Study 2 and not easily changeable anymore. Starting with the surge of Covid-19 at the beginning of 2020, people's beliefs, attitudes, and behavior inclinations regarding Covid-19 might have formed under the influence of their natural lay beliefs about the world. Thus, we observe correlational relationships in both Study 1 and 2. However, over time the beliefs, attitudes, and behavior inclinations regarding Covid-19 might have become fixed due to intense debates with hardened fronts and a general polarization of

the topic. At this point, these outcomes might not have been susceptible to changes in lay beliefs about the world anymore. This might have been the reason Study 2 (conducted in June 2021) did not find an effect of the lay belief about the world manipulation.

This suggests that while lay beliefs about the world manipulation might not affect Covid-19 related perceptions anymore, it might well influence the formation of beliefs, attitudes, and behavioral inclinations regarding a new issue (where people do not have fixed perceptions yet). Therefore, we used a hypothetical pandemic scenario for Studies 3a-c.

Study 3a

The aim of Studies 3a-c was to test if lay beliefs about the world would influence the formation of beliefs, attitudes, and behaviors about a novel pandemic threat that is not Covid-19. We created a pandemic scenario where – similar to Covid-19 – people’s personal behavior contributes to an overall solution. To ensure transferability to Covid-19, the proposed measures in this scenario were similar (e.g., vaccination and personal behavior change) while the specific details were different (e.g., different name, different symptoms and transmission and some unique measures). We expected that those participants who would be exposed to the incremental belief about the world manipulation, would have (1) a stronger belief in the threat; (2) stronger belief in the efficacy of mitigation efforts; (3) more supportive attitudes towards governmental measures against the pandemic; and (4) stronger behavioral intention concerning mitigation behavior.

Method

Participants

The study was pre-registered at the following link: https://aspredicted.org/F7X_3Q2. A power analysis determined a sample of 278 participants to obtain a power of 80% with a standard significance level of $\alpha = 0.05$ to detect an effect of $d = 0.3$ on a one-sided t -test. We recruited 308 people from the US via Prolific (recruiting period: 16/02/2022–03/03/2022) to

accommodate exclusions when people failed an attention check ($N = 25$), a reading comprehension question ($N = 6$) or indicated that their data should not be used (self-exclusion; $N = 6$). We analyzed 271 participants' data (49% female, 49% male, 1% non-binary; mean age 37 years, $SD = 13.8$). Participants were mostly White (61%) with others being Asian (17%), Hispanic (12%), Black (9%) or another ethnicity (1%). The sample slightly tended to be politically liberal ($M = 2.4$ ($SD = 1.1$) on a scale from *Very liberal* (1) to *Very conservative* (5)). The sample was evenly distributed across the randomly assigned experimental groups ($N_{\text{incremental}} = 141$, $N_{\text{entity}} = 130$).

Procedure and measures

After participants gave written consent to the participation information and the data protection form, they read a passage about whether the world was rather dynamic or fixed (lay beliefs about the world manipulation). Then, they read the first part of the hypothetical pandemic scenario and answered questions regarding the perceived threat of this pandemic, their intended behavioral changes, their personal and collective efficacy beliefs regarding the situation, and their attitudes towards measures to slow down the spread of the virus. Next, they read the second part of the scenario and answered further questions on the perceived efficacy of a vaccine, their vaccination readiness, and vaccination intention within the scenario. Finally, participants answered some control questions on the comparability of the scenario and Covid-19.

Below, we explain the measures of interest to this paper, the full material can be found under https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcb.

Descriptive statistics of the main variables are reported in Table 5. Descriptive statistics of the control questions are in the supplement. The experimental manipulation and manipulation check were the same as in Study 2. Regarding the dependent measures, scales from Study 1 and Study 2 were adapted to fit the novel pandemic scenario. Six items of the Covid-19 threat

belief scale, eight items from the Covid-19 related behavior change scale and the full Covid-19 attitude scale from Study 1 were adapted to focus on the novel pandemic instead. Likewise, the five items of the Covid-19 efficacy belief scale from Study 2 that focused on the efficacy of protective measures in general were adapted to focus on the novel pandemic scenario. Furthermore, the item on vaccination intention from Study 2 was adapted to allow for a more nuanced response (from *Very unlikely* (1) to *Very likely* (5) instead of only *Yes* or *No*). Additionally, we included two new scales on vaccine readiness and efficacy beliefs specifically about vaccination.

Table 5. Correlation Matrix of the Main Variables in Study 3a.

Variable	<i>M</i>	<i>SD</i>	<i>α</i>	1	2	3	4	5	6	7	7a	7b	8	8a	8b
1. Entity World Belief	3.51	1.26	.91												
2. Vaccination Intention	4.32	1.15	-	-.30**											
3. Vaccination Readiness	4.36	0.88	.92	-.34**	.85**										
4. Behavior Change Intention	4.18	0.73	.86	-.14*	.44**	.48**									
5. Attitudes Towards Public Measures	3.72	1.18	.94	-.11	.45**	.51**	.59**								
6. Threat Belief	4.96	0.87	.88	-.28**	.56**	.63**	.59**	.56**							
7. Efficacy Belief (general)	4.65	0.96	.80	-.29**	.60**	.62**	.57**	.49**	.68**						
a. <i>Individual Efficacy Belief</i> (general)	4.49	1.05	.75	-.24**	.53**	.55**	.52**	.47**	.59**	.93**					
b. <i>Collective Efficacy Belief</i> (general)	4.90	1.09	.64	-.30**	.55**	.57**	.50**	.39**	.66**	.85**	.60**				
8. Efficacy Belief (vaccination)	4.88	1.11	.89	-.33**	.81**	.82**	.46**	.48**	.60**	.76**	.71**	.64**			
a. <i>Individual Efficacy Belief</i> (vaccination)	4.76	1.23	.89	-.32**	.78**	.78**	.45**	.45**	.56**	.75**	.74**	.59**	.96**		
b. <i>Collective Efficacy Belief</i> (vaccination)	5.07	1.15	.69	-.30**	.73**	.73**	.41**	.44**	.56**	.63**	.54**	.61**	.89**	.72**	
9. Political ideology	2.44	1.10	-	.39**	-.43**	-.51**	-.24**	-.28**	-.40**	-.39**	-.31**	-.41**	-.42**	-.38**	-.42**

N = 271. Pearson correlations were conducted. Higher values of political ideology represent a stronger conservative (vs. liberal) view. * $p < .05$,

** $p < .01$

Novel pandemic scenario. The description of the novel pandemic was divided into two parts: the first part introduced the so-called *SciX virus*, its way of transmission, and the type and severity of its symptoms. The second part of the scenario discussed the so-called *Scimed* vaccine, its effectiveness against catching and transmitting the SciX virus, and its potential side effects (the full scenario text can be found in the supplement).

The SciX virus resembled Covid-19 in that it spread to new countries quickly and was contagious for up to 20 days, even with no symptoms. The virus was similarly more serious for high-risk groups and less serious for the low-risk groups (which participants were told they belonged to). Furthermore, similar preventive measures were introduced by the government (e.g., social distancing). We described that the Scimed vaccine was introduced shortly after the SciX virus was discovered and had a similar efficacy level as the Pfizer-Biontech vaccine (Polack et al., 2020).

The SciX virus differed from Covid-19 in that it transmitted through physical contact (which required people to wear gloves). Furthermore, symptoms were different. In the milder course of the disease, people experience headaches, coughs, and skin rashes for a few days. The severe course of the disease affects the veins, potentially blocking blood supply to the heart and causing heart attacks.

Vaccine readiness. We measured vaccination readiness (i.e., whether people were ready to get vaccinated) with the Vaccine Readiness Scale (2022). It consists of 7 subscales (confidence, complacency, constraints, calculation, collective responsibility, compliance, and conspiracy) that are each measured by 3 items (such as “I sometimes miss out on vaccination because vaccination is bothersome” and “I also get vaccinated because I am thereby protecting other people”). Participants were asked to think about the Scimed vaccine when responding to the items on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). We created an aggregated score of the scale in a way that higher scores reflect higher

vaccine readiness.

Efficacy beliefs about vaccination. We used the same 5 items that were used to measure efficacy beliefs about general measures regarding the scenario but adapted them to focus on the perceived efficacy of vaccination (e.g., “I feel that if I get vaccinated against the SciX virus, it is only a ‘drop in the bucket’ and won’t make a difference.”). Participants responded on a 6-point Likert scale from *Strongly disagree* (1) to *Strongly agree* (6). Like the scale on efficacy beliefs about general mitigation efforts, 3 items referred to people’s efficacy beliefs about individual efforts (e.g., “I feel that through getting vaccinated I can...”), and 2 items referred to efficacy beliefs about collective efforts (e.g., “If humans get vaccinated...”). We created aggregated scores for the scale (and the individual and collective efficacy subscales) in a way that higher scores represent higher efficacy beliefs.

Results

Preliminary results

The manipulation check revealed a significant difference in reported lay beliefs about the world between the two experimental groups. As expected, the incremental group reported lower agreement ($M = 3.3$, $SD = 1.2$) with an entity belief about the world compared to the entity group ($M = 3.7$, $SD = 1.3$), $t(263.65) = -2.53$, $p = .006$, $d = 0.31$. Besides, the groups did not differ in gender, ethnicity, or political orientation ($p > .645$). However, they did differ in age ($M_{incremental} = 35.5$, $SD = 12.7$, $M_{entity} = 38.9$, $SD = 14.7$), $t(256) = -2.03$, $p = .044$. The results did not change substantially when controlling for age (see supplement for the full results). Thus, we report the analyses without controlling for age.

All pandemic-related belief, attitude, and behavior variables were significantly correlated among each other (Table 5). Besides, lay beliefs about the world related to almost all pandemic-related variables: a stronger entity belief about the world correlated with lower vaccination intention and readiness, less intended behavior change and lower threat and

efficacy beliefs (Table 5).

Pandemic-related outcomes

There were no significant differences between the incremental and entity group regarding any of the pre-registered behavioral inclinations, beliefs, or attitudes regarding the pandemic scenario (see Table 6).

Table 6. Group Differences Between the Incremental and Entity Group Regarding the Pandemic-Related Outcomes in Study 3a.

Outcomes	<i>M</i> _{incremental}	<i>M</i> _{entity}	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Vaccination intention ¹	4.4	4.3	0.92	255.29	.179	-0.11
Vaccine readiness ¹	4.4	4.3	0.65	257.96	.257	-0.08
Behavior change intention ¹	4.1	4.2	-1.15	268.25	.875	0.14
Threat belief ¹	5.0	5.0	0.08	256.69	.468	-0.01
Efficacy beliefs about mitigation efforts ¹	4.7	4.6	0.84	260.97	.199	-0.10
Efficacy beliefs about <i>individual</i> mitigation efforts	4.6	4.4	1.79	262.45	.037*	-0.22
Efficacy beliefs about vaccination ¹	5.0	4.8	1.21	256.39	.113	-0.15
Efficacy beliefs about <i>individual</i> vaccination	4.9	4.6	1.79	252.83	.037*	-0.22
Attitudes towards public measures ¹	3.7	3.7	0.04	264.48	.484	-0.01

N = 271. One-sided *t*-tests were conducted testing for higher values in the incremental belief group. ¹Pre-registered analyses. * *p* < .05

A further exploratory analysis revealed significant differences specifically for the two efficacy subscales that focused on individual behavior. People in the incremental group reported higher efficacy beliefs about individual mitigation efforts (*M* = 4.6) than people in the entity group (*M* = 4.4), $t(262.45) = 1.79, p = .037, d = -0.22$. Likewise, the incremental group reported higher efficacy beliefs about individual vaccination (*M* = 4.9) compared to the entity group (*M* = 4.6), $t(252.83) = 1.79, p = .037, d = -0.22$.

Discussion

The aim of Study 3a was to test if participants that were led to adopt an incremental

belief about the world (rather than an entity belief about the world) would report (1) stronger perceived seriousness of a novel pandemic, (2) stronger belief in the efficacy of mitigation efforts, (3) more supportive attitudes towards governmental measures against the pandemic, and (4) stronger behavioral intention concerning mitigation behavior. Study 3a did not find support for this. However, we found that participants in the incremental belief condition reported stronger efficacy beliefs about *individual* efforts specifically. There was also a trend indicating differences in intention to get vaccinated. A possible reason why we did not find the hypothesized effects might be that the manipulation was not strong enough. This is corroborated by the small effect on the manipulation check itself. The effects on vaccine intention and the full efficacy scales were smaller than those assumed in our power analysis, potentially leading to an insufficient sample size to detect these effects. Therefore, strengthening the manipulation might be necessary. The outcome variables were also highly skewed, and it can be difficult to find an effect if there is little variance in the responses. We address these points in Studies 3b-c.

Study 3b

Study 3b aimed to replicate the effect of lay beliefs about the world on efficacy beliefs about individual mitigation efforts and vaccination. It also aimed to show an effect on vaccine intention by strengthening the manipulation of lay beliefs about the world. The manipulation was reinforced with a saying-is-believing exercise, which is a method to increase the internalization of previously received messages (Walton & Cohen, 2011, p. 1448).

Method

Participants

The study was pre-registered here: https://aspredicted.org/2QL_QFG. A power analysis determined a sample of 278 participants to obtain a power of 80% with a standard

significance level of $\alpha = 0.05$, to detect an effect of $d = 0.3$ on a one-sided t -test. We recruited 304 people from the US via Prolific (recruiting period: 11/04/2022–19/04/2022) to account for exclusion of those who failed an attention check ($N = 7$), a reading comprehension question ($N = 4$) or indicated that their data should not be used (self-exclusion; $N = 4$). We analyzed 290 participants' data (49% female, 49% male, 1% non-binary; mean age 41 years, $SD = 13.9$). Participants were mostly White (78%) with others being Asian (8%), Hispanic (8%), Black (4%) or another ethnicity (2%). The sample slightly tended to be politically liberal ($M = 2.4$, $SD = 1.2$ on a scale from *Very liberal* (1) to *Very conservative* (5)). The sample was evenly distributed across the randomly assigned experimental groups ($N_{\text{incremental}} = 147$, $N_{\text{entity}} = 143$).

Procedure and measures

The procedure was the same as in Study 3a. An additional exploratory block was added at the end of the study. The full material including the exploratory block can be found under the following link:

https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcfb. Descriptive statistics of the main variables are displayed in Table 7.

Table 7. Correlation Matrix of the Main Variables in Study 3b.

Variable	<i>M</i>	<i>SD</i>	<i>α</i>	1	2	3	4	4a	4b	5	5a	5b
1. Entity World Belief	3.41	1.29	.92									
2. Vaccination Intention	4.10	1.27	-	-.25**								
3. Vaccination Readiness	4.29	0.95	.93	-.33**	.87**							
4. Efficacy Belief (general)	4.48	1.13	.91	-.40**	.53**	.59**						
<i>a. Individual Efficacy Belief (general)</i>	4.22	1.19	.82	-.35**	.47**	.53**	.95**					
<i>b. Collective Efficacy Belief (general)</i>	4.74	1.18	.88	-.42**	.54**	.59**	.95**	.80**				
5. Efficacy Belief (vaccination)	4.78	1.20	.95	-.40**	.77**	.80**	.80**	.72**	.79**			
<i>a. Individual Efficacy Belief (vaccination)</i>	4.58	1.27	.91	-.37**	.71**	.75**	.78**	.75**	.73**	.97**		
<i>b. Collective Efficacy Belief (vaccination)</i>	4.98	1.22	.91	-.40**	.77**	.80**	.76**	.65**	.80**	.96**	.86**	
6. Political ideology	2.40	1.16	-	.30**	-.43**	-.52**	-.44**	-.35**	-.49**	-.49**	-.42**	-.52**

N = 290. Pearson correlations were conducted. Higher values of political ideology represent a stronger conservative (vs. liberal) view. * $p < .05$,

** $p < .01$

Experimental manipulation. The first part of the experimental manipulation was the same as in Study 3a: participants read a passage about whether the world was rather dynamic or fixed. After that, participants were asked to come up with reasons why the world is changing or fixed (depending on the experimental condition) and why this relates to their life (saying-is-believing exercise). As in the previous studies, we used the lay beliefs about the world scale as a manipulation check.

Behavior intention. Vaccination intention and vaccine readiness were both measured with the same scales as in Study 3a.

Efficacy beliefs about general mitigation efforts. We used the same efficacy belief scale as in Study 3a but added another item to the efficacy of collective action subscale, to even out the number of items of the two subscales. Furthermore, we slightly changed the wording of the items to make them stronger in order to reduce the negative skewness found in the previous study. For example, “I feel that through my personal behavior, I can influence the course of the SciX virus pandemic” was changed to “I feel that through my personal behavior, I can *highly* influence the course of the SciX virus pandemic”. We created aggregated scores for the separate subscales (regarding individual vs. collective mitigation efforts) in a way that higher scores represent higher efficacy beliefs.

Efficacy beliefs about vaccination. The scale was the same as we used in Study 3a, but we added another item to the efficacy of collective vaccination efforts subscale, to even out the number of items on the two subscales. We created aggregated scores for the separate subscales (regarding individual vs. collective vaccination efforts) in a way that higher scores represent higher efficacy beliefs.

Results

Preliminary results

The manipulation check revealed a significant difference in reported lay beliefs about

the world between the two experimental groups. The incremental belief group reported lower agreement ($M = 3.0$, $SD = 1.1$) with an entity belief about the world compared to the entity belief group ($M = 3.8$, $SD = 1.3$), $t(280.18) = -5.99$, $p < .001$, $d = 0.71$. The effect size was medium to large, indicating that we successfully strengthened the manipulation compared to Study 3a ($d = 0.31$). Besides, the groups did not differ in gender, age, or political orientation ($p > .430$). However, they differed in ethnicity (Fisher's exact test, $p = .035$). The results did not change, when controlling for ethnicity. Thus, we report the results of the analyses without controlling for ethnicity.

All pandemic-related belief, attitude, and behavior variables were significantly correlated among each other (Table 7). Again, lay beliefs about the world related to all pandemic-related variables: a stronger entity belief about the world correlated with lower vaccination intention and readiness, and lower efficacy beliefs (Table 7).

Pandemic-related outcomes

There were no significant differences between the incremental and entity belief groups regarding any of the pre-registered outcomes (see Table 8). Specifically, the two groups did not differ in their vaccination intention or in their efficacy belief with regard to individual mitigation efforts or individual vaccination. There was neither a group difference on any of the other pandemic-related outcomes that were collected for exploratory purposes (see Table 8).

Table 8. Group Differences Between the Incremental and Entity Group Regarding the Pandemic-Related Outcomes in Study 3b.

Outcomes	<i>M</i> _{incr}	<i>M</i> _{ent}	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Vaccination intention ¹	4.1	4.1	0.17	287.81	.434	-0.02
Efficacy beliefs about general <i>individual</i> mitigation efforts ¹	4.3	4.2	0.65	287.91	.259	-0.08
Efficacy beliefs about <i>individual</i> vaccination ¹	4.6	4.6	-0.05	282.06	.518	0.01

Outcomes	<i>M</i> _{incr}	<i>M</i> _{ent}	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Vaccine readiness	4.3	4.3	0.47	286.97	.320	-0.06
Health threat related behavior	3.8	3.9	-0.52	288.00	.697	0.06
Efficacy beliefs about general <i>collective</i> mitigation efforts	4.8	4.7	1.19	287.20	.118	-0.14
Efficacy beliefs about <i>collective</i> vaccination efforts	5.0	5.0	0.02	285.96	.492	0.00

N = 290. One-sided *t*-tests were conducted testing for higher values in the incremental group.

¹Pre-registered analyses.

Discussion

As was the goal in Study 3b, the manipulation got stronger by integrating a saying-is-believing task into the protocol and the distribution of the outcome measures were less skewed. However, we were not able to replicate our findings from Study 3a. This may have several reasons. One could be that we dropped the measures on perceived threat and behavior change intention from Study 3a. These additional measures contained some nuanced information about the pandemic scenario. For instance, the intended behavior change measure included information about what type of behaviors can be effective in this situation, which might have led people to think more deeply about the possible benefits of their behaviors (i.e., the efficacy of their mitigation efforts). Therefore, those measures will be reintroduced in Study 3c while also collecting a larger sample.

Study 3c

The aim of Study 3c was to directly replicate Study 3a on a bigger sample, while keeping all measures that could add nuanced information about the scenario. As we only found a significant effect on efficacy beliefs about mitigation efforts and getting vaccinated (and not vaccine intention), our pre-registered hypothesis referred to only these two variables (and not vaccine intention). We expected that those participants who would be exposed to the incremental belief about the world manipulation, would have stronger efficacy beliefs about mitigation efforts and about getting vaccinated.

Method

Participants

The study was pre-registered under the following link: https://aspredicted.org/HKF_RCD. A power analysis determined a sample of 514 participants to obtain a power of 80% with a standard significance level of $\alpha = 0.05$, to detect an effect of $d = 0.22$ on a one-sided t -test (based on the effects found in Study 3a). The study was conducted 24/05/2022 – 26/05/2022 in a US sample via MTurk. We obtained 627 unique complete responses after excluding responses from 21 people who participated more than once (each time the first response was retained, and later responses were removed). We excluded those who failed an attention check ($N = 94$), a reading comprehension question ($N = 0$) or indicated that their data should not be used (self-exclusion; $N = 9$). Finally, we analyzed 524 participants' data (69% female, 28% male, 2% non-binary; mean age = 38 years, $SD = 12.3$). Participants were mostly White (73%) with others being Black (12%), Asian (7%), Hispanic (5%), Native American (1%) or another ethnicity (2%). The sample slightly tended towards being politically liberal ($M = 2.7$, $SD = 1.1$ on a scale from *Very liberal* (1) to *Very conservative* (5)). The sample was evenly distributed across the randomly assigned experimental groups ($N_{\text{incremental}} = 264$, $N_{\text{entity}} = 260$).

Procedure and measures

The procedure was the same as in Study 3a. The full material of the study can be found under the following link: https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcb. Descriptive statistics of the main variables can be found in Table 9. The measures were the same as in Study 3a, but the threat belief scale was reduced to 4 items to decrease the length of the study.

Table 9. Correlation Matrix of the Main Variables in Study 3c.

Variable	M	SD	α	1	2	3	4	5	6	7	7a	7b	8	8a	8b	9
1. Entity World Belief	3.51	1.25	.91													
2. Vaccination Intention	3.80	1.45	-	-.19**												
3. Vaccination Readiness	3.99	1.05	.93	-.26**	.87**											
4. Behavior Change Intention	4.03	0.88	.90	-.19**	.41**	.52**										
5. Attitudes Towards Public Measures	3.99	1.34	.91	-.16**	.48**	.59**	.73**									
6. Threat Belief	4.75	0.93	.81	-.21**	.41**	.54**	.52**	.53**								
7. Efficacy Belief (general)	4.57	1.06	.89	-.32**	.50**	.60**	.57**	.55**	.56**							
a. <i>Individual Efficacy Belief (gen.)</i>	4.40	1.13	.81	-.32**	.47**	.55**	.56**	.53**	.51**	.93**						
b. <i>Collective Efficacy Belief (gen.)</i>	4.73	1.14	.83	-.28**	.47**	.58**	.51**	.49**	.54**	.94**	.75**					
8. Efficacy Belief (vaccination)	4.62	1.26	.93	-.29**	.80**	.85**	.49**	.51**	.53**	.73**	.68**	.68**				
a. <i>Individual Efficacy Belief (vaccination)</i>	4.49	1.37	.91	-.29**	.79**	.83**	.47**	.50**	.49**	.70**	.69**	.63**	.96**			
b. <i>Collective Efficacy Belief (vaccination)</i>	4.76	1.26	.86	-.27**	.74**	.80**	.47**	.48**	.52**	.69**	.61**	.69**	.95**	.83**		
9. Political ideology	2.68	1.14	-	.17**	-.43**	-.53**	-.32**	-.38**	-.36**	-.39**	-.32**	-.40**	-.45**	-.42**	-.45**	
10. Trust	3.04	0.87	.77	-.15**	.54**	.60**	.28**	.29**	.30**	.37**	.34**	.35**	.56**	.54**	.53**	-.27**

$N = 524$. Pearson correlations were conducted. Higher values of political ideology represent a stronger conservative (vs. liberal) view. * $p < .05$,

** $p < .01$

Influence of Covid-19 views. Two questions assessed to what degree participants' responses were influenced by their views about Covid-19. First, participants indicated what rather influenced their answers to the questions on the SciX virus on a 5-point scale (*The information you read about the SciX virus* (1); *Both equally* (3); *Your views about Covid-19* (5)). Second, they indicated how similar their answers had been to what they would have answered to questions about Covid-19 on a 5-point scale (*Very different answers* (1) to *Exactly the same answers* (5)).

Trust. Participants indicated their trust in the US government, their state's government, and scientists in general on a scale from *Cannot be trusted at all* (1) to *Can be trusted a lot* (5). We averaged these items in a way that higher scores represent higher trust ($\alpha = .77$, $M = 3.04$, $SD = 0.87$).

Statistical analysis

Differences between the two experimental groups (on both pre-registered and exploratory outcomes) were tested with one-sided *t*-tests as in the previous studies.

Beyond that, we conducted an exploratory network analysis to explore the correlational relationship of measured lay beliefs of the world (as opposed to the effect of the manipulation). The network analysis was performed with R 4.3.2 (R Core Team, 2023). We residualized the group's effect on all pandemic-related variables to partial out any effect the manipulation had on the variables of interest. As efficacy beliefs about general mitigation efforts and efficacy beliefs about vaccination highly correlated ($r_{\text{Pearson}} = .73$, $p < .001$), we collapsed these two scales for the network analysis. The network analysis aimed to explore how lay beliefs about the world are related to other constructs in the network structure of the pandemic-related behavioral intentions, attitudes, and beliefs. We used the EBICglasso method to generate the network, with a tuning parameter of 0.5 which is a conservative method that helps to avoid spurious edges (Epskamp & Fried, 2018; Foygel & Drton, 2010).

In line with recommendations (Isvoranu & Epskamp, 2023), a rank-transformation was conducted before estimating the network because not all data was normally distributed. According to literature (2018), the most widely used psychological network analysis technique is the partial correlation network (which can be conducted using the EBICglasso methodology). Partial correlation networks estimate partial correlation coefficients ranging from -1 to 1 representing the remaining association between two constructs after controlling for all other variables in the model (Epskamp & Fried, 2018, p. 619).

Results

Preliminary results

The manipulation check revealed a significant difference in lay beliefs about the world between the two experimental groups. The incremental group reported lower agreement ($M = 3.3$, $SD = 1.2$) with an entity belief about the world compared to the entity group ($M = 3.7$, $SD = 1.3$), $t(516.40) = -4.11$, $p < .001$, $d = 0.36$. Besides, the groups did not differ in gender, ethnicity, age, or political orientation ($p > .347$).

All pandemic-related belief, attitude and behavior variables were significantly correlated among each other (Table 9). Besides, as in the previous studies lay beliefs about the world related to all pandemic-related variables: a stronger entity belief about the world correlated with lower vaccination intention and readiness, less intended behavior change, more negative attitudes towards public measures and lower threat and efficacy beliefs (Table 9).

Most participants indicated that they based their answers to some degree on their pre-existing views about Covid-19. The majority (45%) reported their answers to be equally influenced by the presented information and Covid-19. Further 16% reported to be rather or even only influenced by Covid-19. Additionally, most people (81%) reported that they gave mostly or exactly the same answers that they would give to questions about Covid-19. Thus,

the scenario did not create a situation where participants would newly form beliefs, attitudes, and intentions as we had hoped.

Pandemic-related outcomes

There were no significant differences between the incremental and entity belief groups regarding the two pre-registered outcomes: efficacy beliefs about general mitigation efforts and efficacy beliefs about vaccination (see Table 10). There was neither a group difference on any of the other pandemic-related outcomes that were collected for exploratory purposes (see Table 10).

Table 10. Group Differences Between the Incremental and Entity Belief Groups

Regarding the Pandemic-Related Outcomes in Study 3c.

Outcomes	<i>M</i> _{incremental}	<i>M</i> _{entity}	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Efficacy beliefs about mitigation efforts ¹	4.5	4.6	-0.43	520.83	.666	0.04
Efficacy beliefs about getting vaccinated ¹	4.6	4.6	-0.09	521.95	.534	0.01
Vaccination intention	3.8	3.8	-0.07	521.77	.527	0.01
Vaccine readiness	4.0	4.0	-0.28	521.83	.611	0.02
Behavior change intention	4.0	4.1	-0.81	520.47	.790	0.07
Threat belief	4.7	4.8	-0.18	521.99	.570	0.02
Attitude towards measures	4.0	4.0	-0.43	519.89	.667	0.04

N = 524. One-sided *t*-tests were conducted, testing for higher values in the incremental group.

¹Pre-registered analyses.

Network analysis

As all previous studies showed correlational relationships between measured lay beliefs about the world and the pandemic-related outcomes, we conducted a network analysis on these variables to learn more about these relationships. We included measured lay beliefs about the world, general measures (age, political orientation, and trust) and all pandemic-related variables (vaccination intention, the subscales of vaccination readiness, intended behavior change, threat and efficacy beliefs, and attitudes).

The resulting network structure is shown in Fig 2 color-coded by type of measure (attitude, behavior intention, beliefs, and general measures).

Fig 3 displays centrality measures of the nodes in the network (higher numbers reflecting more central nodes). The network structure shows that the items related to vaccination appear in a strong hub, which is connected to efficacy beliefs, attitudes, trust, and political orientation. Interestingly, threat belief and behavior change intention have no strong, direct associations to vaccination-related items, but indirect ones through efficacy beliefs and attitudes. Lay beliefs about the world and age are only connected to few of the other variables.

The centrality plots show that efficacy beliefs are very central to the network, being connected to most outcomes (i.e., behavior intentions and threat belief). Threat belief is only related to general behavior change intention and attitudes—however, it is not related to vaccine-related behaviors. Lay beliefs about the world show one of the lowest centralities in the network, having its strongest connection to efficacy beliefs. Among the non-pandemic-related variables, trust and political ideology have the highest centralities, both being mainly related to vaccination-related items.

Fig 2. Plot of the Network Analysis on Pandemic-Related Behaviors, Attitudes, Beliefs and General Measures.

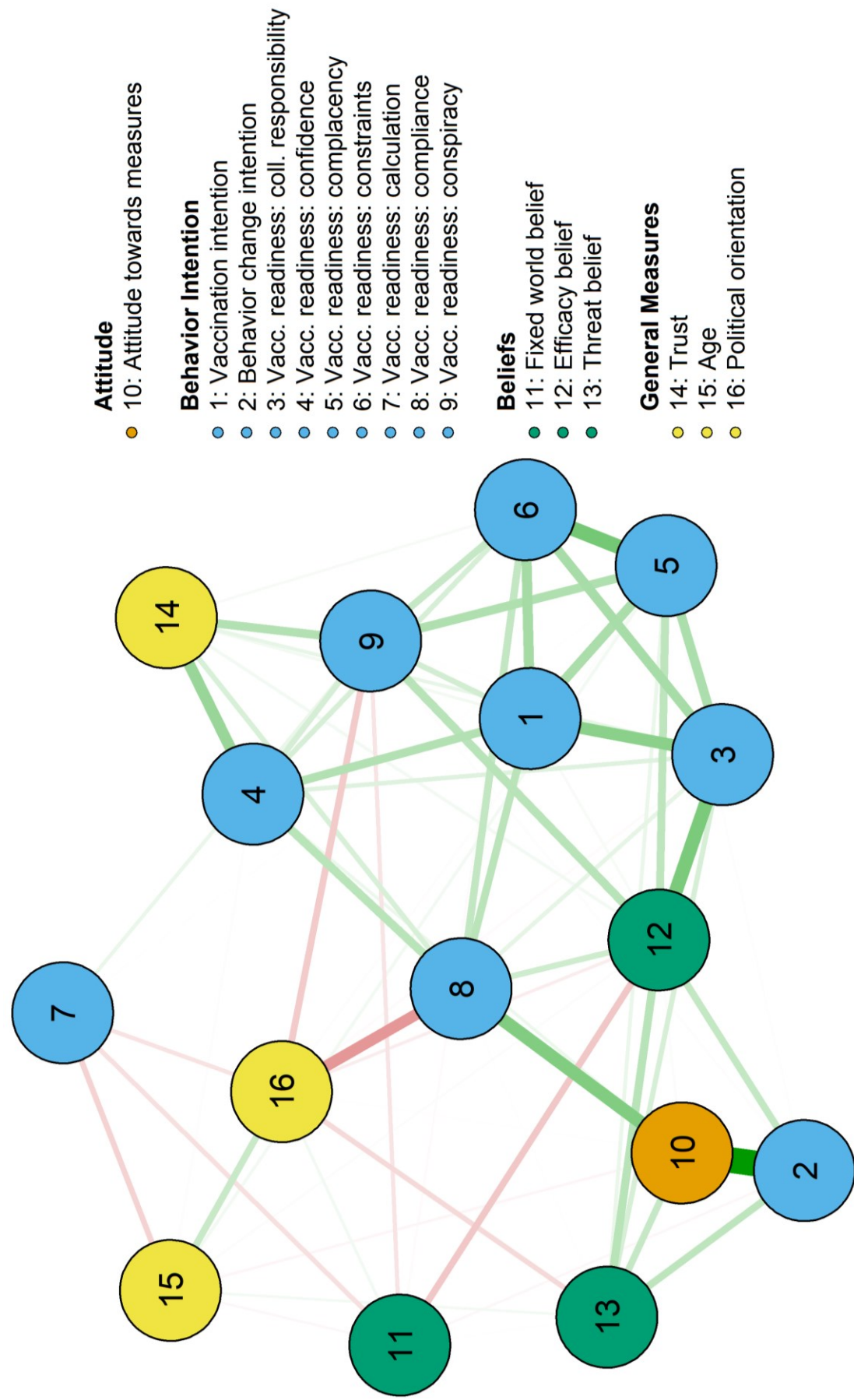
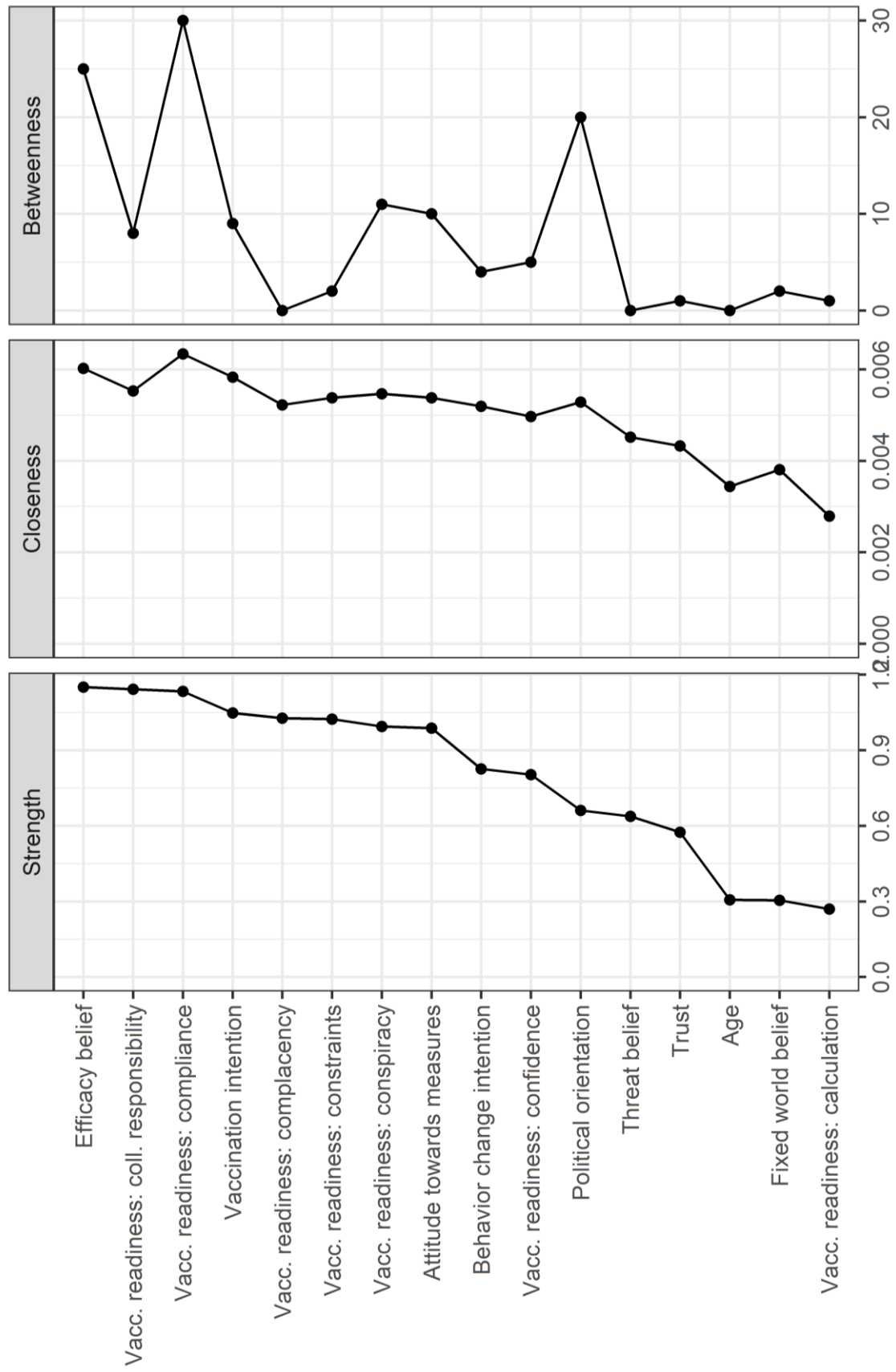


Fig 3. Centrality Plot of the Network Analysis on Pandemic-Related Behaviors, Attitudes, Beliefs, and General Measures.



Discussion

Our effort to replicate Study 3a on a bigger sample was unsuccessful. We expected that those participants who would be exposed to the incremental belief about the world manipulation, would have stronger beliefs in the efficacy of mitigation efforts and the efficacy of getting vaccinated. However, we found no such effects. Yet, our exploratory network analysis revealed interesting, correlational results that we would like to highlight three points from.

First, lay beliefs about the world add unique variance but are not central to the network. They connect directly to efficacy beliefs, and efficacy beliefs then mediate their relationship to most other variables (e.g., behavior intentions). Since efficacy beliefs are a central node in the network and related to several of the pandemic-related outcomes, the relationship between lay beliefs about the world and efficacy beliefs might still be interesting to investigate. It might provide insights about how efficacy beliefs develop.

Second, according to the Health Belief Model, perceived benefits of one's behavior and perceived seriousness of a health threat are important determinants of health behavior. Perceived benefits as measured by the efficacy belief scales in our study in fact appear to be very central in the network. They have the highest strength of direct connections and are connected to important outcomes such as vaccination intention and readiness as well as general behavior change intention (however not to attitudes about public measures). Perceived seriousness, as measured by the threat belief scale, was less central to the network. Still, it was directly related to general behavior change intention and attitudes about public measures, but less so to vaccination intention and readiness.

The third key finding of the network analysis is the role of vaccination intention, which has been the most important dependent variable to our paper. Aside from the variables directly related to vaccine readiness, only efficacy beliefs and trust have a direct connection

to vaccination intention. On the one hand, this shows that increasing efficacy beliefs might be important to achieve behavioral changes (e.g., getting vaccinated) in a pandemic. If people feel that their behavior can influence the course of the pandemic, they also tend to act towards this goal. On the other hand, trust play an important role in vaccination (also shown by its connections to vaccine readiness). It is crucial to trust officials because people might not have the knowledge to fully understand information about vaccines, however if they trust important authorities (scientists or the government), they are also more likely to get vaccinated if it is recommended in a pandemic scenario.

The correlational analyses of the previous studies show that people's lay beliefs about the world are connected to pandemic-related behaviors, behavior intentions, attitudes, and beliefs. The network analysis in study 3c further shows that people's lay beliefs about the world are still associated with pandemic-related efficacy beliefs (and through that with other outcomes) if general measures (e.g., age, political orientation, and trust) and other pandemic-related variables are held constant. However, there were no reliable effects of manipulated lay beliefs about the world on the same outcomes. This opens the question about the underlying causality of the relationship. Possibly, lay beliefs about the world are in fact not a driver of pandemic-related outcomes, but instead lay beliefs about the world are influenced by people's existing views about Covid-19 or pandemics in general. This will be tested in Study 4.

Study 4

The aim of Study 4 was to investigate a possible reversed causal effect, indicating that people might shift their lay beliefs about the world to justify a certain behavior. All previously reported studies find correlations between measured lay beliefs about the world and pandemic-related outcomes, such as behavior and behavior intentions. However, we found no evidence of a causal effect of lay beliefs about the world on these outcomes. A

possible explanation is that lay beliefs about the world do not shape people's behavior, but instead behavior shapes people's lay beliefs because people adopt a certain lay belief to justify their behavior or inaction. Past research shows that people sometimes shift their lay beliefs to support a personally preferred conclusion (e.g., justify a behavior or support a certain reasoning) (Leith et al., 2014). For example, people shifted towards a more incremental belief about personal characteristics after receiving failure feedback or recalling a personal social failure, which would support their personally preferred conclusion (i.e., "I can get better" instead of "I will stay bad at this"). Similarly, people who made a big effort to adhere to the guidelines might be motivated to reassure themselves that this was not a waste by adopting an incremental belief. In contrast, people who did not adhere thoroughly to Covid-19 related guidelines might justify this by adopting an entity belief about the world to avoid appearing reckless. In Study 4, we test this process of motivated reasoning by asking participants to imagine a certain behavior (either reflecting high or low adherence with protective guidelines) and measuring the effect this has on their lay beliefs about the world.

Method

Participants

The study was pre-registered under https://aspredicted.org/9B4_X2B. A power analysis determined a sample of 398 participants to obtain a power of 80% with a standard significance level of $\alpha = 0.05$, to detect an effect of $d = 0.25$. To account for exclusions, we aimed for a sample size of $N = 420$. Overall, 421 participants from the US were recruited through Prolific (on 11/08/2023). Participants' data was excluded if they indicated that their data should not be used ($N = 1$), failed a reading check ($N = 2$) or failed an attention check ($N = 8$). Thus, the final sample size was $N = 410$. The sample consisted equally of men (50%) and women (49%; 1% non-binary). Most participants were White (66%) followed by Black (20%; 5% were Asian and Hispanic each, 1% was Native American and 4% indicated another

race). Participants were on average 45 years old ($SD = 13.6$) and rather politically liberal ($M = 2.6$, $SD = 1.3$ on a scale from *Very liberal* (1) to *Very conservative* (5)). The sample was evenly distributed across the randomly assigned experimental groups ($N_{low\ adherence} = 207$, $N_{high\ adherence} = 203$).

Procedure and measures

After participants gave written consent to the participation information and the data protection form, they read the first part of the same pandemic scenario that was used in Studies 3a-c. This part introduced the so-called *SciX virus*, its way of transmission, and the type and severity of its symptoms. Afterwards, participants answered two reading check items. Next, the manipulation was administered: participants read a scenario that asked them to imagine either enacting or failing to enact protective health behavior. Following this, participants answered questions regarding the scenario, including a manipulation check. Then, participants completed a questionnaire on different kinds of lay beliefs, including lay beliefs about the world. Questions on other lay beliefs were included to mask the focus of the study. Finally, participants answered control questions on how well they were able to imagine the provided scenario and were thanked and debriefed. The full material can be found under https://osf.io/57rpw/?view_only=2ef554e052b94b4b9335d1cdf1eafbcfb.

Manipulation: adherence scenario. To manipulate participants' motive to shift their lay beliefs about the world either towards an entity or incremental belief, we asked them to imagine a concrete situation set within the described pandemic scenario. The first part of the description was identical for both groups: "*You have an important event coming up. Due to the number of people attending (including vulnerable individuals), you plan to test for the SciX virus before the event to ensure everybody's safety, although it isn't mandatory.*" The second part differed between the groups. The high adherence scenario group read: "*On the day of the event, you get tested in the morning. The tests typically take 3-4 hours to be*

analyzed. However, this time it seems to take longer, and you fear you might not get the results in time. Fortunately, you end up receiving the result one hour before the event. As the result is negative, you go to join the event.” Instead, the low adherence scenario group read: *“On the day of the event, just an hour before the start, you suddenly realize that you forgot to take the test. You know there is no time to get tested and receive the results in time for the event. The tests typically take 3-4 hours to be analyzed. You debate what to do and finally decide to go to the event without being tested.”*

Manipulation check. To ensure that the manipulation successfully gave participants a motive to justify their lack of protective behavior, we asked participants how they would feel in the described situation. Participants completed the Positive and Negative Affect Scale (PANAS) (Watson et al., 1988). They reported to what extent they would feel certain emotions (e.g., ashamed, enthusiastic) on a scale from *very slightly or not at all* (1) to *extremely* (5). Separate scores for positive ($\alpha = .92$) and negative ($\alpha = .92$) affect were calculated.

Lay beliefs about the world. The same measure as in Study 1 was used ($\alpha = .94$).

Control questions. After the manipulation check, participants were asked to indicate to what extent they perceived the outcome of the situation to be influenced by themselves (*0% influenced by you* (0) to *100% influenced by you* (100)). This was done to ensure that people felt responsible for the described behavior. At the end of the study, participants were asked how vividly they could imagine the described situation, how immersed they felt in it, and how likely something similar would happen to them (from *not at all vividly / immersed / very unlikely* (1) to *very vividly / immersed / likely* (5)).

Statistical analyses

In line with our pre-registration, we conducted a one-sided *t*-test to test whether the low adherence group reported more negative affect as a manipulation check. Next, we

conducted a second one-sided *t*-test to test if the low adherence group reported a stronger entity belief about the world compared to the high adherence group.

Results

Preliminary results

The manipulation check showed that the manipulation was successful. Participants in the low adherence group reported that they would experience stronger negative affect in the situation ($M = 2.8$, $SD = 0.94$) than the high adherence group ($M = 1.8$, $SD = 0.71$), $t(383.4) = 11.9$, $p < .001$, $d = -1.2$. Additionally, participants in the low adherence group reported lower positive affect ($M = 2.4$, $SD = 0.64$) than the high adherence group ($M = 2.5$, $SD = 0.70$), $t(403.0) = -2.8$, $p = .003$, $d = 0.28$. Besides, the experimental group did not differ in age, gender, ethnicity, or political ideology ($p > .489$).

Overall, participants felt that the outcome of the described scenario was by ca. 70% influenced by themselves ($M = 68.9$, $SD = 28.8$). On average, they could image the situation quite vividly ($M = 4.2$, $SD = 0.84$), felt quite immersed in it ($M = 4.1$, $SD = 0.91$) and considered it moderately likely that something similar would happen to them ($M = 3.2$, $SD = 1.29$).

Lay beliefs about the world

Regarding the main hypotheses, we did not find the expected effect. Participants in the low adherence group did not show a significantly lower incremental belief about the world ($M = 3.4$, $SD = 1.26$) than the high adherence group ($M = 3.5$, $SD = 1.36$), $t(404.4) = -0.98$, $p = .163$, $d = 0.10$.

Discussion

Study 4 found no evidence that people might shift their lay beliefs about the world to justify a certain behavior. Imaging a situation where one exhibits either high or low protective behavior did not lead to differences in participants' lay beliefs about the world.

However, this study does not provide enough evidence to make any final conclusions. Possibly, the manipulation was not strong enough to provide a motive to shift one's belief. Participants in the low adherence group did report more negative affect (e.g., feeling guilty or ashamed), however, this referred to a situation that they knew was not real. An imagined behavior might not provide enough motivation to shift one's lay belief. Actual behavior presents a much stronger need to be justified. Besides, the manipulation mainly provided a motive to adopt an entity belief (in case of low adherence). It did not provide a strong motive to adopt an incremental belief in case of high adherence because there were no costs associated with the high adherence. This might have limited the potential differences between the groups.

General discussion

In the current paper, we provided initial evidence that people's lay beliefs about the world might play a role in the fight against pandemic situations such as the global Covid-19 pandemic. However, the exact role it plays remains unclear. We did not find evidence for a causal effect of manipulated lay beliefs about the world on pandemic-related outcomes, nor a reversed causal effect (of pandemic-related behavior shaping one's lay beliefs about the world). However, we consistently find correlational relationships between naturally occurring lay beliefs and pandemic-related outcomes.

In Study 1, a correlational analysis showed that lay beliefs about the world were related to several variables regarding behavior, beliefs, and attitudes concerning Covid-19 even when controlling for political ideology. Our aim in Study 2 was to show that inducing an incremental belief about the world would result in more favorable beliefs, attitudes, and behavior intentions regarding Covid-19. However, we did not find supporting evidence for this hypothesis. A possible explanation for this lack of evidence was that beliefs and attitudes around Covid-19 might have already been very fixed at the time of Study 2 due to a general

polarization of the topic. Therefore, in Study 3a-c we created a hypothetical pandemic scenario to analyze the influence of manipulated lay beliefs about the world on people's beliefs, attitudes, and behavioral intentions regarding a new health threat. In these studies, we found no evidence either that an incremental belief about the world would result in more favorable beliefs, attitudes, and behavior intentions. However, across all studies we found consistent correlations with measured lay beliefs of the world. Additionally, the network analysis in Study 3c supports that an incremental belief about the world is associated with more favorable behavioral outcomes indirectly through efficacy beliefs and to a lesser extent through threat belief.

Taken together, lay beliefs about the world were consistently associated with pandemic-related outcomes on the correlational level but did not show a causal effect. A possible explanation for this could be that in fact pandemic-related behavior influence people's lay beliefs about the world and not the other way around. For example, people may try to justify their behavioral choices with the suitable lay belief about the world. Therefore, in Study 4 we tested a reversed causal effect of imagined behavior in a pandemic scenario on participants' lay beliefs about the world. However, we did not find evidence for this effect either.

Theoretical implications

Although there was no evidence of a causal effect of lay beliefs about the world, we consistently find that people who report a stronger incremental belief about the world also report more favorable beliefs, attitudes, and behavioral inclinations regarding both Covid-19 and the novel pandemic scenario. This indicates that there is some kind of relationship between them, at least on the correlational level. Past research has shown that an incremental belief about the world is positively related to acknowledging social issues (such as climate change), recognizing one's personal impact on them, maintaining hope about the successful

resolution, and addressing the issue appropriately (Cohen-Chen et al., 2015; Duchi et al., 2020; Shuman et al., 2016; Soliman & Wilson, 2017). Furthermore, past studies in the climate change domain (Duchi et al., 2020; Soliman & Wilson, 2017) indicate that believing in climate change and believing in the efficacy of one's mitigating efforts might act as mediators between lay beliefs about the world and behavioral intentions. With the current paper, we extend these results to the health domain. An incremental belief about the world related to acknowledging a global health threat (either Covid-19 or a novel, hypothetical pandemic) and recognizing one's own impact on it. Thus, this study gives some indication that research on climate change can be helpful to understand other global scale problems, such as the Covid-19 pandemic. Besides that, this study extends past literature on the role of lay beliefs about the world to others social issues. Lay beliefs about the world seem to play a role in several large-scale, social problems where the personal relevance of the problem and one's personal impact on it are ambiguous (be it climate change, political protest, or Covid-19). However, the nature of this relationship remains unclear. Our findings suggest that, at least in the context of a global health pandemic, there is not a simple causal relationship where changes in lay beliefs about the world translate directly to changes in the perceptions of a health threat.

The network analysis in Study 3c showed that lay beliefs about the world are rather peripheral in the overall system of pandemic-related outcomes (as indicated by their low centrality). Low centrality indicates that a variable is only connected to few other variables (e.g., lay beliefs about the world are mainly connected to efficacy beliefs). Low centrality also means that the variable can change rather independently of the other variables in the network (Dalege et al., 2017). Thus, small changes in lay beliefs about the world would not easily spread to other variables in the model. Instead, the different pandemic-related variables (i.e., beliefs, attitudes, and behavioral inclinations) were strongly interrelated among

themselves (indicated by the medium to high centralities). This might lead to them being more difficult to change because they create a stable network that reinforces itself (Dalege et al., 2017). Essentially, the strong network of bidirectional relationships between the variables might suppress changes in each single variable—e.g., low efficacy belief might keep vaccination willingness low, but likewise low vaccination willingness might be rationalized through a low efficacy belief. This is corroborated by the fact that other general variables included in the model, such as political ideology or trust also seem to be less central in the model compared to the pandemic-related variables themselves. While non-central variables can still influence a network, they require larger changes to have an effect. Thus, it may need a substantial change in lay beliefs about the world for it to impact the other variables.

Lay beliefs about the world focus on the perception of the world as changeable. Past studies have also identified other ways in which people differ in how they perceive the world, e.g., perceiving it as just vs. unjust, harmless vs. dangerous or beautiful vs. ugly (Clifton et al., 2019). These world beliefs have been shown to be considerably stable across a long period of time (e.g., 19 months) even with major events happening in the meantime (e.g., the 2016 US election). Possibly, several different world beliefs also form a somewhat robust worldview pattern that is learnt over time and sustains itself. This might make it difficult to change single parts of the worldview system.

Implications for the Health Belief Model

The results of this study do not only provide insights about the role of lay beliefs about the world, but also about the role of two important factors suggested by the Health Belief Model: perceived benefits of health behavior and perceived seriousness of the health threat. Our results highlight the relevance of perceived benefits in the form of efficacy beliefs. Efficacy beliefs were among the most central variables in the network model, while threat beliefs were less important. One explanation for this is that believing in the seriousness

of the health threat might still not lead to health behavior if one does not believe that the behavior will effectively provide protection. Strong beliefs in the efficacy of a health behavior on the other hand might more consistently lead to engagement as long as the threat is perceived at least as somewhat serious – so to speak, “just to be safe”.

Our study also provides new insights on the Health Belief Model. Past studies have mostly focused on perceived benefits of a health behavior for the individual. However, in a global health threat such as the Covid-19 pandemic, benefits for others or the general society come into focus. Especially, when certain groups of people are less affected than others (such as young people being less vulnerable to Covid-19), these people might be motivated by benefits for others or the society rather than benefits for themselves. Our study focused on this aspect of perceived benefits (i.e., the efficacy of health behaviors in protecting others or alleviating the overall course of the pandemic) and showed that they were strongly related to people’s health behavior intentions. This indicates that people do not only take personal benefits into account, but also benefits for others. This might prove useful to motivate people to engage in health behaviors that do not benefit them immediately. For instance, in a pandemic, it might be important to focus on the benefits of preventive behaviors and measures for the sake of helping other people and the society as a whole instead of just the self.

Limitations and future research

Originally, we assumed that we did not find an effect of the manipulation on the Covid-19 related outcomes (Study 2) because lay beliefs about the world primarily exert their effect during the initial formation of beliefs, attitudes, and behavioral intentions but are less influential once these have formed and stabilized. However, the results from Studies 3a-c show that the manipulation neither affected people’s perceptions of a new health threat. Likewise, the strength of the manipulation did not seem to play a major role as the

manipulation was successfully strengthened in study 3b without any changes in the effects on the outcomes.

A possible explanation is that the scenario we created was still too similar to the Covid-19 pandemic. Thus, people might have based their beliefs, attitudes, and behavioral inclinations regarding the new scenario on their pre-existing views regarding Covid-19. In that case, people did not thoroughly process the new information regarding the scenario, but rather used their existing view of Covid-19 as a reference. We deliberately created a scenario that would be similar to the Covid-19 pandemic in order to be able to draw conclusions for the Covid-19 pandemic based on the scenario. However, a downside to this is that people did not perceive it as fundamentally new. In Study 3c, most people reported their answers to be at least as much influenced by Covid-19 as by the novel pandemic scenario and most people reported that they gave mostly the same answers regarding the scenario as they would have done regarding Covid-19. Thus, it is possible that the omnipresent topic of the Covid-19 pandemic overshadowed other related health topics, making it difficult to create a scenario that is independent of the previous Covid-19 experience.

Another explanation is that the manipulation did in fact not change people's lay beliefs about the world in the correct way. In this study, the manipulation's effect on people's lay beliefs about the world was assessed by asking people to self-report their beliefs. Thus, this measure tapped into what people report about their beliefs under optimal conditions (i.e., when having the time and resources to deliberate about their beliefs). However, a recent paper (Sik et al., 2024) suggests that lay beliefs (also known as implicit beliefs) are multifaceted in nature. There might be a second layer to these beliefs, consisting of people's automatic, immediate responses instead of solely their deliberate consideration of the items under optimal conditions. A recent study showed that an implicit measure of lay beliefs of intelligence was predictive of people's learning behavior (2024). Notably, this more

automatic expressions of beliefs were shown to be a better predictor of behavior compared to people's explicitly self-reported beliefs. It is possible that the short persuasive article only changed people's more superficial, explicit beliefs, while their more automatic beliefs remained unchanged. Future studies could measure these automatic beliefs and test a manipulation that is tailored to changing this more automatic layer of lay beliefs about the world.

Conclusion

The global Covid-19 pandemic has put humanity into a situation where the protective behavior of each individual is needed. At the same time, people might not personally feel particularly threatened by the disease or they might think that their behavior will not make much of a difference. We explored how people's lay beliefs about the changeability of the world influence these perceptions of the seriousness of the disease and the efficacy of protective behaviors and, as a result, people's protective behavior. Although we find consistent correlations between believing in a changeable world and threat and efficacy beliefs and protective health behavior and intentions, we did not find support for a causal effect. We also tested a possible reversed causal effect of behavior on lay beliefs about the world but did not find evidence for this effect either. Overall, this indicates that the relationship between lay beliefs about the world and pandemic-related outcomes might be less straightforward. Besides, the results of a network analysis highlighted the importance of beliefs about the efficacy of health behaviors to protect others and alleviate the course of the health threat for behavioral intentions. This provides interesting new insights on what motivates people's health behavior in a global health threat.

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**Paper 3: The Role of Lay Beliefs About Willpower and Daily Demands in Day-To-Day
Pro-Environmental Behavior**

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Abstract

Many people report pro-environmental attitudes but fail to integrate pro-environmental behavior into their daily lives. One reason might be that other high demands in daily life (e.g., from work) make people vulnerable to the temptation to choose easier, but environmentally unfriendly options. Research from other domains indicates that believing that one's willpower is nonlimited facilitates adhering to one's intentions, especially in the context of high demands. Our study aimed to investigate the effect of these lay beliefs about willpower and daily demands in the environmental context. The hypotheses were (1) that a nonlimited willpower belief would be related to more engagement in day-to-day pro-environmental behavior and (2) that this effect would be stronger on days with high demands. Participants ($N = 387$) of an online daily diary study reported their lay beliefs about willpower and their daily demands and pro-environmental behavior over three days. Results confirmed that a nonlimited willpower belief was related to more pro-environmental behavior, mainly because it facilitated sustained pro-environmental behavior on more demanding days. Additionally, we found that people who faced more demands across the entire study period engaged in less pro-environmental behavior irrespective of their willpower belief. These results indicate the relevance of demands and willpower beliefs in pro-environmental behavior. Future studies should examine their causal relationship and might inform future interventions to promote pro-environmental behavior (e.g., suggesting targeting people's demands and their willpower beliefs).

Keywords: pro-environmental behaviour, lay beliefs about willpower, demands, self-regulation, daily diary

Introduction

Climate change is one of the biggest threats to humans and nature. It has already now altered the earth's ecosystems at a global scale and adversely impacted human systems (Pörtner et al., 2022). To reduce the risks it poses to human livelihood, it is vital to limit global warming as much as possible – at best to 1.5°C. This requires rapid, deep reductions in greenhouse gas emissions which can only be achieved through fundamental changes in industries, political policies and individuals' behavior ("IPCC, 2022: Summary for Policymakers," 2022).

Research shows that most people are aware of the threats of climate change. People frequently report positive attitudes towards the environment and intentions to take action to address climate change (Bell et al., 2021; European Commission - Directorate General for Environment, 2021). However, these positive attitudes and intentions often fail to translate into actual pro-environmental behavior. Climate change belief and environmental attitudes are only weakly related to actual pro-environmental behavior and pro-environmental behavior intention only explains around 27% of the variance in actual pro-environmental behavior (Bamberg & Möser, 2007; Hornsey et al., 2016; Juvan & Dolnicar, 2014). Overall, people seem to fail frequently to put their environmental attitudes and intentions into action. Taken together, these observations suggest that pro-environmental behavior is in fact a question of people's ability to regulate their behavior according to their (pro-environmental) intentions.

Consistent with this, researchers have called for a stronger focus on self-regulation processes in environmental psychology to move beyond trying to predict and change pro-environmental intentions and attitudes (Bamberg, 2013; Nielsen, 2017). We entered in a phase, where it is important to learn how these intentions and attitudes translate into behavior. Most people are aware of the urgency of climate change and realize that pro-environmental behavior is necessary and important. However, after a long, exhausting day of work, they can

sometimes find themselves yielding to the temptation of the more convenient or appealing option e.g., driving by car to the grocery store instead of taking the bike or choosing a personally more attractive meat dish over a vegetarian option. When people face such temptations, they need to exert effort to inhibit the unwanted behavioral tendencies and go for the environmental option. This might get more and more difficult the more effort one has had to put forth on other demands over the day already.

Thus, it is important to investigate how to facilitate pro-environmental behavior even in the context of other demands individuals experience in their everyday life. Past research indicates that lay beliefs about willpower (beliefs of willpower as a limited or rather nonlimited resource) are essential when it comes to self-control behavior in face of high demands or under fatiguing conditions. Believing that one's willpower is limited has been shown to lead to lower self-control behavior under conditions of high demands. In contrast, believing that one's willpower is nonlimited has been connected to sustained self-control behavior even under demanding conditions leading to better outcomes e.g., concerning education or health (Francis et al., 2021; Job et al., 2010; Job, Walton, et al., 2015).

Self-Control and Pro-environmental Behavior

Self-control is necessary when people face a conflict between two mutually exclusive behavioral choices where one is instantly appealing while the other is beneficial in the long-run (Milkman et al., 2008). Pro-environmental behavior often involves such a conflict because environmentally unfriendly choices are typically more convenient (e.g., using the car), less effortful (e.g., refraining from recycling), less costly (e.g., buying conventional products instead of sustainable ones), and for many people more attractive (e.g., eating meat dishes, flying to distant locations). Furthermore, established non-environmental habits make environmental unfriendly behavior immediately easy and effortless while actively changing one's habits to a more environmentally friendly behavior requires attention and effort.

Environmentally friendly choices, however, will only unfold their positive effects on nature and society in the (far) future. Accordingly, van der Wal et al. (2018) showed that a stronger future orientation (as opposed to a present orientation) is related to more environmental attitudes and choices.

Supporting the proposition that pro-environmental behavior often involves exercising self-control, past research indicates that people's self-control ability helps them overcome the temptation of short-term attractive choices in favor of environmental ones. People with high trait self-control act more in line with their pro-environmental attitudes (Wyss et al., 2022) and people with high baseline activity in self-control brain areas engage in more daily pro-environmental behavior (Baumgartner et al., 2019).

Within the research community, there is a debate about whether self-control behavior might not only be influenced by individual differences in self-control ability, but also by previous exertion of self-control. The *strength-model of self-control* (Baumeister et al., 1998) postulates that self-control is a limited resource that depletes upon usage. Thus, when people exert self-control on a task, they should perform worse on subsequent self-control activities because their self-control resource is depleted, e.g., people should show less pro-environmental behavior when they experience high other self-control demands in their daily lives. However, while some studies found support for the postulated "ego depletion effect" (Dang et al., 2021; Hagger et al., 2010), others failed to replicate it (Hagger et al., 2016; Vohs et al., 2021). Thus, evidence indicates that self-control is not necessarily behaving like a limited resource. Other research, in turn, has suggested that the question whether self-control is actually limited or not is less important than what people believe about it. This research shows that it is people's beliefs about self-control that determine whether their self-control is depleted by self-control exertion or not (see Francis & Job, 2018 for an overview).

Lay Beliefs About Willpower

People differ in their perception of the nature of their self-control capacity or *willpower* (Job et al., 2010). Some people believe that their self-control is limited and can be depleted by engaging in self-control behavior. This belief is called a *limited willpower belief*. Other people believe that their self-control is unlimited and is not depleted by engaging in self-control behavior but can even be energized by it. This is labelled a *nonlimited willpower belief*. Importantly, these beliefs are different from trait self-control. Trait self-control reflects people's behavioral choices generally whereas willpower beliefs reflect their conception of the nature of self-control capacity in face of accumulating self-regulatory demands (Francis & Job, 2018).

Lay beliefs in general are assumed to be shaped by culture. People's experiences of the world around them and their interaction with others shape how they perceive and make sense of the world. Savani and Job (2017) found that US Americans tended to perceive their willpower as limited while Indians rather perceived it as nonlimited. The authors attribute this to differences in how self-control is portrayed in both cultures. For example, different religious traditions in India encourage frequent exertion of self-control. Such experiences could convey to people that sustained self-control exertion is indeed possible. Besides these general cultural learning mechanisms, some research indicates that lay beliefs about willpower also depend on people's experiences of vitality and energy in the context of goal striving. People who regularly feel energized, because they engage in tasks to have fun, develop a more nonlimited willpower belief over time (Sieber et al., 2019).

Effects of Lay Beliefs About Willpower

Job et al. (2010) showed that people's willpower beliefs determine the effect of previous self-control demands on subsequent self-control behavior. In their study, they experimentally manipulated participants' willpower beliefs and measured performance on a

self-control task after previous self-control demanding or non-demanding tasks. Participants that were led to endorse a limited willpower belief made more mistakes on the second task when the first task was demanding compared to non-demanding. However, participants in the nonlimited willpower belief condition performed equally well regardless of the nature of the first task.

Further studies have corroborated the importance of willpower beliefs for everyday self-control behavior in areas such as education and health (Bernecker & Job, 2015; Di Maio et al., 2020; Francis et al., 2021; Job et al., 2010; Job, Walton, et al., 2015). A nonlimited willpower belief is related to more favorable health behaviors such as less snacking and more physical activity (Francis et al., 2021). Furthermore, Bernecker and Job (2015) showed that a nonlimited willpower belief relates to better therapy adherence in terms of self-care activities, diet, and exercise in patients with type 2 diabetes. Likewise, Di Maio et al. (2020) showed favorable associations of a nonlimited willpower belief and regular physical activity in patients with knee osteoarthritis. Concerning learning and academic performance, people with a nonlimited willpower belief procrastinate less and self-regulate better with respect to their goals (Job et al., 2010; Job, Walton, et al., 2015). Furthermore, students with a nonlimited willpower belief achieve better GPAs (Job, Walton, et al., 2015). These studies indicate that a nonlimited willpower belief helps people to align their everyday behavior with their long-term goals.

Importantly, the positive effect of the nonlimited willpower belief is typically strong under conditions of high demands. The positive effects on health behavior (e.g., on healthier dietary choices and more physical activity) appear especially later in the day when previous demanding activities have presumably built up (Francis et al., 2021). The effects are also stronger for people for whom the health behaviors are new and not habitual and thus more self-control demanding (Bernecker & Job, 2015). Likewise, positive effects on reduced

procrastination and elevated grades emerge especially for students that face high demands or have a high course load (Job, Walton, et al., 2015). In contrast, Di Maio et al. (2020) found that a nonlimited willpower belief only related to more physical activity in patients with milder symptoms but not those with severe symptoms. This might indicate that a nonlimited willpower belief only takes effect up until a certain degree of strain. Nevertheless, most research so far indicates that a nonlimited willpower belief is helpful to keep self-control up in times when demands on self-control are high and people with a limited willpower belief are at risk of self-control failure.

Present Research

So far, no research has examined the effect of lay beliefs about willpower on pro-environmental behavior. With the present study, we aim to close this gap. We predict that a nonlimited willpower belief will positively relate to pro-environmental behavior. Just like health or academic behavior, pro-environmental behavior serves a long-term goal and requires self-control to be shielded against short-term temptations. A nonlimited willpower belief should facilitate this self-control exertion leading people with this belief to engage in more pro-environmental behavior in their daily lives (*hypothesis 1*).

We assume that this effect will be especially strong on days of high demands. Past research indicates that the positive effect of a nonlimited willpower belief is strongest under conditions of high demands. People with a limited willpower belief should more easily feel depleted by the demands of the day leading to less successful self-control on pro-environmental behavior. People with a nonlimited willpower belief, in contrast, should be more able to keep their pro-environmental behavior up even in face of high demands. Specifically, we hypothesize that people with a limited willpower belief perform less pro-environmental behavior on demanding days (compared to less demanding days). In contrast, people with a nonlimited willpower belief should show a smaller decline in pro-

environmental behavior between days of low and high demands (*hypothesis 2*).

Materials and Methods

Power analysis

Power analyses for cross-level effects in multi-level analyses can be done through simulations. However, these require detailed information about effect sizes and the sizes of the variance components, which we did not have in advance. Thus, we used a conservative, but simpler power analysis for a small interaction effect ($f^2 = 0.02$) on level 2 in G*Power (Faul et al., 2009) as reference. This revealed a required sample size of $N = 311$. To account for dropouts on the follow-up questionnaires, we aimed for a sample size of $N = 400$.

Participants

The sample was recruited via social media. Participants were offered up to 5€ for their participation depending on the number of follow-up questionnaires they filled in¹. In total, 398 participants completed the first part of the study. Ten participants were removed because they indicated that their data should not be used (self-exclusion) and one response was removed because a participant filled out the questionnaire twice (the first response was retained). Thus, the final sample at T0 included 387 participants. Their age ranged between 18 and 71 ($M = 26$, $SD = 7.8$) and the majority was female (80%). Most participants were students (78%) and very few (7%) were psychology students. Regarding education status, most participants had passed the final secondary school examinations (55%) or had a university degree (42%). The majority had a yearly income of less than 10,000 € (55%). Overall, the sample leaned towards the political left ($M = 3.7$, $SD = 1.6$; higher values on a scale from 0 to 10 indicated more conservative views).

¹ 46 participants (12%) chose not to get compensated. The other 351 participants received on average 4.30€. Participants were asked to provide their bank information at the end of T0 to receive their compensation. Alternatively, they could indicate that they did not want to receive compensation (e.g., if they did not want to share their bank information).

On the following Thursday (T1), Friday (T2), and Saturday (T3) after T0, participants completed the follow-up questionnaires. Of the 387 participants that were included at T0, 303 (T1), 304 (T2) and 297 (T3) participants completed each of the follow-up questionnaires. For each follow-up questionnaire, participants were excluded if they completed the questionnaire after the allocated time interval² or indicated that their data should not be used (self-exclusion). The final sample sizes were 300 (T1), 303 (T2) and 291 (T3).

Overall, 337 participants (87%) completed at least one follow-up questionnaire. Those participants did not differ from the participants that did not complete any follow-up in willpower beliefs, anticipated demands, pro-environmental behavior intention, political attitude, gender, or student status (all $p > .188$). However, those that did not complete any follow-up questionnaire tended to be slightly younger ($M_{none} = 24$, $M_{any} = 26$, $t(285) = -1.78$, $p = .076$).

Materials

The variables of interest for the present analyses are described below. Table 1 depicts descriptive and reliability statistics and correlations of the main variables. A list of all collected variables is provided in the supplement (Table S1) along with a grand correlation matrix (Table S2). The full material, the data and the data analysis script are available under https://osf.io/qxfae/?view_only=137941ffe9fd4fda98c2c20392e564cd.

Table 1. Descriptive statistics and correlations of the variables.

Variable	<i>M</i>	<i>SD</i>	α	<i>ICC</i>	1	2	3	4	5
<i>Between-person variables</i>									
1. Nonlimited willpower belief	3.3	0.67	.78	—	—				
2. Anticipated demands	3.3	0.60	.57	—	-.12*	—			

² The allocated time interval was from 5pm on the same day to 3am on the following day. Participants should not have been able to complete the questionnaire later, but due to a technical error, some were.

Variable	<i>M</i>	<i>SD</i>	α	<i>ICC</i>	1	2	3	4	5
3.PEB intention	3.8	0.47	.80	–	.14**	-.15**	–		
4.Social desirability	3.7	0.58	.62	–	.14**	-.15**	.32***	–	
<i>Within-person variables</i>									
5.Daily demands	2.7	0.57	.60-.71	.34	-.10†	.42***	-.06	-.03	–
6.Daily PEB	3.8	0.38	.60-.63	.58	.16**	-.10†	.61***	.23***	-.13*

Note. For within-person variables: mean, standard deviation and correlations refer to the by-person average and Cronbach's α refers to the range across all three time points. The intraclass correlation coefficient (ICC) is calculated by dividing the between-person variance component of the null model by the sum of the between-person and within-person variance components of the null model. $N = 387$ for between-person variables and $N = 337$ for within-person variables. † $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Measures at T0

Lay Beliefs About Willpower. Lay beliefs about willpower were measured with the scale by Bernecker and Job (2015). It consists of 12 items representing the subscales strenuous mental activity (e.g., “When I have focused strongly on something, I feel full of strength and am able to immediately tackle a new challenging task”), resisting temptations (e.g., “As situations accumulate where I have to resist temptations, it becomes increasingly difficult to restrain myself”) and strenuous physical activity (e.g., “After a physically demanding activity, I feel full of energy and can immediately continue with something challenging”). All items were rated on a scale from 1 (*strongly disagree*) to 6 (*strongly agree*). The 12 items were averaged to a summary index of lay beliefs about willpower with higher scores reflecting greater agreement with a nonlimited willpower belief ($\alpha = .78$).

Anticipated Demands. Anticipated demands were measured with an adapted version of the NASA-TLX (Hart & Staveland, 1988). Participants were asked to rate the level of demands they anticipated over the next 7 days concerning six dimensions: mental demands, physical demands, temporal demands, performance, effort, and frustration. Each item

consisted of the dimension itself and a short explanation (e.g., “Mental demands – e.g. thinking, deciding, remembering, concentrating...? Will your activities in the next 7 days be easy or demanding, simple or complex, will they require high accuracy?”). The items were rated on a scale from 1 (*low*) to 5 (*high*), except for the item on performance which was rated from 1 (*good*) to 5 (*poor*). The six items were averaged to an index of anticipated demands with higher scores reflecting higher anticipated demands ($\alpha = .57$).

Pro-Environmental Behavior Intention. Participants were asked to rate the extent to which they planned to perform 21 pro-environmental behaviors over the next 7 days (the supplement includes further information on the selection of the specific behaviors). The behaviors were introduced as means to reduce one's greenhouse gas emissions. Each was feasible on a daily basis and related to energy and water conservation, nutrition and consumption, waste and recycling, or transportation (see Table S3 for details). All items were rated on a scale from 1 (*never*) to 5 (*always*). The 21 items were averaged to an index of pro-environmental behavior intention with higher scores reflecting higher pro-environmental behavior intention ($\alpha = .80$).

Social Desirability. Participants' general tendency to respond in socially desirable ways was measured through the six-item social desirability scale by Kemper et al. (2012). The scale included items capturing the exaggeration of positive qualities (e.g., “Even when I'm stressed myself, I always treat others with kindness and courtesy.”) and the understatement of negative qualities (e.g., “There have been times when I took advantage of someone”). All items were rated on a scale from 1 (*does not apply at all*) to 5 (*completely applies*). The six items were averaged to an index of social desirability with higher scores reflecting higher socially desirable response behavior ($\alpha = .62$).

Measures at Follow-Ups

Daily Demands. Daily demands were measured with an adapted version of the

NASA-TLX (Hart & Staveland, 1988). Participants were asked to think back to their activities that day including work or study tasks and private activities and rate the level of demands of their overall activities concerning six dimensions: mental demands, physical demands, temporal demands, performance, effort and frustration. Each item consisted of the dimension itself and a short explanation (e.g., “Temporal demands – How much time pressure did you feel in terms of the frequency or pace with which today’s activities occurred? Were the activities slow and leisurely or fast and hectic?”). The items were rated on a scale from 1 (*low*) to 5 (*high*), except for the item on performance which was rated from 1 (*good*) to 5 (*poor*). The six items were averaged to an index of daily demands with higher scores reflecting higher demands ($.60 \leq \alpha \leq .71$ across the three time points).

Daily Pro-Environmental Behavior. Participants were asked to rate the extent to which they had performed 21 pro-environmental behaviors on that day. The behaviors were the same that were used in the pro-environmental behavior intention scale (see Table S3; the supplement includes further information on the selection of the behaviors). All items were rated on a scale from 1 to 5 (with differing labels appropriate for each item). Where necessary, participants also had the option to indicate that they did not have the opportunity to perform that behavior (e.g., could not buy regional produce, because they did not go grocery shopping). The 21 items were averaged to an index of pro-environmental behavior with higher scores reflecting more pro-environmental behavior ($.60 \leq \alpha \leq .63$ across the three time points).

Procedure

Participants could access the first questionnaire of the study via a link that was distributed on social media³. This questionnaire included the measures of T0. At the end of

³ Primarily, the link was posted in large student Facebook groups. Additionally, a master student shared it in their personal networks. The description of the study did not include any reference to pro-environmental behavior (i.e., it was described as investigating everyday behavior generally). This was done to reduce self-

the questionnaire, participants indicated an e-mail address to be contacted for the three follow-up questionnaires. On the next Thursday, Friday, and Saturday after completing T0 (i.e., starting one to seven days after T0), participants received an e-mail invitation to participate in each of the follow-up questionnaires which included the measures of T1 to T3.

Ethics Statement

The study was approved by the Institutional Review Board of the Department of Work, Economy, and Social Psychology at the University xxx [blinded for review] (Ref: 2021/M/016) and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants.

Data Analysis

The data in this study has a multi-level structure with data from three follow-up time points nested within participants. Thus, we used random effects modelling to test our hypotheses on participants' daily pro-environmental behavior. Each model included by-person random intercepts and where appropriate random slopes. The analyses were conducted using the lme4 (v1.1.27.1; Bates et al., 2015) and lmerTest (v3.1.3; Kuznetsova et al., 2017) packages for R (R Core Team, 2021) as well as the misty package (v0.4.6; Yanagida, 2022) to calculate the R^2 by Rights and Sterba (2019). Between-person predictors (such as willpower beliefs) were centered at the grand mean. The within-person predictor (daily demands) was centered within clusters. Additionally, the cluster mean of the within-person predictor (centered at the grand mean) was entered as level 2 predictor to disentangle within and between cluster effects following general recommendations (e.g., Enders & Tofighi, 2007; González-Romá & Hernández, 2017). The outcome (daily pro-environmental behavior) was not transformed.

selection upon starting the study (however, the focus on pro-environmental behavior became clear over the course of the study).

In addition to the main hypotheses, we explored the relationship between lay beliefs about willpower, anticipated demands, and pro-environmental behavior intentions. This only includes data from T0, which does not follow a multi-level structure. Thus, we conducted a multiple linear regression analysis. All variables were z-scaled to ease the interpretation of the coefficients.

Results

Predicting Daily Pro-Environmental Behavior From Lay Beliefs About Willpower

The first multi-level model (see Table 2) shows a positive relationship between a nonlimited willpower belief and daily pro-environmental behavior. As expected, people with a nonlimited willpower belief performed more pro-environmental behavior in their daily lives, $b = 0.09$, $CI = [0.03, 0.15]$, $p = .004$.

Between-Person Interaction With Average Demands

Beyond that, a second multi-level model (see Table 2) shows a main effect of average demands. Higher average demands were related to less pro-environmental behavior, $b = -0.09$, $CI = [-0.17, -0.01]$, $p = .023$. Thus, people that faced higher demands overall across the study period engaged in less pro-environmental behavior on average compared to people that faced lower demands. This effect was independent of people's willpower belief (i.e., the interaction of average demands and willpower belief was nonsignificant). Thus, high average demands were related to lower average pro-environmental behavior for both people with a limited and nonlimited willpower belief.

Table 2. Fixed effects of lay beliefs about willpower and daily demands on daily pro-environmental behavior.

Predictor	Model 1				Model 2			
	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>CI</i>	<i>p</i>
Intercept	3.85	0.02	[3.81, 3.89]	<.001***	3.85	0.02	[3.81, 3.89]	<.001***
<i>Between-person variables</i>								
Nonlimited willpower belief	0.09	0.03	[0.03, 0.15]	.004**	0.08	0.03	[0.02, 0.14]	.009**
Daily demands (M)					-0.09	0.04	[-0.17, -0.01]	.023*
Nonlimited willpower belief × Daily demands (M)					-0.09	0.06	[-0.20, 0.03]	.124
<i>Within-person variables</i>								
Daily demands (CWC)					-0.01	0.02	[-0.06, 0.03]	.543
<i>Cross-level interaction</i>								
Nonlimited willpower belief × Daily demands (CWC)					0.08	0.03	[0.02, 0.16]	.016*
Between-person <i>R</i> ²	.03				.05			
Within-person <i>R</i> ²	-				.01			
Total <i>R</i> ²	.02				.04			

Note. Daily demands (M) refers to the cluster mean in daily demands (centered at the grand mean). Daily demands (CWC) refers to the within clusters centered daily demands. The *R*² measures quantify the proportion of between-person, within-person and total variance that is explained by the fixed effects in the model. *b* = unstandardized coefficients. *CI* = percentile bootstrapped confidence intervals. * *p* < .05, ** *p* < .01, *** *p* < .001.

Within-Person Interaction With Daily Demands

Turning away from differences in pro-environmental behavior between persons and turning to differences within persons between different days, the multi-level model shows a cross-level interaction between people's willpower beliefs and daily demands, $b = 0.08$, $CI = [0.02, 0.16]$, $p = .016$. When people with a limited willpower belief (-1SD) experienced higher demands on a day, they showed less pro-environmental behavior compared to days of low demands, $b = -0.07$, $t(113.6) = -2.22$, $CI = [-0.13, -0.01]$, $p = .028$ (see Figure 1). Among people with a nonlimited willpower belief (+1SD), this was not the case, $b = 0.04$, $t(183.4) = -1.20$, $CI = [-0.02, 0.11]$, $p = .231$. Instead, their pro-environmental behavior remained high even on demanding days. Thus, people reacted differently to fluctuations in demands across the three days depending on their willpower beliefs. While people with a nonlimited willpower belief seemed to be unaffected by changes in demands, people with a limited willpower belief reduced their pro-environmental behavior if they experienced more demands on a certain day. Thus, a nonlimited willpower belief seemed to buffer against the detrimental effect of single more demanding days on pro-environmental behavior (but not against the effect of high average demands on a person's average pro-environmental behavior).

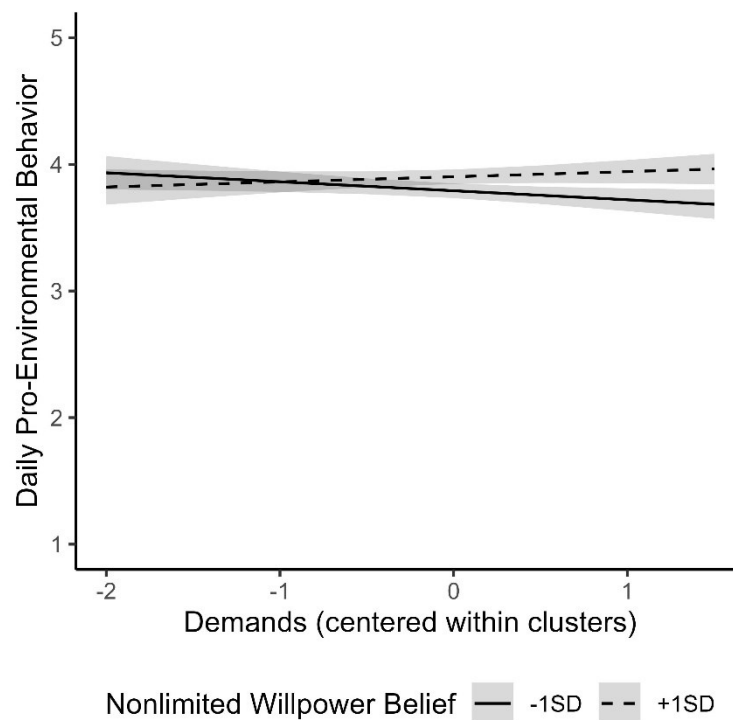


Figure 1. Graph of the cross-level interaction effect of lay beliefs about willpower and daily demands (centered within clusters) on daily pro-environmental behavior. The 95 % confidence interval is depicted.

Controlling for Pro-Environmental Behavior Intention, Social Desirability, and Weekday

As pro-environmental behavior intention and social desirability were both related to the main variables (see Table 1) and demands differed between the weekdays (see Table S4), the analyses were repeated controlling for each of the three variables. The results were similar to those presented here (see Table S5-S7). Both the cross-level interaction and the main effect of mean demands remained significant. The main effect of lay beliefs about willpower was reduced to marginal significance specifically when controlling for pro-environmental behavior intention. This indicates that the effects are largely independent from the specific weekday, social desirability, and pro-environmental behavior intention. However, the relationship between lay beliefs about willpower and pro-environmental behavior might be influenced by behavior intention.

Predicting Pro-Environmental Behavior Intention From Lay Beliefs About Willpower and

Anticipated Demand

The previous results show that lay beliefs about willpower in interaction with daily demands related to pro-environmental behavior. In a further exploratory analysis, we wondered whether people might also adjust their behavioral intentions for a specific timeframe by considering their anticipated demands and whether lay beliefs about willpower would moderate such anticipatory effects.

The results of a multiple linear regression showed that pro-environmental behavior intentions were negatively related to anticipated demands, $\beta = -0.13$, $t(384) = -2.64$, $CI = [-0.23, -0.03]$, $p = .009$, and positively to a nonlimited willpower belief, $\beta = 0.12$, $t(384) = 2.41$, $CI = [0.02, 0.22]$, $p = .016$; adjusted $R^2 = .03$ (for the model with both main effects). However, there was no interaction of the two predictors, $\beta = -0.00$, $t(383) = -0.09$, $CI = [-0.10, 0.09]$, $p = .926$. Instead, people seemed to take their anticipated demands and their lay beliefs about willpower into account separately when forming their pro-environmental behavior intention.

Discussion

The aim of this study was to investigate how lay beliefs about willpower and daily demands relate to daily pro-environmental behavior. The results revealed a relationship between lay beliefs about willpower and overall pro-environmental behavior. People with a more nonlimited willpower belief engaged in more pro-environmental behavior in their daily lives than their counterparts with a limited willpower belief. Additionally, people's willpower beliefs moderated how daily changes in demands related to pro-environmental behavior. People with a limited willpower belief reported reduced pro-environmental behavior on days of higher demands. However, people with a nonlimited willpower belief reported the same high level of pro-environmental behavior on both days of low and high demands.

Besides, we found a between-subject level effect of the average demands that a person

experienced over the study period. Those people that reported more demands overall performed less pro-environmental behavior. This shows that generally facing high demands (compared to other people) is related to less pro-environmental behavior. Temporarily high demands (i.e., single days of higher demands than usual), on the other hand, are only associated with less pro-environmental behavior if people endorse a limited willpower belief. Thus, a nonlimited willpower belief seems to buffer against the detrimental influence of temporarily higher demands, but not the detrimental effect of chronically high demands.

Previous studies identified two mechanisms through which lay beliefs about willpower shape self-control behavior, which might equally underlie its relationship to pro-environmental behavior. First, studies showed that people with a limited willpower belief react to effort exertion with a motivational shift towards a rest goal (Job, Bernecker, et al., 2015). When people with a limited willpower belief experience high demands over the day, this should repeatedly activate their goal to rest. Under these conditions, they should be inclined to make choices that are more in line with resting, i.e. choosing less effortful, but environmentally unfriendly options (e.g., driving a car instead of riding a bike). Second, studies have shown that effort exertion reduces self-efficacy concerning subsequent tasks specifically in people with a limited willpower belief (Chow et al., 2015). Thus, after a demanding day people with a limited willpower belief might feel like they are simply unable to exert effortful pro-environmental behavior (e.g., feeling too tired to take the bike).

Both mechanisms imply that lay beliefs about willpower mainly matter when a pro-environmental behavior is perceived as effortful. Under these conditions, motivation to rest and feelings of low self-efficacy should impair behavior while effortless behaviors should be less impacted. Thus, the present research is built on the assumption that pro-environmental behavior is typically effortful since it requires self-control to choose environmental behavior over often more convenient and attractive non-environmental alternatives. When considered

on their own during T0 assessment, participants deemed the individual pro-environmental behaviors as not too difficult (see supplement). This is consistent with the overall high degree of pro-environmental behavior (especially on less demanding days) indicating that people can perform these behaviors. However, our results suggest that pro-environmental behavior does become more difficult once other demands are introduced. In line with this, pro-environmental behavior suffered under high demands. If pro-environmental behaviors were truly not effortful (e.g., when being habitual), we would not assume demands or willpower beliefs to matter. Such a differential effect on effortful as compared to habitual pro-environmental behavior should be investigated in future research.

Overall, the results of this study complement research from other areas such as health or education that have shown that a nonlimited willpower belief is related to people's ability to follow their goals in face of rising demands. The present paper expands this research to the environmental domain and provides it with new insights. Much past environmental research has focused on increasing people's environmental attitudes and their willingness to engage in pro-environmental behavior. In contrast, we focused on the conditions that help people translate their environmental intentions into actual pro-environmental behavior in daily life. Namely, we found evidence for the importance of one's beliefs about willpower and one's experienced demands in predicting actual pro-environmental behavior. This is a fruitful complement to past research because successfully adopting pro-environmental behavior requires multiple steps, i.e., first forming environmental goals and behavior intentions and subsequently implementing these into sustained action.

Based on past literature, we expected lay beliefs about willpower to be mainly related to actual behavior. A nonlimited willpower belief supports self-regulation and thus helps people behave in line with their intentions in face of demands. However, our additional analyses indicate that willpower beliefs might also relate to behavioral intentions. A

nonlimited willpower belief was associated with stronger intentions to act pro-environmentally. Along the same lines, anticipated demands were also related to pro-environmental behavior intention albeit negatively. This could indicate that participants did not form their behavioral intentions purely based on how they would wish to behave. Rather, they might have considered what they would actually be able to accomplish given their expected demands and adjusted their intentions accordingly. Likewise, given that people with a limited willpower belief have a stronger goal to rest and lower self-efficacy after effort exertion, it is plausible that they adjusted their intentions accordingly as well. Thus, people that anticipated encountering higher demands and those who believed that their willpower is easily depleted reported less ambitious intentions.

Anticipated demands and lay beliefs about willpower did not interact with each other. This is in line with the results on daily pro-environmental behavior: a nonlimited willpower belief only buffered against temporarily high demands, but not against overall high demands. Anticipated demands were measured by asking participants about the overall demands they expected in the upcoming 7 days. As in the case of actual pro-environmental behavior, overall anticipated demands were related to behavioral intention similarly for both people with limited and nonlimited willpower beliefs.

Limitations

The sample of the present study consisted of people with relatively high environmental intentions. The underlying theory would suggest that these are exactly the conditions under which lay beliefs about willpower and demands should affect pro-environmental behavior. Lay beliefs about willpower are supposed to help people sustain their goal-directed behavior when they face increasing demands. Thus, they should only matter among people that aim to act pro-environmentally in the first place. Among people with no environmental intentions, lay beliefs about willpower should not relate to pro-

environmental behavior, i.e. pro-environmental behavior should be low regardless of demands or willpower belief. Thus, it is unlikely that the present results would generalize to populations with low pro-environmental intentions. Future research should examine a possible three-way interaction of environmental intentions, willpower beliefs, and demands in a sample that varies adequately in environmental intentions.

During the study, participants were informed that the behaviors investigated were means to reduce one's greenhouse gas emissions. This is important as we would assume that both demands and lay beliefs about willpower only influence behavior if people perceive the behavior to be beneficial for the environment. Otherwise, they would likely not be motivated to try to do it in the first place. Thus, our results would likely not replicate in people who are unaware of the environmental impact of a behavior. In such a case, informing people about the impact should be the first step towards possible behavioral change.

Overall, the sample included a high number of women and students. This might explain the relatively high environmental intentions in the sample which have been discussed above. However, this sample might also differ in other ways from the general population. Besides, the reported effects size are small. Thus, while the results present interesting new insights, it is important for future research to replicate the results in a more diverse sample and possibly over a longer study period. The second would also increase the variability in both demands and pro-environmental behavior which could lead to more robust effects.

Finally, the present study is correlational in nature. Thus, no inferences regarding causality can be made. Past studies have experimentally shown the causal effect of willpower beliefs on self-control tasks in the lab (Job et al., 2010). Thus, it is reasonable to assume the same direction in the case of pro-environmental behavior. Still, future studies should establish causality by investigating the effect of experimentally manipulated willpower beliefs on pro-environmental behavior.

Practical implications

As stated above, a nonlimited willpower belief seems to act as a buffer against negative effects of high demands on pro-environmental behavior. However, it should be noted that a nonlimited willpower belief only acted as a buffer regarding within-person variations in demand, i.e. *temporarily* high demands, and not chronically high demands. Thus, this research should not be interpreted as a call for teaching people a more favorable willpower belief as the sole measure of coping with soaring demands. Instead, we argue that in order to increase pro-environmental behavior it is important to promote an overall less demanding and stressful lifestyle. This is in line with some past research that found negative correlations between stress and everyday pro-environmental behavior (Kaida & Kaida, 2019). In times where culture promotes constant self-optimization and perfectionism (Curran & Hill, 2019), it might be important to complement interventions and campaigns targeting pro-environmental behavior with messages to reduce overall demands and stress. Those could aim to foster a self-compassionate mindset of focusing on one's most important values and goals instead of trying to be perfect at everything at once. A decelerated lifestyle might even have a twofold favorable effect for the environment. On the one hand, reduced demands seem to allow room for more pro-environmental behavior and on the other hand, a decelerated lifestyle can by itself involve reducing activities that happen to be environmentally unfriendly (e.g., frequently traveling to different locations by plane).

The influence of demands on engagement in pro-environmental behavior has further implications for the design of pro-environmental behavior options. Considering our results that other high demands hinder pro-environmental behavior, it might be important to reduce the demands of the pro-environmental behavior itself. There are already approaches that focus on making pro-environmental behavior fun and exciting or just as easy as possible. Examples include approaches to use gamification to make pro-environmental behavior fun

and engaging (for an overview see Douglas & Brauer, 2021). These might convert pro-environmental behavior from yet another task that needs to be done to a fun activity that people like to engage in. Other studies have investigated different nudges to create contexts that make pro-environmental behavior easier (for examples see Byerly et al., 2018). For example, providing environmental options as defaults transfers demands from the environmentally friendly to the environmentally unfriendly choices.

In addition to reducing demands where possible, fostering a more nonlimited willpower belief might help people keep up their pro-environmental behavior when they are *temporarily* faced with higher demands than usually, which can never be avoided altogether. This might be especially helpful during the formation of new habits. Habits, once formed, are strong predictors of pro-environmental behavior with the additional advantage that they require only minimal effort (Klöckner, 2013; Lanzini & Khan, 2017). However, establishing a habit requires regular repetition of the behavior, which initially has to be regulated deliberately. This requires considerable effort and self-control. A nonlimited willpower belief could help people keep the behavior up even during times of higher demands so it can eventually become habitual. Research indicates that already kindergarteners differ in their beliefs about willpower (Compagnoni et al., 2020). Thus, it might be promising to create environments that foster a nonlimited willpower belief at a young age. However, further studies should first establish the causality of the relationship between willpower beliefs and pro-environmental behavior.

Conclusions

The present study outlines how daily demands and people's beliefs about their own willpower relate to their engagement in pro-environmental behavior. People that faced lower overall demands reported more pro-environmental behavior than those that faced higher demands. People also reported less pro-environmental behavior on days that were more

demanding compared to less demanding days. This, however, was only true for people with a limited willpower belief. People with a nonlimited willpower belief showed no difference between more or less demanding days, i.e., they always reported the same high level of pro-environmental behavior. This evidence provides new insights into the self-regulation processes that underlie pro-environmental behavior. Further research should investigate the causal effects of willpower beliefs and demands. In the long term, these results could prove beneficial for the development of interventions aimed at promoting pro-environmental behavior. It may be fruitful to give special attention to demands not only associated with pro-environmental behavior itself, but people's general lifestyles. Additionally, promoting a nonlimited willpower belief may serve as a means to mitigate some of the negative effects of demands.

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Paper 4: Saving the Environment? That's Beyond My (Will)Power!

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We have no known conflict of interest to disclose.

To date, the authors did not conduct further studies on the present research question investigating the effect of lay beliefs about willpower on effort exertion (as measured by cardiovascular reactivity) for pro-environmental behavior beyond the ones reported in this manuscript.

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Abstract

Many people see climate change as a major problem that needs to be addressed. However, many still do not engage in the necessary pro-environmental behavior. One possible problem is that pro-environmental behavior may require self-control given that being non-environmental is usually less effortful or otherwise less costly. In the present research, we examine whether lay beliefs about willpower (i.e., people's beliefs about the nature of self-control) predict pro-environmental behavior. Study 1 (N = 165) tested the correlational relationship between lay beliefs about willpower and performance and effort exertion (as assessed by cardiovascular reactivity) on an environmental task. The results showed an association of a nonlimited willpower belief with better performance and more effort exertion (as measured by pre-ejection period, but not systolic blood pressure). Study 2 (N = 208) assessed the causal effect on the same outcomes by experimentally manipulating participants' willpower beliefs. Consistent with Study 1, there was a marginally significant causal effect on performance. Opposite to Study 1, there was no difference in effort exertion as measured by pre-ejection period, but a trending difference in systolic blood pressure (which was exploratorily analyzed). The results indicate that promoting a nonlimited willpower belief may be a starting point to foster pro-environmental behavior, however the experimental effects were weaker than the correlational ones. Still, the results add to the growing body of research showing that self-control processes are involved in pro-environmental behavior and may be a useful target to promote a more environmental lifestyle.

Keywords: pro-environmental behavior, lay beliefs about willpower, effort, cardiovascular measures, self-control.

Introduction

Addressing climate change is the biggest challenge of our time. Rapid and large-scale changes are necessary at every level including the system and individual levels to mitigate its negative effects on nature and humans (Lee et al., 2023). Interestingly, many people especially in the global north are aware of the threats posed by climate change. For example, EU citizens rank climate change as the single most serious problem facing the world (Special Eurobarometer 513- Climate Change, 2021) and in many countries a majority of the population sees climate change as a major threat (Poushter et al., 2022). However, climate action lags behind the widespread awareness in the population. For example, 35 % of Europeans reported to not have taken a single action to fight climate change in the past six month (Special Eurobarometer 513- Climate Change, 2021). This gap between people's positive environmental awareness, attitude, and intentions on the one side and their actual behavior on the other has been observed repeatedly (Bamberg & Möser, 2007; Carrington et al., 2014; Hornsey et al., 2016; Juvan & Dolnicar, 2014).

One barrier to more pronounced pro-environmental behavior despite people's awareness of the problem might be that environmental behavior is typically effortful. Pro-environmental behavior usually requires more cognitive or physical effort, or effort in terms of changing one's habits than non-environmental alternatives (e.g., when taking the bike, engaging in political action, or considering the environment in one's travel plans). At the same time, the positive effects of pro-environmental behavior will primarily unfold in the future (i.e., preventing future harms of climate change). Sometimes there are structural barriers that make pro-environmental behavior objectively almost impossible (e.g., when there is no public transport infrastructure). In other cases, however, it might just be that people give in to the easier, effortless non-environmental behavior option instead of an existing, but effortful environmental option as the result of a self-control failure.

Adhering to long-term goals in face of alternatives that are more attractive in the short-term is influenced by how people think about the nature of their self-control (i.e., their lay beliefs about willpower). People that believe their self-control capacity (colloquially called “willpower”) is nonlimited are better at acting in line with their long-term goals—be it regarding academic (Job, Walton, et al., 2015), health (Bernecker & Job, 2015), or environmental behavior (Jankowski & Job, 2023). So far, research showing that a nonlimited willpower belief is related to more pro-environmental behavior has only been correlational (Jankowski & Job, 2023). In order to use these insights to foster people’s pro-environmental behavior, it is important to provide support for the underlying causality of the effect. The aim of this study is to provide such support and test if inducing a nonlimited willpower belief can increase people’s engagement in and effort exertion for pro-environmental behavior.

Effort as Barrier to Pro-Environmental Behavior

Pro-environmental behavior is often perceived as effortful. Generally, pro-environmental behavior is defined as engagement in behaviors that benefit the environment and avoidance of behaviors that harm the environment (Lange & Dewitte, 2019). These behaviors can be effortful in terms of cognitive effort (e.g., informing oneself about eco-friendly products and companies), physical exertion (e.g., riding a bike instead of driving), or having to fight existing habits (Dreijerink et al., 2021). Unfortunately, especially behaviors that are rather impactful in terms of reducing emissions (Wynes & Nicholas, 2017) are perceived as more effortful (e.g., eating vegetarian or using public transport) (Dreijerink et al., 2022). Generally, people report less engagement in those pro-environmental behaviors that they perceive as more effortful (Dreijerink et al., 2022). Similarly, pro-environmental behavior is reduced when costs for pro-environmental behavior rise or when the necessary work for it increases (Lange & Dewitte, 2022; Wyss et al., 2022). Thus, higher perceived effort might be a considerable barrier to engagement in pro-environmental behavior.

Since pro-environmental behavior is often effortful, people might need self-control to engage in it. Self-control is the capacity to overwrite a dominant response tendency in a conflict between different behavioral tendencies (de Ridder et al., 2012). Typically, this has been studied regarding conflicts between a behavior option that is more valuable in the short run and one that is more valuable in the long run (Ainslie, 1975; Mischel, 1974). However, it also includes conflicts between a short-term impulse and one's moral standards or prosocial benefits. Pro-environmental behavior contains both aspects. First, pro-environmental behavior serves a goal in the farther future (i.e., reducing negative impacts of climate change) and competes with alternative behaviors that are more valuable in the short run (e.g., because they are less effortful or otherwise less costly). Second, pro-environmental behavior is often done for the sake of others (e.g., future generations or people in other, more vulnerable countries) and competes with alternatives that are more immediately rewarding for oneself. Research indicates that self-control is helpful in resolving these conflicts in favor of pro-environmental behavior. People with high self-control act more pro-environmentally and are also better able to align their behavior with their environmental intentions (Baumgartner et al., 2019; Colombo et al., 2023; Wyss et al., 2022). Thus, self-control seems to be beneficial for pro-environmental behavior.

Hence, an important question is how people can be supported in a possible self-control conflict arising in the context of pro-environmental behavior. Past research suggests that people do not only differ in their general self-control ability, but also in how they think about the nature of self-control. Importantly, studies have shown that how people think about self-control influences their engagement in effortful behaviors that require self-control (e.g., Job, Walton, et al., 2015).

Lay Beliefs about Willpower

Lay beliefs about willpower describe what people think about the nature of self-

control (Job et al., 2010). Some people hold the belief that self-control is a limited resource that depletes when it is used (a *limited willpower belief*). They assume that after having used their self-control on a strenuous task, their self-control is depleted, thus, leaving them less self-control capacity for consecutive tasks. Other people do not believe that self-control is a limited resource, but rather view their self-control capacity as nonlimited (a *nonlimited willpower belief*). They do not assume that a previous strenuous task would impair their capacity for a next task. Hence, people differ in whether they see their self-control capacity rather as something limited or abundant.

Importantly, lay beliefs about willpower refer to what people *think* how self-control works, but make no claim about whether self-control is truly limited or nonlimited. Rather, they may explain why self-control seems to be limited in some cases but not in others: because lay beliefs about willpower act like a self-fulfilling prophecy. Past research indicates that people with a limited willpower belief show reduced self-control behavior after a strenuous task while people with a nonlimited willpower belief do not show such an effect (Job et al., 2010). Thus, people's willpower beliefs have meaningful effects on their actual self-control exertion.

Lay beliefs about willpower have been shown to affect real-life behavior in different domains such as health (Bernecker & Job, 2015; Di Maio et al., 2020; Francis et al., 2021; Job et al., 2010, study 4), education (Job et al., 2010, study 4; Job, Walton, et al., 2015), or pro-environmental behavior (Jankowski & Job, 2023). People who believe that their willpower is nonlimited tend to engage in healthier behaviors. For example, they are less likely to snack excessively (Bernecker & Job, 2015; Francis et al., 2021), more physically active (Bernecker & Job, 2015; Francis et al., 2021), and more inclined to participate in self-care activities (Bernecker & Job, 2015). Additionally, these individuals exhibit behaviors conducive to learning, such as reduced procrastination and enhanced self-regulation in pursuit

of their goals (Job et al., 2010; Job, Walton, et al., 2015). A common thread among these behaviors is that, although they may require effort in the short term, they are likely to result in positive outcomes in the future. In line with this, previous research has indicated that people with a nonlimited willpower belief also do more pro-environmental behavior in their daily lives (Jankowski & Job, 2023). In a daily diary study, participants with a nonlimited willpower belief reported more engagement in pro-environmental behavior across three days. Thus, a nonlimited willpower belief seems to help people engage in effortful behavior for the sake of long-term positive consequences, e.g., for the environment.

Further research has investigated the underlying mechanism how lay beliefs about willpower relate to self-control behavior. Studies indicate that people with a limited willpower belief have a stronger goal to rest after they exerted effort on a task (Job, Bernecker, et al., 2015). Specifically, people with a limited willpower belief display a preference for rest-conducive objects and take longer breaks after exerting effort. Likely, it is this increased motivation for a break and reduced willingness to exert further effort that leads to downstream differences in self-control behavior. People with a limited willpower belief are simply less motivated to exert themselves in self-control behavior when they have already done something strenuous. This mechanism is corroborated by studies showing that behavioral differences between people with a limited vs. nonlimited willpower belief are especially pronounced under conditions of high demands (Francis et al., 2021; Jankowski & Job, 2023; Job, Walton, et al., 2015). When people with a limited willpower belief have already exerted themselves, their rest goal should be especially strong leading to less willingness to exert further effort. Thus, reduced willingness to exert effort may be one mechanism why people with a limited willpower belief engage in less self-control behavior.

Overall, past research shows that a nonlimited willpower belief is related to increased engagement in effortful behavior that serves long-term goals. Likely, this is because people

with a limited willpower belief are more motivated to rest and less willing to exert effort especially after previous strenuous tasks.

Cardiovascular Measures of Effort

Studies investigating effort exertion in the context of pro-environmental behavior typically use one of two approaches. Some studies use participants' self-reports on how much effort they are willing to exert on a specific behavior (Schultz & Oskamp, 1996) or how effortful they perceive certain pro-environmental behaviors and to what extent they engage in them (Dreijerink et al., 2022). A downside to self-reports is that they are subjective. Past research indicates a considerable gap between people's self-reported and actual pro-environmental behavior (Kormos & Gifford, 2014; Nielsen et al., 2022). Possible reasons include limited memory, reporting biases, or ambiguity in the items themselves (e.g., what is considered "very effortful") (Lange et al., 2023). Additionally, self-reports are difficult to implement in experimental research because participants need time to implement a behavior change after an experimental manipulation (Lange et al., 2018; Lange & Dewitte, 2019). In that case, researchers often resort to measuring intentions instead (Lange & Dewitte, 2019), which is an important predictor to behavior, but different from it (Bamberg & Möser, 2007). Thus, while self-reports provide valuable insights into some aspects of behavior (especially people's explicit account of their behavior and intention), they cannot cover all facets of it.

Other studies use tasks that are connected to environmental benefits (typically through a donation to an environmental NGO) to assess pro-environmental effort exertion. Those studies either measure task performance as an indicator of effort (assuming that more effort directly translates to better performance) (Krebs et al., 2023) or systematically vary the effort needed for the task (by manipulating its difficulty) and measure people's choices depending on task difficulty (Lange & Dewitte, 2022). These approaches overcome some of the disadvantages of self-reports because task engagement is a form of actual behavior (with

actual costs) and thus less subjective and beyond that easily implemented into experimental designs. However, using task performance to measure pro-environmental effort relies on the assumption that task performance is only influenced by effort. Depending on the task, performance might, however, also be influenced by external factors such as ability.

In the present study, we aim to complement the approach of using an environmental task with a more direct measure of effort exertion. A stream of research on motivational intensity theory routinely uses cardiovascular measures as indicators of effort exertion (R. A. Wright, 1996). This approach is based on the association between β -adrenergic stimulation of the heart and vasculature and effort responses to performance challenges (Obrist, 1976, 1981). Specifically, certain cardiovascular responses (e.g., pre-ejection period of the heart or systolic blood pressure) should vary with effort in response to a performance challenge. Previous studies show that these cardiovascular measures are good indicators of effort exertion on both cognitive (Mlynski, Wright, et al., 2020; Richter & Gendolla, 2009) and physical tasks (R. A. Wright et al., 2012). They reliably show increases under conditions where higher effort exertion is expected, e.g., when incentives are higher (Richter & Gendolla, 2009; R. A. Wright et al., 2002) or when being socially evaluated (R. A. Wright et al., 2002). Thus, cardiovascular measures of effort are a valuable addition to measure not only performance on an environmental task, but also effort exerted on it.

Present Study

Past correlational evidence shows that a nonlimited willpower belief is related to higher self-reports of pro-environmental behavior. The present research expands this evidence in two ways. First, we aim to show that a nonlimited willpower belief also relates to increased performance and effort exertion (as assessed by cardiovascular indicators) on an environmental task. Second, we aim to provide evidence for a causal effect of manipulated lay beliefs about willpower on effort exertion and performance on an environmental task.

Study 1: Correlational Study

The aim of the first study was to establish whether lay beliefs about willpower relate to effort exertion on and performance in a task that benefits environmental protection. To achieve this, we measured participants' lay beliefs about willpower and their engagement in an environmental effort task.

Method

Participants

Participants were recruited through the participant pool of the university xxx [blinded for review]. Originally, $N = 166$ participants completed the study¹. One participant was removed, because they were interrupted during the main task because of a technical problem leading to a final sample size of $N = 165$. Most participants were women (77%) and students (78%; 38% psychology students). On average, participants were 26 years old ($SD = 7.5$). Participants either participated for course credit (15%) or were compensated with 10€ (85%).

Procedure

Before coming to the lab for the main part of the study, participants completed a preliminary online questionnaire including the assessment of their lay beliefs about willpower and demographics. The online questionnaire was completed between 1 and 38 days ($Mdn = 6$ days) before the lab appointment. Participants were only invited to the main part of the study if they did not report any conditions that might impact the cardiovascular measurements (e.g., hypertension) in the preliminary questionnaire. In the lab, participants were set up for the cardiovascular measurements (i.e., a blood pressure cuff and electrodes were attached to them). The experimenter ran a baseline measurement of the cardiovascular indicators while

¹ The data was collected as part of a project on a different research question. The sample size was based on a power analysis for that project for an effect size of $d = 0.4$. This required a sample size of $N = 156$, but $N = 170$ was aimed for to account for possible exclusions.

the participants listened to relaxing music. The baseline phase lasted 10 minutes and cardiovascular indicators were measured during the last two minutes of the phase. Then, a text-based manipulation was administered². After that, participants completed the environmental effort task. Once completed, the equipment for the cardiovascular measurement was removed and participants were thanked and debriefed.

Ethics Statement and Materials

The study was approved by the Institutional Review Board of the Department of Occupational, Economic, and Social Psychology at the University xxx [*blinded for review*] (Ref: 2022/M/006, title: “Effort for Environment”) and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants. The full study material, data and data analysis scripts are available online under https://osf.io/r9j3f/?view_only=102c7b993be540f98e56c3b74c58430d.

Lay beliefs about willpower. Lay beliefs about willpower were measured with 12 items by Bernecker and Job (2015). The scale covers willpower beliefs regarding three types of tasks: mental activity, resisting temptations, and strenuous physical activity (e.g., “When I have focused strongly on something, I feel full of strength and am able to immediately tackle a new challenging task”, 1 = *strongly disagree* to 6 = *strongly agree*). The items were averaged such that higher scores reflect greater agreement with a nonlimited willpower belief ($\alpha = 0.80$).

Performance in the environmental effort task. Participants completed a clicking task (adapted from Mlynski, Reza, et al., 2020; Schuler et al., 2017) with the prospect that a 3€ donation to an environmental NGO (“atmosfair”) would be made if they exceeded a

² The manipulation was part of a different research question and targeted participants’ beliefs about whether the world is changeable or fixed. Although the manipulation was not relevant to the current study, we re-ran our analyses including the experimental group as a covariate which had no impact on the results. Full details are in the supplement.

certain, undisclosed performance level (see supplement for further details on the donation). During the task, they heard 24 rounds of sounds that each lasted 5 seconds and were interrupted by 10 seconds of silence. Participants were told to click the mouse button as often as possible while each sound lasted. The average number of clicks that the participants achieved across all sounds was considered their task performance. Overall, 49 participants reached the performance level and 147€ were donated after the study was completed.

Cardiovascular indicators of effort exertion on the environmental effort task.

During the task, participants' effort exertion was assessed through cardiovascular measures. The main indicators were pre-ejection period of the heart (PEP) and systolic blood pressure (SBP). PEP and SBP were both assessed during the baseline phase and during the environmental effort task. We noninvasively measured impedance cardiogram and electrocardiogram signals with a Cardioscreen 1000 system (Medis) to assess PEP. B-point location was estimated based on the interval between the R peak of the electrocardiogram and the Z peak of the impedance cardiography dZ/dt waveform of valid heartbeat cycles (Lozano et al., 2007). PEP (in milliseconds) was automatically determined as the interval between R onset and B point (Berntson et al., 2017). Additionally, PEP determinations were recorded in a spreadsheet at intervals of 15 seconds for the duration of the baseline period and environmental effort task. Due to an error, the start and end times of the environmental effort task were not correctly recorded. Thus, the interval recorded PEP values were utilized for analysis. SBP was oscillometrically recorded at intervals of 30 seconds with a Dinamap Carescape V100 monitor (GE Healthcare). For each indicator, the change from baseline to task was calculated by subtracting the mean values during baseline from the mean values during the task. For pre-ejection period, lower values (i.e., negative change) indicate more effort; for systolic blood pressure, higher values indicate more effort.

Data Analysis

To remove any measurement artefacts in the interval recorded SBP and PEP data, single data points were excluded if they were more than 15 points away from both the previous and following data point (e.g., a PEP of 149 would be excluded in the following data array: 112, 149, 121). The first or last data point of a measurement was excluded if it was more than 20 points away from the adjacent data point. Overall, 22 data points from 18 participants were excluded this way (out of a total of 7112 data points). Additionally, change scores in the cardiovascular data that were further than three standard deviations away from the mean of the respective experimental group were removed (this concerned the PEP change score of one participant).

To assess the relationship between lay beliefs about willpower and task engagement, simple regression analyses with lay beliefs about willpower as predictor and the three individual outcomes (task performance, PEP change, and SBP change) were conducted.

Results and Brief Discussion

Descriptive statistics on the measures can be found in Table 1.

Table 1

Descriptive Statistics of Study 1

Variable	<i>M</i>	<i>SD</i>	α	1	2	3	4	5
1. Nonlimited willpower belief	3.39	0.62	0.80					
2. Task performance	33.17	4.58	-	.22**				
3. PEP change	-5.83	7.72	-	-.20*	-.25**			
4. SBP change	5.80	6.68	-	.11	.25**	-.49**		
5. PEP (baseline)	127.81	16.04	-	.01	-.01	-.27**	.10	
6. SBP (baseline)	107.38	10.61	-	.06	.14	-.06	-.02	-.22**

Note. For PEP, negative change indicates more effort exertion. For SBP, positive change indicates more effort exertion. * $p < .05$, ** $p < .01$.

We found a positive association of a nonlimited willpower belief with performance in

the environmental task, $\beta = 0.22$, $p = .005$. Similarly, a nonlimited willpower belief was related to a larger negative change in PEP from the baseline to the environmental task (indicating more effort on the task), $\beta = -0.20$, $p = .013$. There was no significant relationship between willpower beliefs and SBP change, $\beta = 0.11$, $p = .158$.

These results are generally in line with past studies showing an association between lay beliefs about willpower and pro-environmental behavior. They extend past results by showing that a nonlimited willpower belief is not only related to more self-reported pro-environmental behavior, but also better performance and more effort exertion (as measured by pre-ejection period) on an environmental task. However, the results of the cardiovascular measures were mixed, i.e. there was a correlation with pre-ejection period, but not systolic blood pressure. Pre-ejection period is often considered the more accurate indicator (Brownley et al., 2000; Kelsey, 2012), but systolic blood pressure is also vastly used (for a review, see Richter et al., 2016). In general, both are valid indicators of sympathetic activity, but neither is a perfect representation of it and each of them is subject to unique kinds of error variance (e.g., due to participants moving or concurrent parasympathetic activity). Such error variance may be the reason that we find diverging results on the measures. As a next step, we aimed to test if there is a causal effect of lay beliefs about willpower on pro-environmental effort and performance.

Study 2: Experimental Study

Study 1 showed that a nonlimited willpower belief is related to more effort exertion (as measured by pre-ejection period) and better performance on an environmental task. Next, we aimed to investigate the causality of this effect. To achieve this, we manipulated participants' lay beliefs about willpower and assessed their engagement in the same environmental effort task. The study was pre-registered (see https://aspredicted.org/MHD_JHP).

Method

Participants

A power analysis based on the effect sizes on PEP and performance ($d = 0.35$) from the correlational study revealed a necessary sample size of $N = 204$. As in Study 1, participants were recruited through the participant pool of the University xxx [blinded for review]. Originally, $N = 209$ complete responses were collected. However, one participant accidentally participated twice, so the second participation of that person had to be removed. Thus, the final sample size was $N = 208$. Similar to the Study 1, most participants were women (73%) and students (79%). On average, participants were 26 years old ($SD = 8.2$). Participants either participated for course credit (20%) or were compensated with 8€ per hour³ (80%). Participants were distributed equally across both experimental groups ($n = 105$ in the limited willpower belief group and $n = 103$ in the nonlimited willpower belief group).

Procedure

The procedure was similar to the one from Study 1. Before coming to the lab for the main part of the study, participants completed a preliminary online questionnaire including their baseline lay beliefs about willpower, environmental attitude, and demographics. The online questionnaire was completed between 1 and 68 days ($Mdn = 7$ days) before the lab appointment. During the lab appointment, participants were first set up for the cardiovascular measurements (i.e., a blood pressure cuff and electrodes were attached to them) and the experimenter ran a baseline measurement of the cardiovascular indicators while the participants listened to relaxing music. The baseline phase again lasted 10 minutes and cardiovascular indicators were measured during the last two minutes of the phase. Next,

³ Most participants (72%) completed other tasks for a different project after the main tasks for this study. These participants got an additional incentive for those tasks. Participants only got to know about the additional incentive after completing the materials for the present study.

participants were randomly assigned to one of the experimental groups and received the respective manipulation of their willpower beliefs. After that, participants reported their fatigue and completed the environmental effort task. After this main task, the majority (72%) of the participants completed other tasks (e.g., a Stroop task) for a different project unrelated to the present work. For the remaining participants, the experiment ended after the environmental effort task. Once all tasks were completed, the equipment for the cardiovascular measurement was removed and participants were thanked and debriefed.

Ethics Statement and Materials

The study was approved by the Institutional Review Board of the Department of Occupational, Economic, and Social Psychology at the University xxx *[blinded for review]* (Ref: 2022/M/014, title: “Fatigue and incentives effect on self-control”) and adhered to the requirements of the Declaration of Helsinki. Informed consent was obtained from all participants. The full study material, data, analysis scripts and results on secondary moderation analyses (including initial willpower beliefs, environmental attitude, and fatigue) are available online under https://osf.io/r9j3f/?view_only=102c7b993be540f98e56c3b74c58430d.

Manipulation: Lay beliefs about willpower. The manipulation of participants’ lay beliefs about willpower consisted of three parts. First, participants read a text elaborating ostensible research results that show that willpower depletes over time (limited willpower belief group) or is activated over time (nonlimited willpower belief group). Next, participants answered questions on the main statements of the text to increase processing of the main message: they summarized the main statement in free text form and answered five single choice questions. Finally, they completed a biased questionnaire. The items of this questionnaire were phrased in a way to elicit agreement with the respective willpower belief (e.g., “Sometimes it can be very tiring to think about something with concentration.”,

1 = *strongly disagree* to 6 = *strongly agree*). The biased questionnaire was also used as a manipulation check by assessing whether participants on average agreed with the statements as expected ($\alpha = 0.86$ for limited willpower belief, $\alpha = 0.83$ for nonlimited willpower belief).

Performance in the environmental effort task. As in Study 1, participants completed a clicking task (adapted from Mlynski, Reza, et al., 2020; Schuler et al., 2017) with the prospect that a 3€ donation to an environmental NGO (“World Wide Fund For Nature”) would be made if they exceeded a certain, undisclosed performance level (see supplement for further details on the donation). They heard 12 five-second sounds that were each separated by 10 seconds of silence. Participants were told to click the mouse button as often as possible during each sound. Their average number of clicks across all rounds was considered their task performance. Overall, 22 participants reached the performance level and 66€ were donated after the study was completed.

Cardiovascular indicators of effort exertion on the environmental effort task. Similar to Study 1, pre-ejection period of the heart (PEP) and systolic blood pressure (SBP) were measured as indicators of effort exertion. The equipment to measure PEP and SBP as well as the determination of the PEP were the same as in Study 1. PEP was automatically recorded during the baseline phase and the environmental effort task. SBP was recorded at intervals of 60 seconds during each of the phases. For each indicator, the change from the baseline phase to the task was calculated by subtracting the mean values during baseline from the mean values during the task. For pre-ejection period, lower values (i.e., negative change) indicate more effort; for systolic blood pressure, higher values indicate more effort.

Task success importance. We asked participants how important it was for them to do well on the environmental effort task before and after the task (“How important is [*was*] it to you to be successful in the clicking task?”, 0 = *not at all* to 10 = *very much*). Because both items correlated highly ($r = .89$) they were aggregated. This served to check whether

participants with a high environmental attitude saw the task as more important indicating that the task was perceived as environmental.

Lay beliefs about willpower. In the preliminary online questionnaire, participants' baseline lay beliefs about willpower were assessed through the 12-item scale by Job et al. (2010). This scale assesses beliefs about two types of tasks: mental activity and resisting temptation (e.g., "After a strenuous mental activity, my energy is exhausted and I need to recover in order to recharge it", 1 = *strongly disagree* to 6 = *strongly agree*). The items were averaged such that higher scores reflect greater agreement with a nonlimited willpower belief ($\alpha = 0.80$).

Environmental attitude. Participants' environmental attitude was assessed with the German version of the new ecological paradigm (Dunlap et al., 2000; German translation by Schleyer-Lindenmann et al., 2018). It included 15 items (e.g., "The balance of nature is very delicate and easily upset", 1 = *strongly disagree* to 5 = *strongly agree*, $\alpha = 0.76$).

Data Analysis

Again, interval recorded SBP data was checked to remove any measurement artefacts. One data point in SBP was removed because it was more than 80 points away from the other values in the same measurement block. As preregistered, we removed change scores in the cardiovascular measures if they were more than three standard deviations away from the mean of the respective experimental group (this concerned one PEP change score and three SBP change scores).

To check if the manipulation was successful, we conducted one-sample *t*-tests separately for each experimental group to assess whether the average agreement to the items of the biased questionnaire was above the midpoint of the response scale (indicating overall agreement). Group differences on baseline characteristics or demographics were checked with two-sided *t*-tests (for metric data) and Pearson's χ^2 test or Fisher's exact test (for

categorical data).

The main analysis was conducted in line with our preregistration (https://aspredicted.org/MHD_JHP). We conducted one-tailed *t*-tests comparing the experimental groups regarding their PEP change and their performance on the environmental effort task. An additional, non-preregistered two-tailed *t*-test was conducted on SBP change.

Results and Brief Discussion

Descriptive statistics on the measures can be found in Table 2.

Table 2

Descriptive Statistics of Study 2

Variable	<i>M</i>	<i>SD</i>	α	1	2	3	4	5	6	7
1. Task performance	33.34	4.70	-							
2. PEP change	-8.40	9.44	-	-.19**						
3. SBP change	7.87	7.80	-	.26**	-.57**					
4. PEP (baseline)	126.88	15.11	-	-.16*	-.04	-.02				
5. SBP (baseline)	108.41	9.65	-	.12	-.25**	-.07	-.34**			
6. Success importance	7.62	2.13	-	.17*	-.12	.15*	.03	-.26**		
7. Nonlimited willpower belief ¹	3.27	0.66	.80	-.07	.04	-.04	.10	.04	-.17*	
8. Environmental attitude ¹	3.87	0.46	.76	-.01	-.06	.08	.09	-.19**	.25**	-.04

Note. For PEP, negative change indicates more effort exertion. For SBP, positive change indicates more effort exertion. ¹ Assessed during the preliminary online questionnaire before the main lab part of the study. * $p < .05$, ** $p < .01$.

Manipulation Checks

The manipulation was successful as both experimental groups showed agreement above the scale mid-point to their respective biased items ($M_{nonlim} = 5.0$, $SD_{nonlim} = 0.62$, $t(102) = 25.04$, $p < .001$; $M_{lim} = 5.3$, $SD_{lim} = 0.62$, $t(104) = 29.27$, $p < .001$). The two experimental group did not differ in age, gender, student status, baseline willpower beliefs,

environmental attitude, or task success importance ($p > .265$).

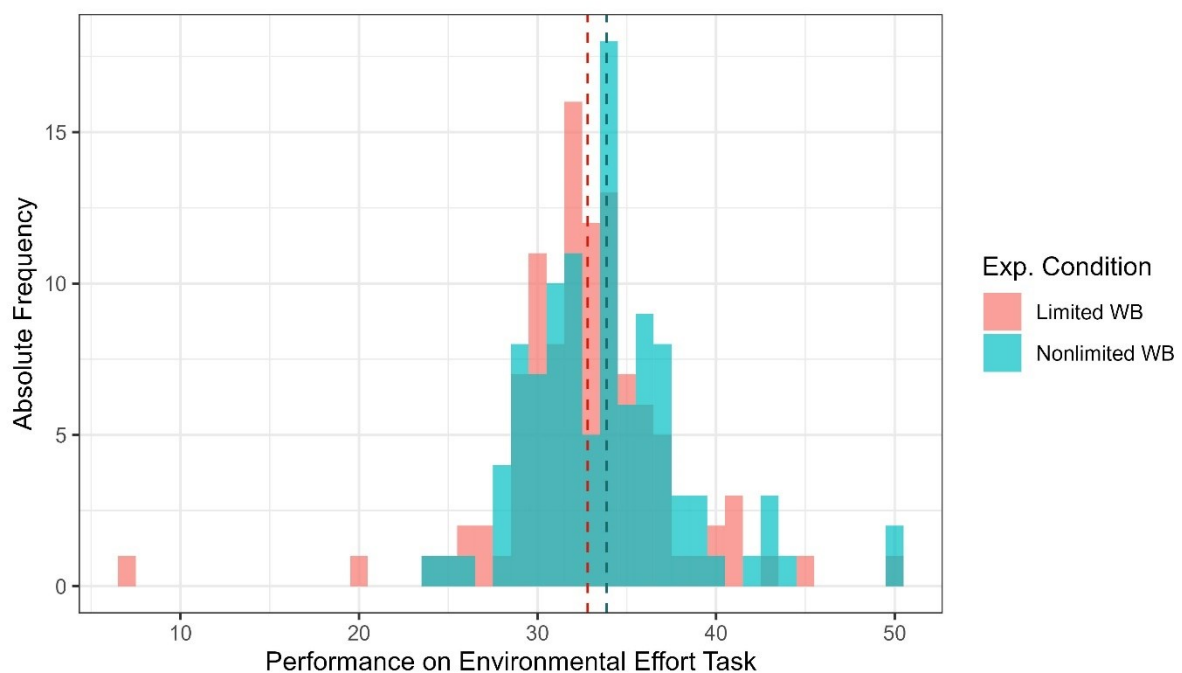
As expected environmental attitude related significantly to higher success importance regarding the task ($r = .25$, $t(205) = 3.64$, $p < .001$) indicating that the task was perceived as serving the environment.

Pre-Registered Analyses

We found a marginally significant difference on the planned one-tailed t -test between the experimental groups' task performance in the expected direction. The nonlimited willpower belief group performed better ($M = 33.9$, $SD = 4.40$) than the limited willpower belief group ($M = 32.8$, $SD = 4.94$), $t(202.75) = -1.63$, $p = .052$, $d = .23$ (see Figure 1). Contrary to our hypothesis, we did not find a difference in PEP change ($M_{nonlim} = -8.9$, $SD_{nonlim} = 9.63$; $M_{lim} = -7.9$, $SD_{lim} = 9.27$), $t(201.93) = 0.79$, $p = .215$, $d = -0.11$ (one-tailed t -test).

Figure 1

Distribution of Performance on the Environmental Effort Task Depending on Experimental Group



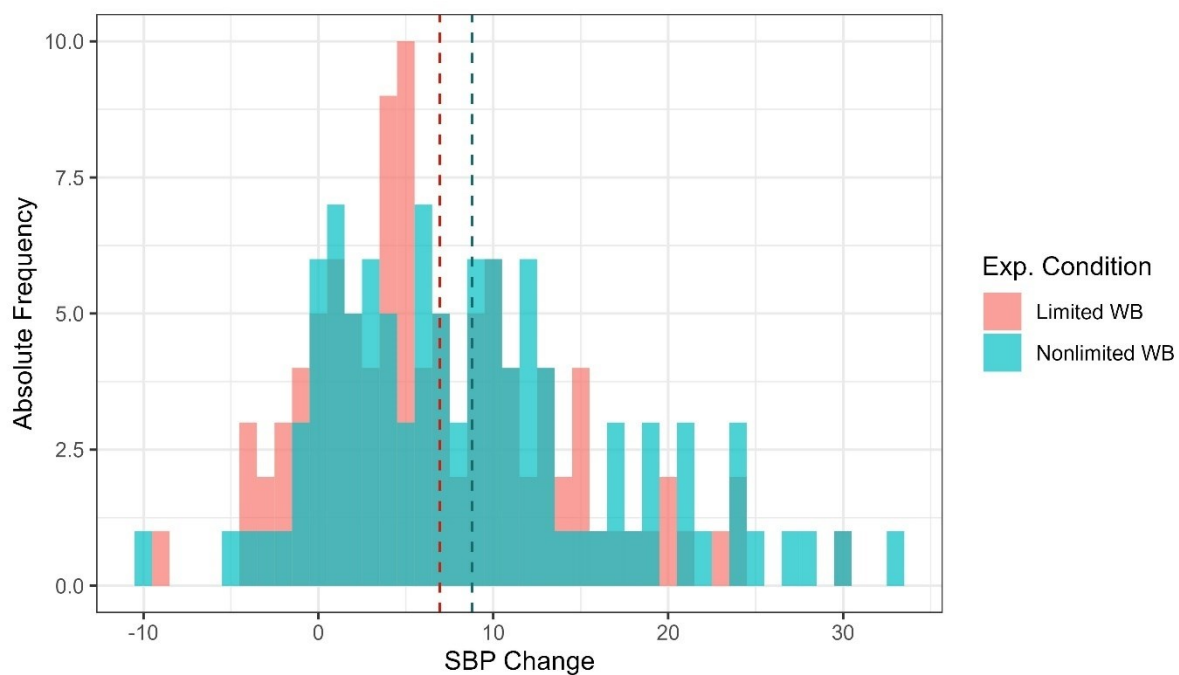
Note. WB = Willpower Belief.

Exploratory Analyses

In addition to our preregistered analyses, we tested for group differences in SBP change as this is also a commonly used measure of effort exertion. On this indicator, we found a trending difference in line with our hypotheses regarding effort exertion. The nonlimited belief group had a slightly higher increase in SBP from baseline to the environmental effort task ($M = 8.8$, $SD = 8.28$) than the limited willpower belief group ($M = 6.9$, $SD = 7.19$), $t(199.09) = -1.71$, $p = .089$, $d = 0.24$ (two-tailed t -test; see Figure 2).

Figure 2

Distribution of Change in Systolic Blood Pressure From Baseline to Task Depending on Experimental Group



Note. SBP Change = Difference between systolic blood pressure at baseline and during the environmental effort task (higher values indicate more effort exertion during the task), WB = Willpower Belief.

This experimental study complements Study 1 by investigating the causal effect of manipulated lay beliefs about willpower on performance and effort on an environmental task. In line with Study 1, there was a marginally significant effect on performance on an

environmental task. However, the results regarding effort exertion were inconsistent. There was no effect on pre-ejection period and the exploratorily tested effect on systolic blood pressure was only trending.

General Discussion

The present study aimed to investigate the effects of lay beliefs about willpower on people's performance and effort exertion on an environmental task. The first (correlational) study established an association between a nonlimited willpower belief and better performance and higher effort exertion in terms of pre-ejection period (but not systolic blood pressure) on an environmental task. The second (experimental) study complemented these results by investigating the causal relationship. The results of this study were mixed. There was a marginally significant difference in performance on the environmental task between the two experimental groups: performance was slightly higher in the nonlimited willpower belief group. However, we did not find the hypothesized difference in effort in terms of pre-ejection period. An additional exploratory analysis on systolic blood pressure showed a trending difference between the experimental groups: the nonlimited willpower belief group tended to exert more effort on the task. Thus, while we find correlational associations between a nonlimited willpower belief and better performance and more effort exertion (in terms of pre-ejection period) on an environmental task in Study 1, the results of Study 2 regarding the causal effects are mixed.

Theoretical Implication

The present research responds to increasing calls to view pro-environmental behavior not only as a question of environmental concern, but also a question of self-regulation. Researchers have noted that many people want to act pro-environmentally but struggle to put those intentions into action. The present study adds evidence to the notion that pro-environmental behavior (partially) depends on self-control because it shows that mechanisms

that we know support self-control may also be involved in pro-environmental behavior. Past research on willpower beliefs shows that people with a nonlimited willpower belief engage more in effortful, self-control behaviors e.g., related to health (Bernecker & Job, 2015) or education (Job, Walton, et al., 2015). The present study expands these results by showing that the mechanism may similarly apply to the environmental domain, e.g., regarding performance on an environmental task. This complements past research indicating that a nonlimited willpower belief is related to increased self-reported pro-environmental behavior (Jankowski & Job, 2023). The present study also provides some tentative evidence that this relationship may be causal, i.e. a nonlimited willpower belief may increase people's engagement in pro-environmental behavior. However, it is important to bear in mind that the experimental effects in Study 2 were considerably smaller than the correlational ones in Study 1 and while rather consistent with the correlational effects in case of performance, they were mixed for effort exertion. This still adds to our understanding of the mechanism underlying the relationship between the lay beliefs about willpower and pro-environmental behavior. However, further research is needed.

Past studies suggest that people with a limited willpower belief may engage in less self-control behavior because they are more focused on getting rest and less willing to exert effort after previous demands (Job, Bernecker, et al., 2015). The present study adds some support to this notion because a limited willpower belief was related to decreased effort exertion on the task as measured by cardiovascular engagement. It is important to bear in mind that the results regarding cardiovascular engagement were inconsistent between the two studies. Thus, while the results add some support to the assumption that people with a limited willpower belief are less willing to exert effort, further studies are needed to assess the robustness of this effect.

It is a common notion in environmental research that pro-environmental behavior is

effortful and this presents a barrier to action. Past research examined this by asking participants how effortful they perceive certain pro-environmental behaviors or by experimentally varying effort by manipulating the difficulty of the behavior. The present research complements these approaches with a direct measure of indicators of effort exertion. It uses established cardiovascular methods from a longstanding research tradition regarding motivational intensity theory. This approach adds to previous methods because it focuses not only on the visible outcome (i.e., people's performance of pro-environmental behavior), but also how much people are exerting themselves to achieve these outcomes.

Past research has indicated that pro-environmental behavior requires different types of effort, e.g. mental effort, physical exertion or effort of fighting habitual responses (Dreijerink et al., 2021). Similarly, lay beliefs about willpower have been investigated with regard to different domains of self-control activities such as mental activities, physical activities and resisting temptations (see e.g., Francis & Job, 2018). Research has shown that the subdomains of willpower beliefs are especially predictive for behaviors in the same domain (e.g., beliefs about physical activities were more predictive of physical exercise; Bernecker & Job, 2015). The present manipulation focused on beliefs about willpower in mental activities. This is a good starting point as pro-environmental behavior is often considered as mentally effortful, e.g., due to the need to get informed about environmental alternatives (Dreijerink et al., 2021). Future research might extend these results by looking at the differential effects of other domains of willpower beliefs which might be important for specific pro-environmental behaviors. For example, behavior that requires mostly physical exertion (e.g., taking the bike instead of the car) might rather be influenced by people's lay beliefs about willpower regarding physical activities. This might provide interesting insights about differences between various pro-environmental behaviors as pro-environmental behavior covers a range of considerably different behaviors.

Limitations and Future Research

The effects in the experimental study were smaller than we had previously expected. A possible explanation for this is that the study design did not include an initial fatiguing task. Instead, participants were only fatigued due to naturally occurring demands and working through the materials of the willpower belief manipulation. Past research shows that the influence of lay beliefs about willpower increases with increasing demands (Francis et al., 2021; Jankowski & Job, 2023; Job, Walton, et al., 2015). Thus, the effects that we found might be on the lower end representing conditions of mild fatigue. Future research might profit from including an effortful initial task to investigate the possible effect of lay beliefs about willpower under highly demanding conditions. Past research would suggest that the effect would be stronger here.

A general limitation concerns the ecological validity of the environmental task because it differs from typical pro-environmental behaviors that people encounter in their daily lives. While this is true, it needs to be considered that “natural” pro-environmental behaviors are themselves heterogeneous. For example, taking the bike to work, buying from eco-friendly brands, and joining an environmental protest have little in common regarding the activities themselves. Their common denominator is that they benefit the environment—in fact pro-environmental behavior is solely defined through its benefit (or avoidance of harm) to the environment (e.g., Lange & Dewitte, 2019). The environmental task fits this definition because good task performance is connected to an environmentally beneficial donation. The diversity in pro-environmental behaviors per se poses a challenge for research because it raises the question whether results on one type of behavior can be transferred to another. This is also true for the present results. In lab research in particular, it is a challenge to operationalize pro-environmental behavior adequately. Some researchers have incorporated opportunities for “natural” pro-environmental behavior in lab settings (e.g., by observing if

participants turn off the lights (Murtagh et al., 2015) or dispose of materials in the appropriate recycling bin (Huffman et al., 2014)). While these behaviors have high face validity, they are rather effortless, limiting the transferability to pro-environmental behaviors that require effort. The present environmental task tries to satisfy the general criteria of benefitting the environment while also requiring effort which was crucial to our research question.

A look at participants' environmental attitudes shows that most of them cared about the environment. These are exactly the conditions where one would expect lay beliefs about willpower to matter. When people want to act pro-environmentally, they need to figure out a way to translate their intention into action—this is where a nonlimited willpower belief typically provides support. However, when people have no intentions of acting pro-environmentally, pro-environmental behavior is not a question of self-control and lay beliefs about willpower should not matter. Thus, we would not expect our results to replicate in a sample of people with low concern for the environment. Future research might investigate the interaction between environmental concern and lay beliefs about willpower in a sample that varies more in environmental concern.

Practical Implications

The present study indicates that a nonlimited willpower belief may have a causal effect on better performance on an environmental task. This provides an interesting starting point to foster pro-environmental behavior. Thus far, no interventions to promote a nonlimited willpower belief in people have been published, but this might be an important next step. Past studies show that differences in beliefs about willpower are already present in young children (Compagnoni et al., 2020). Thus, kindergartens and schools might provide a promising context to foster a nonlimited willpower belief at an early age. Given that a nonlimited willpower belief is related to several positive outcomes (e.g., beneficial health or academic behavior) this might provide a range of benefits. Overall, this research shows that

promoting pro-environmental behavior is not only a question of fostering environmental attitudes and concern. Self-regulatory processes need to be taken into account. Thus, practitioners should additionally consider how people can be supported in putting their environmental intentions into action.

Conclusion

In sum, the present research investigated the effect of perceiving one's self-control as nonlimited (rather than a limited resource) on effort exertion for the environment and performance on an environmental task. Study 1 showed an association of a nonlimited willpower belief with better performance and more effort exertion (as measured by pre-ejection period, but not systolic blood pressure). In line with that, Study 2 showed a causal effect on performance, albeit only marginally significant. Regarding effort exertion, the results were mixed as there was no effect on effort exertion as measured by pre-ejection period, and only a trending difference in systolic blood pressure (which was exploratorily analyzed). These results do not provide conclusive evidence about the effect of lay beliefs about willpower on effort exertion for environmental causes. Still, they complement past research showing that not only attitudes, but also self-regulatory mechanisms are involved in pro-environmental behavior. The study also tested a new approach to measure effort exertion for an environmental cause in form of cardiovascular measures of effort. The present study provides an interesting starting point for future research. Future research might investigate the conditions that moderate the effect of a nonlimited willpower belief on pro-environmental behavior, e.g., the presence of previous demands or a match between the domain of the willpower belief and type of pro-environmental behavior.

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General Discussion

This dissertation examined how people's lay beliefs impact their perception of and reaction to global social problems, specifically climate change and Covid-19. Across four papers including 12 individual studies, I find evidence that people's lay beliefs play a role during the formation of environmental or Covid-19 related intentions and the implementation of such intentions. Specifically, lay beliefs about the world were related to variables connected to the motivation to act, and lay beliefs about willpower were related to the implementation of behavior. Interestingly, the results differed between the climate change and Covid-19 contexts, indicating that the specific characteristics of the social problem influence the role lay beliefs play.

The first paper investigated the effect of lay beliefs about the world on climate change related perceptions and intentions. Across three studies, inducing an incremental belief about the world increased people's response efficacy regarding environmental protection. People in the incremental belief group felt more like their personal and collective behavior contributes to climate change mitigation. There was also some indication that an incremental belief increased people's intention to act on climate change—possibly due to their higher response efficacy. Interestingly, there was no effect on climate change belief in contrast to the results from previous correlational studies.

The second paper aimed to transfer these results to the Covid-19 context. There were consistent correlations between an incremental belief about the world and higher threat belief, response efficacy, and intention to engage in protective behavior regarding both Covid-19 and a hypothetical pandemic scenario. However, inducing an incremental belief about the world did not increase any of the variables. An additional study tested a possible reversed causal effect of people shifting their lay beliefs to justify their behavior within the hypothetical scenario. However, there was no support for this effect either. Thus, while an

incremental belief is associated with favorable Covid-19 related beliefs and intentions, the underlying causal relationship requires further research.

The third and fourth papers showed that lay beliefs about willpower relate to people's engagement in pro-environmental behavior. This effect emerged for different study settings and measures, namely daily pro-environmental behavior reported in a daily diary study and engagement in an environmental task in a controlled laboratory setting. The daily diary study further showed that people with a nonlimited willpower belief especially reported more pro-environmental behavior than their limited willpower belief counterparts on days of high demand.

The fourth paper tested the causal effect of lay beliefs about willpower on engagement in pro-environmental behavior. The respective results were mixed: the causal effects were smaller than the correlational associations and did not emerge consistently across different indicators of task engagement. Thus, it is not possible to draw a final conclusion in that regard.

Theoretical Implications

Lay Beliefs About the World

The present dissertation adds to existing research on lay beliefs about the world in two ways. First, it adds evidence about the underlying causality of the relationship between lay beliefs about the world and climate change related beliefs and intentions which had previously only been established on the correlational level (Duchi et al., 2020; Soliman & Wilson, 2017). The present findings show that lay beliefs about the world causally influence people's environmental response efficacy and their intentions to act. This is in line with the assumption that lay beliefs about the world shape how people process and interpret information on climate change and consequently their views about it. This complements past research showing that inducing an incremental belief increases people's hope that long-

standing intergroup conflicts will be solved (Cohen-Chen et al., 2015). It seems that an incremental belief about the world makes people think more positively about the solvability of global problems in different domains.

Interestingly, inducing an incremental belief about the world did not increase participants' climate change beliefs despite previous studies showing correlational associations (Duchi et al., 2020; Soliman & Wilson, 2017). A possible reason is that this was investigated in European samples (in contrast to previous studies in the US). In Europe, climate change is more acknowledged as a serious threat compared to the US (Poushter et al., 2022) and, accordingly, the European samples showed high climate change beliefs. If the consensus about the existence of climate change is strong in a society, this norm may override the influence of people's lay beliefs about the world. In such cases, climate change belief may be less about what one personally believes to be true or likely and more about a simple, universally known fact. Thus, inducing an incremental belief would not further increase people's climate change belief. Interestingly, there was still an effect on response efficacy, indicating that the notion that pro-environmental behavior is effective in mitigating climate change may be less established in European society than the existence of climate change. Thus, the influence of lay beliefs about the world on climate change related beliefs may also depend on the predominant views in society.

As a second extension, this dissertation tested the influence of lay beliefs about the world in a previously unstudied domain, namely Covid-19. The most interesting finding is that an incremental belief about the world consistently correlates with beneficial beliefs and intentions regarding Covid-19 and a hypothetical pandemic scenario but does not causally influence them. This contrasts with research showing a causal effect in other domains and indicates that specific characteristics of the problem influence the association with people's lay beliefs about the world. A noteworthy difference between Covid-19 and climate change is

that Covid-19 has a more immediate effect on people (e.g., on their own health, or the health of vulnerable friends or family members). Thus, people may not only be motivated by the aim to mitigate the pandemic at a larger level, but also by directly protecting specific people. In that case, people's beliefs about the changeability of the world would be less important than beliefs about the ability to change things in one's immediate surroundings. It would be interesting for future studies to investigate lay beliefs about the world in relation to different global social problems (e.g., political extremism or inequality) to investigate more in detail which characteristics shape their effect.

Lay Beliefs About Willpower

The present research provides evidence for an association between a nonlimited willpower belief and pro-environmental behavior on two different types of measures. First, people with a nonlimited willpower belief reported more everyday pro-environmental behavior in a three-day daily diary study. Second, they engaged more in a task that was set up to benefit environmental protection through a donation. They performed better on the task and showed more cardiovascular effort in terms of the pre-ejection period of the heart (the gold standard of cardiovascular assessment of effort exertion; Brownley et al., 2000; Kelsey, 2012). Thus, this dissertation shows that lay beliefs about willpower also play a role in a previously unexplored domain, namely pro-environmental behavior.

Interestingly, pro-environmental behavior is not merely an additional domain of research but also differs in relevant ways from behaviors previously studied in the context of lay beliefs about willpower. Such behaviors (e.g., physical activity, healthy diet, or behaviors conducive to learning) are clearly and mostly exclusively beneficial to oneself (e.g., one's future health or academic success). Pro-environmental behavior can also be personally beneficial (by reducing future harms from climate change to oneself), but this connection is less clear because it depends on the environmental action of the rest of the world.

Additionally, benefits are not exclusive to oneself, but pro-environmental behavior is in large part also about protecting (potentially more vulnerable) others. The self-control conflict that arises is, then, not only between rewards now vs. later, but also e.g., between rewards for me now vs. for others later. The present results provide evidence that a nonlimited willpower belief is also helpful for this different type of more pro-social self-control conflict.

This dissertation employed a new measure of behavioral engagement in the context of lay beliefs about willpower: namely cardiovascular measures of effort. Previous studies have focused on successful enactment of behavior (e.g., successfully going for a run or completing homework instead of procrastinating). Cardiovascular measures allow for a deeper look into the influence of effort exertion on these outcomes. In fact, I find that people with a nonlimited willpower belief show a stronger cardiovascular response (in terms of the pre-ejection period of the heart) indicating they exert themselves more on the task. This is then connected to better outcomes (i.e., higher task performance). Thus, a nonlimited willpower belief seems to increase beneficial goal-directed behaviors because it relates to higher readiness to exert effort.

While the correlational results regarding lay beliefs about willpower and pro-environmental behavior are promising, evidence for a causal effect is still limited. There was a marginally significant effect of an induced nonlimited willpower belief on higher task performance, but no difference regarding the main cardiovascular outcome (pre-ejection period). On a secondary outcome (systolic blood pressure), there was a trending effect indicating more effort exertion in the nonlimited willpower group. Thus, while there is some indication that lay beliefs about willpower have a causal effect, more research is needed in that regard. A possible reason for the different results on the two cardiovascular indicators is that sympathetic activity cannot be measured directly (while being noninvasive). Thus, each indicator is just a proxy of the underlying sympathetic activity which is affected by different

error sources (e.g., participants' movement or concurrent parasympathetic activity). This can lead to diverging effects. Pre-ejection period is typically considered the most reliable indicator (Brownley et al., 2000; Kelsey, 2012) giving some weight to the correlational results. Systolic blood pressure, while also frequently used (for a review see Richter et al., 2016), is assumed to be less accurate, indicating that the results regarding the causal effect on cardiovascular reactivity should be interpreted with caution. These problems may also have been aggravated by a sample size possibly too small to detect changes from a rather short manipulation of participants' lay beliefs. Overall, there is some cautious indication of a causal effect, but more research is needed to understand the full picture.

An interesting feature of both lay beliefs about willpower and pro-environmental behavior is that they can refer to very different types of behavior. Pro-environmental behavior is inherently diverse ranging from making environmental consumption decisions (a cognitive task) to riding one's bike to work (a physical task). Similarly, people can hold different beliefs about whether engaging in cognitive tasks will deplete their willpower or whether engaging in physical tasks will do so. Lay beliefs about willpower are more predictive of behavior if the assessed subdomain matches the behavioral domain (e.g., willpower beliefs regarding physical tasks are more predictive of physical activity; Bernecker & Job, 2015; Bernecker & Kramer, 2020). Thus, it would be interesting to investigate specific subdomains of lay beliefs about willpower in combination with respective types of pro-environmental behavior. This might give a more detailed view of how people's lay beliefs about willpower relate to pro-environmental behavior.

Lay Beliefs in General

Research disproportionally shows benefits for one of the poles of lay beliefs both about willpower and about the world. A nonlimited willpower belief relates to more healthy behavior (Bernecker & Kramer, 2020; Francis et al., 2021), better academic performance

(Job, Walton, et al., 2015), and higher relationship satisfaction (Francis et al., 2023).

Likewise, an incremental belief of the world relates to higher hope (Cohen-Chen et al., 2015), more feelings of efficacy (Duchi et al., 2020), and more normative political engagement (Shuman et al., 2016). This raises the question of why some people still tend towards the “unfavorable” lay beliefs (e.g., a limited willpower belief) despite their disadvantages.

First, the seemingly unfavorable belief may provide a justification for inaction. If the world is unchangeable, a lack of pro-environmental behavior is not a sign of laziness or ignorance but simply the rational decision to refrain from futile behavior. Similarly, attributing environmentally unfriendly decisions to a temporary, out-of-control lack of willpower due to previous exertion might feel better than concluding one does not care as much about the environment as one thought. Thus, the “negative” pole of these lay beliefs may protect one’s self-image by providing a justification for behavior that does not meet one’s own standards. There is some evidence that people actively shift their lay beliefs when it supports a preferred conclusion. For example, people shifted towards an incremental belief about personal characteristics in the context of a personal failure (Leith et al., 2014). This supports the self-serving conclusion that one can improve rather than that one’s failure-related characteristics are fixed. Study 4 of the second paper tested this motivated belief approach in the context of Covid-19 but did not find evidence for this effect. However, the motivation to change one’s lay belief might have been too weak in this study because it was based on imagining a certain behavior which provides less motivation than actual behavior. It would be interesting for future research to investigate a motivated change of one’s lay beliefs to justify a certain behavior.

Besides, the typically unfavorable lay belief poles might also have genuinely positive effects that have just not been studied so far. An entity belief about the world, while not giving people hope about positive future change, might still give people a sense of security

and predictability about the future. It assures people that things will stay the way they are. For people who are doing well, this may be very reassuring, and for others, it may at least reassure them that things will not get worse. This could reduce anxiety about the future. On the other hand, a limited willpower belief may help people disengage from goals that are not worthwhile (anymore). The notion that their willpower capacity is limited might foster reflections about whether one's resources are currently optimally allocated or whether one should shift to a more fruitful goal. Similarly, it may help people when a current strategy to attain a goal is not efficient. People with a limited willpower belief may be more motivated to look for better strategies to protect their resources, while people with a nonlimited willpower belief may be more likely to stick to an inefficient strategy because they do not mind exerting themselves. Thus, it is plausible that the lay belief poles that have so far been mostly connected to negative outcomes have some context-specific positive effects. Future research should investigate this further to get a full picture of the effects of lay beliefs.

Environmental Psychology

The present dissertation adds to environmental psychology research by showing the relevance of people's general lay beliefs on behavior. Previous research has already shown that specific perceptions e.g., about climate change or environmental protection play a role in pro-environmental behavior (Bamberg & Möser, 2007). I expand this by showing that context-independent beliefs about the world or one's willpower also play a role. Such general beliefs have not typically been targeted in climate change communication but might be a fruitful addition to existing communication focusing on climate change specific information. For example, fostering an incremental belief about the world may facilitate the integration of subsequent climate change related information because it reduces some of the tension with people's underlying worldviews. Thus, integrating the present evidence on lay beliefs in existing interventions focused on climate change specific beliefs may be promising.

The present research further corroborates calls to view pro-environmental behavior not only in terms of environmental attitudes or values but to also focus on self-regulation processes to bridge the intention-behavior gap (Bamberg, 2013b; Nielsen, 2017). I show that a nonlimited willpower belief that supports goal-directed behavior in other areas also fosters pro-environmental behavior. It might, thus, be fruitful to leverage evidence on how to support self-regulation in other behavior domains for the environmental context. Stage models provide a good framework for this endeavor because they explicitly depict both the motivation and volition stages as equally important parts of the overall process. Such models highlight the need for more research on the volition stage, as previous research has focused largely on the motivation stage.

The present research also adds evidence on the impact of everyday demands on pro-environmental behavior. Although intuitive, the effect of demands and stress has not received much attention in environmental research. Some previous studies show that stress is negatively related to pro-environmental behavior (Kaida & Kaida, 2019; Zhang & Cai, 2022). The present research corroborates this by showing that people with higher demands report less pro-environmental behavior. Interestingly, a nonlimited willpower belief did not buffer against the negative effect of overall demands, but only the negative effect of single days that were more demanding than usual. Thus, a beneficial belief about willpower cannot counter all negative effects of demands on pro-environmental behavior. Instead, future research should investigate if a reduction of everyday demands may have a positive effect on pro-environmental behavior. This would indicate that it is necessary to reduce the burden on people to give them room to act pro-environmentally.

Health Psychology

Finally, this dissertation takes a unique perspective on health behavior and specifically Covid-19 related protective behavior. Covid-19 differs from many other health

behaviors because protective behavior is not only meant to protect oneself but also others. In some cases, it may even be mainly enacted to protect others: e.g., in the early stages of the pandemic, young and healthy people were not assumed to be at high risk (although this changed later in the face of Long Covid). This research takes a closer look at the conditions when people intend to engage in protective behaviors even when they are personally not much at risk, but rather to protect others or serve a more abstract aim (such as reducing the strain on the health care system). I find evidence that an incremental belief about the world is related to higher intentions to engage in protective behaviors in this scenario. However, as discussed previously these results emerged only on the correlational level. Thus, the role of lay beliefs about the world in pandemic-related health behavior is not fully understood yet. Still, looking at health behavior in terms of other aims than protecting oneself seems to provide interesting additional insights.

Strengths, Limitations, and Future Research

Methodology

A main strength of the dissertation is the variety of methods across the papers. Some data was collected through online studies that participants completed at a place of their choice, thus, creating a natural, relaxing environment where they are easily able to report their natural tendencies. Other data was collected in the lab, where the context is more unnatural for participants, but where distractions could be avoided, and it was possible to create the same circumstances for all participants. Besides, the main outcomes (i.e., perceptions, intentions, and behavior) were assessed with different types of measures, such as general self-reports, daily diary measures, task performance, and cardiovascular measures of effortful engagement. This variety reduces biases created by the disadvantages of each individual type of measure. For example, daily diaries reduce memory biases, task engagement and cardiovascular measures overcome problems due to the costlessness of self-

reporting high intentions, and self-reports make it possible to assess variables such as beliefs that are difficult to assess otherwise. Finally, the studies combine the assessment of naturally occurring lay beliefs with experimental manipulation. This way not only the naturally occurring associations can be tested, but inferences about the causal relationship between the variables are possible as well. This range of methods makes the results more robust compared to reliance on a single methodology.

Despite this variety in the methods, still, all studies examined short-term effects over a maximum of a few days. Thus, it is not possible to conclude how long a shift in one's lay belief lasts and how this would influence one's perception or behavior over a longer period. To assess this, it will be necessary to create interventions that change people's lay beliefs more fundamentally and find ways to sustain such changes over time. A line of research on so-called wise interventions postulates that long-term changes in fundamental beliefs can be achieved if interventions trigger an iterative, self-sustaining process (Walton & Wilson, 2018). The idea is that people's newly adopted belief shapes their interpretation of upcoming situations; this promotes behaviors that are suitable to create outcomes that in turn reinforce the belief. Such interventions would be a first step to investigating to what extent people's lay beliefs can be changed and what effect that has on behavior in the long run.

Some limitations arise from the samples of the present studies. All samples were collected in Western countries. Additionally, many of the samples were younger and more politically liberal and had a higher proportion of women and students than the general population. This likely led to samples with higher concern for environmental issues just due to the demographic composition (even if the studies were never advertised as studying climate change to reduce self-selection) (Hornsey et al., 2016). The effect this sample composition might have had on the results differs between the types of lay belief. Regarding lay beliefs about the world, results might still be transferrable to samples that are less

concerned about climate change. In fact, an entity belief about the world might just be the reason why they are less concerned. For example, conservatives have been shown to hold more of an entity belief about the world which may contribute to lower intentions to mitigate climate change (Chan & Faria, 2022). Thus, inducing an incremental belief about the world might prove even more effective in such populations. However, future studies should empirically test this assumption. Regarding lay beliefs about willpower, on the other hand, a different sample should lead to considerably different results. Lay beliefs about willpower are assumed to play a role during the volition stage, i.e., during the implementation of a behavior intention. Thus, among people who do not care about climate change and do not intend to behave environmentally friendly, a nonlimited willpower belief would not be expected to support behavior implementation. Future studies may also investigate this assumption more in detail.

Theoretical Directions

The present research focused on the effects of lay beliefs about the world on cognitive variables such as beliefs about climate change or Covid-19 or appraisals of the efficacy of mitigation efforts. Another interesting avenue would be to test the influence on emotions e.g., in the context of climate change. An incremental belief about the world may relate to the hope that the climate crisis will successfully be mitigated. This is indicated by research showing that an incremental belief increases people's hope that an intractable conflict will be solved (Cohen-Chen et al., 2015). It may, however, also relate to negative emotions. People with an incremental belief might feel more anger, e.g., at the inaction of politicians or fellow citizens, because they are convinced such action would be effective. They may also be more afraid because significant negative change becomes more likely within their worldview. Finally, they may feel more guilty about acting non-environmentally friendly because it represents a missed opportunity to contribute to positive change. These different emotions are

related to pro-environmental behavior. Feelings of guilt have repeatedly been associated with more pro-environmental behavior (for a meta-analysis see Shipley & van Riper, 2022). Besides, there is some evidence of the positive effects of hope (Geiger et al., 2023), anger (Reese & Jacob, 2015), and fear (van Zomeren et al., 2010) as well. Thus, lay beliefs about the world may also influence pro-environmental behavior by eliciting certain emotions about climate change.

The present studies focused mainly on individual behaviors such as people's individual transportation or eating choices or their individual engagement in a task that can elicit an environmental donation. However, climate change is a system-wide problem that also requires system-level change and there are calls to reduce the focus on individual behavior. While this is true, it is important to keep in mind that system-level changes are often produced by a cumulation of individual behaviors (e.g., joining a protest may lead to a policy change). Similarly, donating to an environmental NGO may be an individual behavior by itself but the NGO may then advocate for change at a higher level. Thus, individual behaviors can elicit system-level change especially when coordinated among many people. Still, it would be fruitful to investigate variables that are more directly tied to system-level change such as support for environmental policies. It is plausible that people's lay beliefs about the world would influence perceptions of the effectiveness of and support for such policies. Thus, the present results can be transferred to some degree to different individual behaviors that contribute to system-level change in varying degrees. Still, future research should also investigate the effects on direct support for system-level change (e.g., in terms of policy change).

Practical Implications

The present research shows that factors non-specific to climate change or Covid-19 should be considered when fostering behavior in these contexts. Communication around

climate change or Covid-19 typically focuses on providing information or messages specifically about the target problem. However, it might be fruitful to complement this approach by adding messages targeting people's lay beliefs about the world or about willpower. To this end, future research would need to create and test intervention messages that may foster a certain lay belief and a rationale to sustain such belief changes.

Fostering a nonlimited willpower belief may be one way to help people implement their intentions into action. Another way to support this might be reducing people's demands. High demands were related to less pro-environmental behavior. Thus, campaigns may advertise for a "slower" lifestyle where people focus on what is important to them instead of trying to achieve several goals at once. Simultaneously, a fruitful system-level change may include reducing the everyday demands on people.

Finally, there is some indication that lay beliefs already form at an early age (Compagnoni et al., 2020). Thus, schools may be the right place to foster beneficial lay beliefs. This may have positive effects beyond the ones found in these studies and help kids and future adults feel efficacious about their actions, engage in change-promoting behavior, and successfully stick to their goals.

Conclusion

Overall, this dissertation provides evidence that people's lay beliefs play a role in global social problems such as climate change and Covid-19. Different lay beliefs matter at different stages, i.e., lay beliefs about the world relate to motivational variables such as efficacy beliefs and intentions, and lay beliefs about willpower relate to variables connected to the enactment of behavior such as effort exertion or overcoming demands. There are differences between the contexts of climate change and Covid-19 which need to be explored further. Similarly, more research is needed regarding the causal effects of lay beliefs about willpower. Future research may also expand the present results by investigating the effects on

other variables such as support for policies or by creating and testing interventions that change lay beliefs long-term. Thus, the present research broadly establishes the role of lay beliefs in global social problems and provides starting points for several interesting avenues for further research.

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Paper 1: Supplemental Material

Overview of Constructs and Measurements Across All Three Experiments

Table S1

Constructs and How They Were Measured Across All Three Experiments

Construct	Experiment 1	Experiment 2	Experiment 3
Response efficacy	• Collective response efficacy (8 items; Jugert et al., 2016) • Personal response efficacy (8 items; Hornsey et al., 2021)	• Collective response efficacy (8 items; Jugert et al., 2016) • Personal response efficacy (8 items; Hornsey et al., 2021) • General response efficacy (4 items; Soliman & Wilson, 2017)	• Collective response efficacy (8 items; Jugert et al., 2016) • Personal response efficacy (8 items; Hornsey et al., 2021)
Climate change belief	—	Climate change belief (6 items; Brick et al., 2017)	Climate change belief (12 items; Sinatra et al., 2012)
Intention to act on climate change	—	Intention to act (4 items; Heath & Gifford, 2006)	Intention to act (4 items; Heath & Gifford, 2006; adapted from exp. 2 to focus more on future intentions)
Feelings of working together	—	Feelings of working together (3 items; adapted from Howe et al., 2021)	Feelings of working together (3 items; adapted from Howe et al., 2021)
Perception of dynamic norms	—	Perception of dynamic norms (3 items; newly developed)	Perception of dynamic norms (3 items; same as experiment 2)
Goal commitment	—	—	Goal commitment (5 items from DeShon & Landis, 1997; 2 items from Brunstein et al.,

Construct	Experiment 1	Experiment 2	Experiment 3
			1998)
Initial environmental attitude	—	Famous people rating task (newly developed)	Famous people rating task (same as experiment 2)
Lay beliefs about the world (manipulation check)	Lay beliefs about the world (3 items; Dweck et al., 1995)	Lay beliefs about the world (3 items; Dweck et al., 1995)	Lay beliefs about the world (3 items; Dweck et al., 1995)
Demographics	• Gender • Age • Ethnicity • Political orientation	• Gender • Age • Political orientation	• Gender • Age • Occupation • Political orientation

Non-Parametric Analyses From Experiment 1-3

Table S2

Results of the Non-Parametric Wilcoxon Tests Regarding Differences Between the Experimental Groups

	Median		<i>W</i>	<i>p</i>
	Entity Belief	Increm. Belief		
<i>Experiment 1:</i>				
Political orientation	2.0	3.0	9,986	.018*
Age	34.0	38.0	10,190	.042*
Incremental belief about the world	3.0	3.5	9,582	.002**
Collective response efficacy	5.0	5.0	10,909	.132
<i>Experiment 2:</i>				
Age	24.0	23.0	10,354	.470
Collective response efficacy	5.0	5.3	8,558	.027*
General response efficacy	4.0	4.0	8,627	.034*
Climate change belief	6.0	6.2	9,626	.364
Intention to act	4.5	4.5	10,068	.618

	Median		<i>W</i>	<i>p</i>
	Entity Belief	Increm. Belief		
<i>Experiment 3:</i>				
Political orientation	3.0	3.0	9,042	.649
Age	23.0	22.0	9,561	.346
Incremental belief about the world	3.7	4.3	6,338	<.001***
Climate change belief	5.2	5.3	8,450	.208

Note. Wilcoxon tests were conducted in addition to the planned *t*-tests whenever an assumption of the *t*-test was potentially violated. *** $p < .001$, ** $p < .01$, * $p < .05$

Mediation Analyses for Experiment 1-3

For each of the outcomes in Experiment 1-3 that showed a significant difference between the two experiment groups, additional mediation analyses were conducted estimating the indirect effect of the experimental group through measured lay beliefs about the world on the outcomes. The results of the analyses are below. Overall, all indirect effects are either significant or trending at $p < .150$.

Table S3

Results of an Additional Mediation Analysis Testing the Indirect Effect of the Experimental Group Through Measured Lay Beliefs About the World on Response Efficacy in Experiment 1

Path	<i>b</i>	<i>SE</i>	LL	95% <i>CI</i>	UL	95% <i>CI</i>	β	<i>z</i>	<i>p</i>
Combined response efficacy									
Response efficacy regressed on incremental belief group (c path)	0.12	0.10	-0.07		0.33		0.06	1.23	.220
Incremental belief about the world regressed on incremental belief group (a path)	0.34	0.14	0.08		0.60		0.14	2.49	.013*
Response efficacy regressed on incremental belief about the world (b path)	0.38	0.05	0.27		0.48		0.46	6.95	<.001***
Indirect effect (ab path)	0.13	0.06	0.03		0.25		0.07	2.29	.022*
Total effect (total path)	0.25	0.11	0.05		0.47		0.13	2.27	.023*

Note. *N* = 307. LL = lower limit. UL = upper limit. *CI* = confidence interval. Bootstrap sample size = 5000. *** *p* < .001, ** *p* < .01, * *p* < .05

Table S4

Results of an Additional Mediation Analysis Testing the Indirect Effect of the Experimental Group Through Measured Lay Beliefs About the World on Outcomes in Experiment 2

Path	<i>b</i>	<i>SE</i>	LL	95% <i>CI</i>	UL	95% <i>CI</i>	β	<i>z</i>	<i>p</i>
Combined response efficacy									
Response efficacy regressed on incremental belief group (c path)	0.05	0.08	-0.11		0.20		0.03	0.57	.568

Path	<i>b</i>	<i>SE</i>	LL	95% <i>CI</i>	UL	95% <i>CI</i>	β	<i>z</i>	<i>p</i>
Incremental belief about the world regressed on incremental belief group (a path)	0.53	0.12	0.29		0.77		0.25	4.33	<.001***
Response efficacy regressed on incremental belief about the world (b path)	0.30	0.04	0.22		0.37		0.44	7.70	<.001***
Indirect effect (ab path)	0.16	0.04	0.08		0.25		0.11	3.72	<.001***
Total effect (total path)	0.20	0.09	0.03		0.37		0.14	2.34	.019*
Perception of dynamic norms									
Perception of dynamic norm regressed on incremental belief group (c path)	0.17	0.10	-0.02		0.37		0.10	1.67	.094
Incremental belief about the world regressed on incremental belief group (a path)	0.53	0.12	0.28		0.78		0.25	4.24	<.001***
Perception of dynamic norm regressed on incremental belief about the world (b path)	0.10	0.06	-0.01		0.20		0.12	1.74	.083
Indirect effect (ab path)	0.05	0.03	0.00		0.14		0.03	1.5	.134
Total effect (total path)	0.22	0.1	0.03		0.43		0.13	2.17	.030*
Feelings of working together									
Feelings of working together regressed on incremental belief group (c path)	0.11	0.15	-0.17		0.40		0.04	0.74	.462
Incremental belief about the world regressed on incremental belief group (a path)	0.53	0.12	0.29		0.77		0.25	4.36	<.001***
Feelings of working together regressed on incremental belief about the world (b path)	0.33	0.07	0.19		0.46		0.28	4.71	<.001***
Indirect effect (ab path)	0.17	0.06	0.08		0.31		0.07	3.10	.002**
Total effect (total path)	0.28	0.15	-0.01		0.58		0.11	1.91	.056

Note. *N* = 281. LL = lower limit. UL = upper limit. *CI* = confidence interval. Bootstrap sample size = 5000. *** *p* < .001, ** *p* < .01, * *p* < .05

Table S5

Results of an Additional Mediation Analysis Testing the Indirect Effect of the Experimental Group Through Measured Lay Beliefs About the

World on Outcomes in Experiment 3

Path	<i>b</i>	<i>SE</i>	LL	95% <i>CI</i>	UL	95% <i>CI</i>	β	<i>z</i>	<i>p</i>
Combined response efficacy									
Response efficacy regressed on incremental belief group (c path)	0.06	0.09	-0.11		0.24		0.05	0.75	.454
Incremental belief about the world regressed on incremental belief group (a path)	0.60	0.14	0.33		0.87		0.26	4.35	<.001***
Response efficacy regressed on incremental belief about the world (b path)	0.20	0.04	0.12		0.29		0.33	4.79	<.001***
Indirect effect (ab path)	0.12	0.04	0.06		0.22		0.09	2.93	.003**
Total effect (total path)	0.19	0.09	0.02		0.35		0.13	2.17	.030*
Intention to act									
Intention to act regressed on incremental belief group (c path)	0.23	0.14	-0.04		0.51		0.10	1.65	.099
Incremental belief about the world regressed on incremental belief group (a path)	0.60	0.14	0.33		0.87		0.26	4.38	<.001***
Intention to act regressed on incremental belief about the world (b path)	0.13	0.06	0.00		0.25		0.13	2.00	.046*
Indirect effect (ab path)	0.08	0.05	0.00		0.19		0.03	1.69	.091
Total effect (total path)	0.31	0.14	0.05		0.58		0.14	2.26	.024*
Feelings of working together									
Feelings of working together regressed on incremental belief group (c path)	0.24	0.15	-0.04		0.54		0.10	1.65	.099
Incremental belief about the world regressed on incremental belief group (a path)	0.60	0.13	0.34		0.86		0.26	4.48	<.001***
Feelings of working together regressed on incremental belief about the world (b path)	0.14	0.07	0.00		0.27		0.13	2.04	.042*

Path	<i>b</i>	<i>SE</i>	LL	95% <i>CI</i>	UL	95% <i>CI</i>	β	<i>z</i>	<i>p</i>
Indirect effect (ab path)	0.08	0.05	0.01		0.20		0.03	1.76	.078
Total effect (total path)	0.33	0.15	0.04		0.62		0.13	2.21	.027*

Note. *N* = 267. LL = lower limit. UL = upper limit. *CI* = confidence interval. Bootstrap sample size = 5000. *** $p < .001$, ** $p < .01$, * $p < .05$

Results From Different Project Including the Manipulation of Lay Beliefs About the World (Jankowski et al., 2023)

We ran another experiment that used the same manipulation as part of a different project focusing on cardiovascular measures of effort for the environment. That project is mainly reported elsewhere (Jankowski et al., 2023). Participants were recruited through the participant pool of the [university blinded for review]. Originally, $N = 166$ participants completed the study. After excluding participants who failed a reading check on the manipulation text ($N = 6$) or experienced technical issues ($N = 1$), the final sample size was $N = 159$. Participants were mostly women (77%) and students (78%) with a mean age of 26 years ($SD = 7.3$). A considerable proportion (39%) were psychology students and overall participants leaned towards the political left ($M = 2.5$, $SD = 1.0$; 1 = *political left*, 7 = *political right*).

The experiment included the same manipulation of lay beliefs about the world as experiment 1 with participants being randomly assigned to either the incremental belief group ($n = 80$) or the entity belief group ($n = 79$). Response efficacy (measured with the same scales as experiment 1) was assessed before and after the manipulation. After the manipulation, participants did an environmental task (a clicking task adapted from Schuler et al., 2017) where they could elicit a donation for an environmental NGO if they performed to a certain standard. During the task cardiovascular measures of effort (pre-ejection period of the heart and systolic blood pressure) were assessed. Additionally, performance and self-reported importance of being successful at the task were assessed.

Schuler, E. R., Mlynski, C., & Wright, R. A. (2017). Influence of mortality salience on effort-related cardiovascular response to an identity-relevant challenge. *Motivation Science*, 3(2), 164–171. <https://doi.org/10.1037/mot0000052>

Table S6*Results Regarding Differences Between the Experimental Groups in a Different Project**(Jankowski et al., in prep)*

	Entity Belief		Increm. Belief		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	95% CI
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Combined response efficacy	4.7	0.74	4.7	0.61	-0.05	150.67	.481	0.01	[-0.30, 0.32]
<i>Personal response efficacy</i>	4.2	0.91	4.2	0.80	0.00	154.33	.499	0.00	[-0.31, 0.31]
<i>Collective response efficacy</i>	5.2	0.78	5.2	0.66	-0.09	152.33	.465	0.01	[-0.30, 0.33]
Effort (PEP) ¹	-5.1	8.01	-6.7	7.44	1.30	146.58	.097†	-0.21	[-0.53, 0.11]
Effort (SBP)	5.0	6.58	6.4	6.70	-1.37	157.00	.087†	0.22	[-0.09, 0.53]
Env. task performance	7.7	1.94	7.8	2.11	-0.21	156.29	.418	0.03	[-0.28, 0.34]
Task success importance	33.3	4.37	33.1	4.63	0.21	156.70	.585	-0.03	[-0.35, 0.28]
Incremental belief about the world (manipulation check)	3.6	1.24	3.9	1.01	-1.86	149.73	.032*	0.30	[-0.02, 0.61]

Note. One-sided *t*-tests were conducted. Combined response efficacy belief refers to the average across the personal and collective response efficacy subscales. PEP = Pre-ejection period of the heart. SBP = Systolic blood pressure. *N* = 159. ¹ Pre-ejection period (PEP) is coded such that lower values indicate more effort. * *p* < .05, † *p* < .10

Table S7

Results of Linear Regression Analyses on the Effects of the Experimental Group on Response Efficacy (Post Manipulation) Controlling for Response Efficacy Pre Manipulation

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>	<i>Adj. R²</i>
Combined response efficacy (post)						.67
Intercept	-0.07	0.06	-1.04	.300	[-0.19, 0.06]	
Exp. group	0.13	0.09	1.46	.145	[-0.05, 0.31]	
Combined response efficacy (pre)	0.82	0.05	18.02	< .001***	[0.73, 0.91]	

Note. Experimental group is coded: 0 = entity belief group, 1 = incremental belief group.

Outcome and predictors except the experimental group are z-standardized. *** $p < .001$

Paper 2: Supplemental Material

Study 2: additional measures on support of vaccination policy

Participants read a short description of a recent proposal by the WHO to mitigate the pandemic (namely, the necessity of providing 11 billion Covid-19 vaccine doses to poorer countries). We further informed participants that the US had already announced a policy to provide 500 million vaccine doses, but the country could further support this case.

Subsequently, participants answered two questions. First, participants indicated how much additional money the US should provide to support vaccination in poorer countries in their opinion (using a slider from \$0 to \$50 billion). Second, we asked participants if they were eligible to pay taxes. If they affirmed this, they indicated how much of a tax increase they would be willing to pay to fund these expenditures (using a slider from 0% to 10% with an additional response option of more than 10%). The incremental and entity beliefs groups did not differ in their responses to any of the two items (see Table S1).

Table S1. Tests of Differences Between the Experimental Groups Regarding Support of Vaccination Policy in Study 2.

Outcome variable	<i>M (SD)</i>		<i>df</i>	Statistic (<i>t</i> or χ^2)	<i>p</i>	<i>d</i>
	Incremental	Entity				
Supported governmental spending on vaccination	10.63 (12.12)	11.38 (13.32)	395	-0.59	.555	0.06
Tax increase willingness ¹	1.37 (1.85)	1.44 (2.00)	388	-0.35	.726	0.04

N = 397. *t*-tests were conducted unless otherwise indicated. ¹*N* = 390. Participants that did not currently pay taxes did not answer this question.

Studies 3a-c: full scenario text

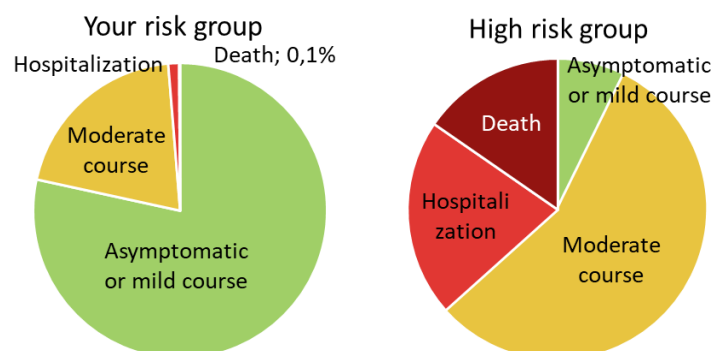
[Part 1] Scientists in Brazil have identified a novel virus, the so-called SciX virus.

First, the virus does not get much attention, but after a few weeks, it turns out to be very

infectious. It spreads to several other countries, and a Public Health Emergency of International Concern is declared. As the virus spreads to all countries around the world, reliable experts state that a global pandemic is emerging.

You follow the information of several experts that you deem knowledgeable and reliable concerning this situation. This is how they describe the virus: The symptoms of the SciX virus can range from almost none to life-threatening. A mild course of the disease lasts for a few days, causing headaches, coughs and skin rashes. A more serious course of the disease can affect the veins, potentially blocking blood supply to the heart and causing heart attacks. In the worst case, the virus can result in hospitalization and even death. The experts have noticed that people differ in their susceptibility to the SciX virus depending on factors such as demographics. You are personally counted among the low susceptibility group. This means that it's likely that you would suffer from only a mild course of disease if you got infected with the SciX virus. Other people, however, have a much larger risk of suffering from a serious course of disease, including hospitalization and death.

"People from high risk groups have a much more severe course of disease than people from your risk group (including you)."



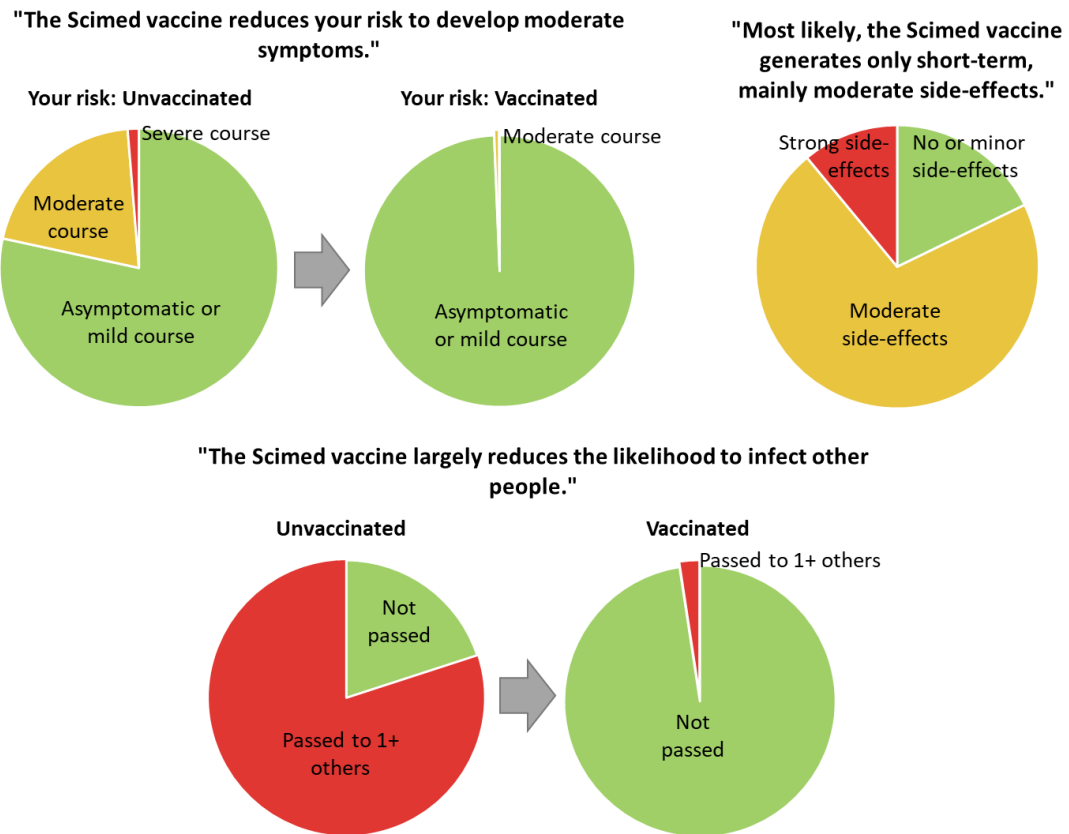
Transmission of the SciX virus occurs through physical contact, either by touching people that are infected by the virus themselves or by touching surfaces that are contaminated by the virus. People remain contagious for up to 20 days, and can spread the virus even if they do not develop symptoms. On surfaces, the virus can stay active for several days, depending on the specific surface. The risk of getting infected is highest when directly

touching infected people and when touching surfaces that are newly contaminated and haven't been properly cleaned.

Due to these facts, governments all over the world are implementing preventive measures to slow down the spread of the SciX virus and protect the people that are most vulnerable to the virus. International scientists that you consider experts on infectious diseases are issuing recommendations of personal behavior to reduce the risk of infections (most importantly social distancing).

[Part 2] Shortly after the SciX virus is discovered, scientists all over the world start researching possible vaccines against the SciX virus. Only a few months later, a Swiss biotechnology corporation starts testing a vaccine (called Scimed) in cooperation with a US-based pharmaceutical company. Scimed is tested over seven months with over 50,000 participants in several countries.

The vaccine is thoroughly discussed in the media and you follow the assessment of the experts that you consider most competent. According to them, the clinical trials show that two doses of Scimed can prevent symptoms from the SciX virus with high efficacy (approx. 95%). That means that participants who had been vaccinated had a 95% lower risk of getting symptoms from the SciX virus than participants who had not been vaccinated and had a 97% lower risk of passing the virus to others. Side-effects of the vaccine are limited to short-term side-effects. 70% of the participants experienced strong headaches, chills and exhaustion over 3-4 days after the vaccination. 10% experienced fever and flu-like symptoms that lasted up to a week. No long-term side-effects were observed. Due to the high efficacy and only short-term side-effects, Scimed is starting to get approved by the national drug regulation authorities. France is the first country to approve it, and countries all over the world follow shortly after.



First, the supply of Scimed is still limited, and the most vulnerable people are prioritized to get vaccinated first. But soon after, the vaccine becomes available to anyone as well as to you.

National governments encourage their citizens to get vaccinated. They emphasize that getting vaccinated does not only protect oneself from the SciX virus, but also helps protect other people. Getting vaccinated reduces the chance of passing the SciX virus to other people.

Studies 3a-c: descriptive results of the control questions

Table S2. Descriptive Results of the Control Questions on the SciX Virus Scenario in Studies 3a-c.

Question	1	2	3	4	5
1. When reading the scenario about the SciX virus and answering the questions, to what extent did you think of Covid-19? (1 = not at all; 5 = completely)					

Question	1	2	3	4	5
Study 3a	3%	12%	31%	38%	16%
2. To what extent did your experience with Covid-19 influence your answers on the questions? (1 = not at all; 5 = completely)					
Study 3a	9%	17%	29%	31%	13%
3. Which of the two rather influenced your answers to the questions on the SciX virus scenario? (1 = the information you read about the SciX virus; 5 = your views about Covid-19)					
Study 3a	19%	23%	36%	13%	8%
Study 3b	24%	21%	36%	12%	7%
Study 3c	23%	16%	45%	9%	7%
4. Were your answers similar to what you would have answered to questions about Covid-19? (1= very different answers; 5 = exactly the same answers)					
Study 3a	0%	2%	7%	63%	27%
Study 3b	1%	4%	14%	62%	19%
Study 3c	1%	2%	16%	56%	25%
5. Comparing the described SciX virus to the current coronavirus (SARS-CoV-2), what would you say: Symptoms from the SciX virus are... (1 = milder; 5 = more serious)					
Study 3a	3%	14%	62%	17%	4%
Study 3b	3%	13%	61%	19%	4%
6. The SciX virus requires... (1 = softer measures; 5 = stricter measures)					
Study 3a	2%	10%	63%	18%	7%
Study 3b	1%	8%	52%	27%	12%
7. Comparing the described Scimed vaccine to the BionTech vaccine against Covid-19, what would you say: Scimed is... (1 = less effective in preventing disease; 5 = more effective in preventing disease)					
Study 3a	0%	3%	62%	24%	12%
Study 3b	4%	16%	61%	13%	6%
8. The side-effects from Scimed are... (1= milder; 5 = more serious)					
Study 3a	2%	8%	62%	23%	5%
Study 3b	3%	7%	50%	32%	9%

Note. Percentage of participants that chose the respective response options on the control questions in Studies 3a-c.

Study 3a: results when controlling for age

Table S3. Multiple Linear Regressions of the Effect of the Experimental Group on the Pandemic-Related Outcomes While Controlling for Age.

Outcome	<i>b</i>	<i>CI</i>	<i>t</i>	<i>p</i>
<i>Vaccination intention</i>				
(Intercept)	4.42	4.02 – 4.82	21.54	<.001***
Group	-0.13	-0.40 – 0.15	-0.89	.373
Age	-0.00	-0.01 – 0.01	-0.20	.841
<i>Vaccination readiness</i>				
(Intercept)	4.35	4.04 – 4.66	27.67	<.001***
Group	-0.07	-0.29 – 0.14	-0.68	.495
Age	0.00	-0.01 – 0.01	0.27	.785
<i>Health threat-related behavior change</i>				
(Intercept)	3.98	3.72 – 4.24	30.55	<.001***
Group	0.09	-0.09 – 0.26	0.99	.325
Age	0.00	-0.00 – 0.01	1.28	.202
<i>Threat belief</i>				
(Intercept)	4.89	4.58 – 5.20	31.28	<.001***
Group	-0.02	-0.23 – 0.20	-0.14	.888
Age	0.00	-0.01 – 0.01	0.50	.616
<i>Efficacy beliefs about mitigation efforts</i>				
(Intercept)	4.55	4.21 – 4.88	26.51	<.001***
Group	-0.11	-0.35 – 0.12	-0.97	.334
Age	0.00	-0.00 – 0.01	1.03	.304
<i>Efficacy beliefs about <u>individual</u> mitigation efforts</i>				
(Intercept)	4.46	4.09 – 4.83	23.84	<.001***
Group	-0.24	-0.49 – 0.01	-1.89	.060†
Age	0.00	-0.01 – 0.01	0.84	.404
<i>Efficacy beliefs about vaccination</i>				
(Intercept)	4.77	4.38 – 5.16	24.04	<.001***
Group	-0.18	-0.45 – 0.08	-1.35	.179
Age	0.01	-0.00 – 0.02	1.11	.270

Outcome	<i>b</i>	<i>CI</i>	<i>t</i>	<i>p</i>
<i>Efficacy beliefs about individual</i>				
<i>vaccination</i>				
(Intercept)	4.62	4.19 – 5.04	21.20	<.001***
Group	-0.29	-0.59 – -0.00	-1.97	.050*
Age	0.01	-0.00 – 0.02	1.43	.153
<i>Attitudes towards measures</i>				
(Intercept)	4.28	3.87 – 4.69	20.60	<.001***
Group	0.05	-0.23 – 0.33	0.33	.740
Age	-0.02	-0.03 – -0.01	-3.03	.003**

Note. *N* = 271. Experimental group is coded as 0 = incremental belief group, 1 = entity belief

group. † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Paper 3: Supplemental Material

Description of the construction of the pro-environmental behavior scales

For the pro-environmental behavior scales, behaviors that have a positive impact on the environment were collected from three sources: a past study that used experience sampling to measure daily PEB – thus was somewhat similar to our approach (Bissing-Olson et al., 2016), research on the impact of individual actions on CO₂ emissions (Wynes & Nicholas, 2017), and recommendations for a more environmental lifestyle by the UN (United Nations, n.d.). The three sources overlapped considerably with regard to the behaviors, e.g. each emphasized the importance of conservation of resources (e.g., water, energy), sustainable transportation and appropriate disposal of waste (including recycling). Wynes & Nicholas' (2017) and the UN's recommendations additionally included environmental food choices (e.g., plant-based diet, regional produce). For each of the collected behaviors, it was considered if they were usually enacted over the course of a few days. Behaviors that did not meet that criterion were removed (e.g., behaviors regarding air travel, zero-waste fashion or printing). The remaining 21 behaviors became part of the pro-environmental behavior scales used in this study.

Bissing-Olson, M. J., Fielding, K. S., & Iyer, A. (2016). Experiences of pride, not guilt, predict pro-environmental behavior when pro-environmental descriptive norms are more positive. *Journal of Environmental Psychology*, 45, 145–153.

<https://doi.org/10.1016/j.jenvp.2016.01.001>

United Nations. (n.d.). *Act Now*. United Nations; United Nations.

<https://www.un.org/en/actnow>

Wynes, S., & Nicholas, K. A. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research*

Table S1. Complete list of collected variables.

T0	
Lay beliefs about willpower	Lay beliefs about willpower scale (Bernecker & Job, 2015)
Lay beliefs about the world ¹	Lay beliefs about the world scale (Dweck et al., 1995)
Mindfulness ¹	Comprehensive Inventory of Mindfulness Experiences (Bergomi et al., 2014)
Pro-environmental behavior difficulty	Participants indicated how difficult or unfamiliar they find 21 pro-environmental behaviors (see Table 2)
Pro-environmental behavior intention	Participants indicated to what extent they planned to do 21 pro-environmental behaviors (see Table 2) over the next seven days
Anticipated demands	Adapted from the NASA-TLX (Hart & Staveland, 1988)
Social desirability	Social desirability scale (Kemper et al., 2012)
Meditation experience ¹	3 items on meditation experience (yes / no), meditation frequency and time period of frequent meditation
Demographics	Age, gender, education status, residence, job status, working hours, income, number of people in household and political attitude
Self-exclusion	Participants indicated if they deem their data unusable (e.g. due to distraction)
T1-T3	
Daily demands	Adapted from the NASA-TLX (Hart & Staveland, 1988)
Daily pro-environmental behavior	Participants indicated to what extent they had engaged in 21 pro-environmental behaviors (see Table 2) on the respective day
Self-exclusion	Participants indicated if they deem their data unusable (e.g. due to distraction)
Only T3	
Typicality of T1-T3	Participants indicated how similar T1 to T3 were to their typical Thursday to Saturday

Unusual events	Participants indicated if there were unusual events during T1 to T3
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Note. ¹ These variables were included as part of a master thesis on a separate research question.

Table S2. Grand correlation matrix of all collected measures.

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10
<i>Between-person variables</i>												
1. Nonlimited willpower belief	3.3	0.67										
2. Fixed world belief	3.8	1.08	-.04									
3. Mindfulness	3.7	0.52	.36**	-.14**								
4. PEB difficulty	2.7	0.63	-.24**	.12*	-.33**							
5. PEB intention	3.8	0.47	.14**	-.11*	.23**	-.65**						
6. Anticipated demands	3.3	0.60	-.12*	.06	-.30**	.17**	-.15**					
7. Desirability	3.7	0.58	.14**	-.08	.35**	-.35**	.32**	-.15**				
8. Age	26.2	7.79	-.02	.03	.16**	-.17**	.08	-.08	.02			
9. Political attitude ^a	3.7	1.60	-.00	.13**	.01	.16**	-.22**	.07	-.11*	.04		
<i>Within-person variables</i>												
10. Daily PEB	3.8	0.38	.16**	-.06	.21**	-.52**	.61**	-.10	.23**	.06	-.13*	
11. Daily demands	2.7	0.57	-.10	-.01	-.17**	.08	-.06	.42**	-.03	-.02	-.02	-.13*

Note. For within-person variables: mean, standard deviation and correlations refer to the by-person average. *N* = 387 for between-person variables and *N* = 337 for within-person variables unless noted otherwise. ^a Higher values indicate more conservative views; *N* = 380. * *p* < .05. ** *p* < .01.

Table S3. 21 target behaviors of the pro-environmental behavior (PEB) intention and daily pro-environmental behavior (PEB) scales.

Behavior	PEB Intention			Daily PEB		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
1. Turn the heating to a maximum of 21°C.	387	3.5	1.35	313	3.3	0.85
2. Turn off the light when leaving the room.	387	4.7	0.61	334	4.4	0.71
3. Turn off the light when daylight is sufficient.	387	4.7	0.66	337	4.2	0.80
4. Turn off electronic devices (e.g. computer / laptop, TV, radio) after use (no stand-by)	387	3.9	1.13	332	3.1	1.33
5. Unplug cell phone from charger after battery is fully charged	387	4.2	1.10	324	3.9	1.09
6. Shower for a maximum of 8 minutes on average.	387	3.6	1.27	295	3.1	1.07
7. Run the faucet as short as possible when washing dishes by hand	387	4.1	1.10	261	4.0	0.90
8. Fill the dishwasher completely before turning it on.	284	4.7	0.62	196	4.4	0.86
9. Cook in an energy-saving way (e.g. with little water, matching lids)	387	4.0	0.94	276	3.7	1.03
10. Eat meals without dairy products or eggs	387	3.1	1.05	337	3.4	1.04
11. Eat meals without meat / fish	387	3.7	1.12	337	4.1	0.97
12. Avoid consuming products imported from overseas (e.g. bananas, mangoes, avocados, pineapples, coffee, chocolate, green/black tea)	387	2.8	0.96	337	3.8	0.72
13. Refrain from consuming snacks and beverages in disposable packaging (e.g., takeaways, fast food, coffee to go, delivery services)	387	3.6	1.06	337	4.4	0.72
14. Not throwing away food (e.g., because too much was bought/prepared, spoiled, etc.)	387	4.1	0.96	337	4.7	0.54
15. Separate trash correctly	387	4.4	0.85	323	4.3	0.95
16. Buy regional food	387	3.3	0.84	211	2.7	1.10
17. Buy seasonal fruits and vegetables (e.g. in winter: pumpkin, cabbage, lamb's lettuce, carrots, apples)	387	3.5	0.86	211	2.4	1.23
18. Buy organic food.	387	3.2	1.02	211	2.3	1.29

Behavior	PEB Intention			Daily PEB		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
19. Do not use a car (incl. cab / Uber / carpool) on long distances (over 10 km) if other means of transport are an alternative	387	3.4	1.41	225	3.7	1.59
20. Do not use a car (incl. cab / Uber / carpool) on short distances (up to 10 km) if other means of transportation are an alternative	387	4.0	1.19	293	4.1	1.31
21. Carpool if you use a car	265	2.8	1.36	155	2.7	1.68

Note. *N* varies between the items because people that indicated that they will not (in case of pro-environmental behavior intention) or did not (in case of daily pro-environmental behavior) have the opportunity to exert that behavior were treated as missing values (e.g. because they do not own a dishwasher or did not go grocery shopping).

Table S4. Results of paired *t*-tests comparing daily demands between the different weekdays.

Weekday	<i>M</i>	<i>SD</i>	Thursday (T1)	Friday (T2)
7. Thursday (T1)	2.9	0.67		
8. Friday (T2)	2.7	0.70	$t(272) = 4.21, p < .001$	
9. Saturday (T3)	2.5	0.70	$t(262) = 6.92, p < .001$	$t(266) = 4.08, p < .001$

Table S5. Fixed effects of lay beliefs about willpower and daily demands on daily pro-environmental behavior when controlling for pro-environmental behavior intention.

Predictor	Model 1				Model 2			
	β	SE	CI	p	β	SE	CI	p
Intercept	3.85	0.02	[3.82, 3.88]	<.001***	3.85	0.02	[3.82, 3.88]	<.001***
<i>Between-person variables</i>								
Nonlimited willpower belief	0.05	0.02	[-0.00, 0.09]	.065†	0.04	0.03	[-0.01, 0.09]	.100
Daily demands (M)					-0.06	0.03	[-0.12, -0.00]	.046*
Pro-environmental behavior intention	0.49	0.03	[0.43, 0.56]	<.001***	0.48	0.03	[0.42, 0.55]	<.001***
Nonlimited willpower belief × Daily demands (M)					-0.03	0.04	[-0.11, 0.05]	.477
<i>Within-person variables</i>								
Daily demands (CWC)					-0.01	0.02	[-0.06, 0.03]	.552
<i>Cross-level interaction</i>								
Nonlimited willpower belief × Daily demands (CWC)					0.08	0.03	[0.01, 0.15]	.020*
Between-person R^2	.50				.49			
Within-person R^2	-				.01			
Total R^2	.29				.30			

Note. Daily demands (M) refers to the cluster mean in daily demands (centered at the grand mean). Daily demands (CWC) refers to the within clusters centered daily demands. The R^2 measures quantify the proportion of between-person, within-person and total variance that is explained by the fixed effects in the model. β = unstandardized coefficients. CI = percentile bootstrapped confidence intervals. [†] $p < .1$, * $p <$

.05, ** $p < .01$, *** $p < .001$.

Table S6. Fixed effects of lay beliefs about willpower and daily demands on daily pro-environmental behavior when controlling for social desirability.

Predictor	Model 1				Model 2			
	β	SE	CI	p	β	SE	CI	p
Intercept	3.85	0.02	[3.81, 3.89]	<.001***	3.85	0.02	[3.81, 3.89]	<.001***
<i>Between-person variable</i>								
Nonlimited willpower belief	0.08	0.03	[0.02, 0.14]	.014*	0.07	0.03	[0.01, 0.13]	.031*
Daily demands (M)					-0.08	0.04	[-0.16, -0.01]	.023*
Social desirability	0.14	0.04	[0.07, 0.21]	<.001***	0.14	0.04	[0.06, 0.21]	<.001***
<i>Level 2 interaction</i>								
Nonlimited willpower belief $\times$ Daily demands (M)					-0.09	0.06	[-0.20, 0.02]	.091†
<i>Within-person variable</i>								
Daily demands (CWC)					-0.02	0.02	[-0.06, 0.03]	.509
<i>Cross-level interaction</i>								
Nonlimited willpower belief $\times$ Daily demands (CWC)					0.08	0.03	[0.01, 0.15]	.016*
Between-person R^2	.09				.10			
Within-person R^2	-				.01			
Total R^2	.05				.07			

Note. Daily demands (M) refers to the cluster mean in daily demands (centered at the grand mean). Daily demands (CWC) refers to the

within clusters centered daily demands. β = unstandardized coefficients. The R^2 measures quantify the proportion of between-person, within-person and total variance that is explained by the fixed effects in the model. CI = percentile bootstrapped confidence intervals. $\dagger p < .1$, $* p < .05$, $** p < .01$, $*** p < .001$.

Table S7. Fixed effects of lay beliefs about willpower and daily demands on daily pro-environmental behavior when controlling for weekday.

Predictor	Model 1				Model 2			
	β	SE	CI	p	β	SE	CI	p
Intercept	3.85	0.02	[3.81, 3.89]	<.001***	3.85	0.02	[3.80, 3.89]	<.001***
<i>Between-person variable</i>								
Nonlimited willpower belief	0.09	0.03	[0.03, 0.15]	.003**	0.08	0.03	[0.02, 0.15]	.008**
Daily demands (M)					-0.09	0.04	[-0.16, -0.01]	.024*
Weekday (Friday) (M)	-0.12	0.16	[-0.43, 0.21]	.432	-0.08	0.16	[-0.40, 0.23]	.610
Weekday (Saturday) (M)	-0.05	0.16	[-0.35, 0.26]	.727	-0.09	0.15	[-0.38, 0.21]	.557
<i>Level 2 interaction</i>								
Nonlimited willpower belief $\times$ Daily demands (M)					-0.09	0.06	[-0.18, 0.03]	.127
<i>Within-person variable</i>								
Daily demands (CWC)					-0.03	0.02	[-0.08, 0.02]	.196
Weekday (Friday) (CWC)	-0.01	0.02	[-0.06, 0.04]	.763	-0.02	0.02	[-0.06, 0.03]	.430
Weekday (Saturday) (CWC)	-0.05	0.02	[-0.10, 0.00]	.065 $\dagger$	-0.07	0.03	[-0.12, -0.02]	.007**
<i>Cross-level interaction</i>								

Predictor	Model 1			Model 2				
	β	<i>SE</i>	<i>CI</i>	<i>p</i>	β	<i>SE</i>	<i>CI</i>	<i>p</i>
Nonlimited willpower belief $\times$ Daily demands (CWC)								
Between-person R^2	.03				0.08	0.03	[0.02, 0.15]	.016*
Within-person R^2	-							
Total R^2	.02							

Note. The categorical variable weekday was dummy-coded and centered within clusters following the recommendation by Yaremych et al., (2021). The within-cluster slopes (Weekday (Friday) (CWC) and Weekday (Saturday) (CWC)) can be interpreted as changes in one person’s pro-environmental behavior between Thursdays (the reference category) and Fridays or Saturdays respectively. The between-cluster slopes (Weekday (Friday) (M) and Weekday (Saturday) (M)) can be interpreted as the difference in pro-environmental behavior between a person that only reported their behavior on Thursdays compared to a person that reported their behavior only Fridays or Saturdays respectively. See Yaremych et al., (2021) for further details. Likewise, daily demands (M) refers to the cluster mean in daily demands (centered at the grand mean). Daily demands (CWC) refers to the within clusters centered daily demands. β = unstandardized coefficients. The R^2 measures quantify the proportion of between-person, within-person and total variance that is explained by the fixed effects in the model. *CI* = percentile bootstrapped confidence intervals. † $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Yaremych, H. E., Preacher, K. J., & Hedeker, D. (2021). Centering categorical predictors in multilevel models: Best practices and interpretation. *Psychological Methods*. <https://doi.org/10.1037/met0000434>

Paper 4: Supplemental Material

Study 1: Analyses Including Experimental Group as Covariate

The data collection for Study 1 was part of a research project on a different research question. For this research question, the study included a manipulation of participants' beliefs about whether the world is changeable or fixed. Although the manipulation was not relevant to the current study, we re-ran our analyses including the experimental group as a covariate. The results of these analyses are in Table S1.

Table S1

Results of Multiple Regression Analyses Including Experimental Group as Covariate

	β	<i>SE</i>	<i>t</i>	<i>p</i>	<i>Adj. R</i> ²
Performance					.04
Intercept	0.01	0.11	0.08	.937	
Nonlimited willpower belief	0.22	0.08	2.82	.005**	
Experimental group	-0.02	0.15	-0.11	.911	
PEP change					.04
Intercept	0.10	0.11	0.89	.373	
Nonlimited willpower belief	-0.20	0.08	-2.57	.011*	
Experimental group	-0.20	0.16	-1.26	.209	
SBP change					.01
Intercept	-0.08	0.11	-0.75	.456	
Nonlimited willpower belief	0.11	0.08	1.44	.152	
Experimental group	0.16	0.16	1.06	.291	

Note. For PEP, negative change indicates more effort exertion. For SBP, positive change indicates more effort exertion. * $p < .05$, ** $p < .01$.

Details on the Donations for the Environmental Task

In Study 1, the donation was made to atmosfair GmbH. Each participant could achieve a donation of 3€. In total, 49 participants reached the threshold for donating (37

clicks), thus, 147€ were donated after the completion of the study. The target organization was introduced with a short text:

*“The donation of €3 goes to atmosfair GmbH. atmosfair is a non-profit climate protection organization based in Berlin. atmosfair promotes **active climate protection by offsetting greenhouse gases**. atmosfair expands renewable energies in countries where they are still scarce (especially in developing countries). This saves CO₂ that would otherwise have been produced by fossil fuels in these countries. atmosfair is particularly well known for the possibility of offsetting greenhouse gases produced during air travel. For more information, please take a look at the atmosfair flyer on the table next to you. A donation of €3 to atmosfair **offsets approx. 1.5% of the average CO₂ emissions** of an Austrian in a whole year.”*

At the end of the study, participants were asked how convinced they were that a success in the task would lead to a donation. The average response (on a scale from 0 (*not at all*) to 10 (*completely*)) was $M = 6.4$ ($SD = 2.8$) indicating that participants had some reservations, but overall tended to believe that the donation would be made. Low responses might also partially be due to the question itself inducing doubts about the donation.

In Study 2, the donation was made to World Wide Fund for Nature (WWF). Each participant could achieve a donation of 3€. In total, 22 participants reached the threshold for donating (38 clicks), thus, 66€ were donated after the completion of the study. Again, the target organization was introduced with a short text:

*“World Wide Fund For Nature (WWF) is one of the largest international environmental protection organizations. WWF is primarily committed to protecting the diversity of nature, reducing humanity's ecological footprint and the sustainable use of natural resources. The **donation of €3** that you can achieve in the following task will go to the **WWF's rainforest protection project**. The rainforest plays an important role for the*

global climate because it can absorb and store large amounts of CO₂. Protecting the rainforest is therefore an important contribution to climate protection.”

At the end of the study, participants were again asked how convinced they were that a success in the task would lead to a donation. The average response was similar to Study 1 ($M = 6.4$, $SD = 3.0$, scale: 0 (*not at all*) to 10 (*completely*)) indicating that participants had some reservations, but overall tended to believe that the donation would be made.

English Abstract

Global social problems like climate change and Covid-19 are serious threats to human health and livelihood and require quick, substantial action. However, their global scope makes it difficult to motivate people to act. People may underestimate the severity of these problems because their consequences are rather abstract and diffuse or only lie in the future. People may also feel like any personal mitigation efforts would be ineffective on a large scale. Additionally, even people who intend to tackle these problems do not always translate their intentions into action. Different lay beliefs that people hold (i.e., their core assumptions about specific aspects of the world) may influence both (1) perceptions of problem severity and own effectiveness and (2) successful implementation of behavioral intentions. Papers 1 and 2 investigated the effect of people's lay beliefs about whether the world is changeable or fixed on their perceptions and behavioral intentions regarding climate change and Covid-19. Inducing the lay belief of a changeable world increased participants' efficacy beliefs regarding pro-environmental behavior (across three studies) and their intention to act (albeit only in one of two studies). Similarly, the lay belief of a changeable world correlated with higher pandemic-related threat perception, efficacy beliefs, and intentions to act. However, no causal effect could be established in this context. Papers 3 and 4 investigated the effect of people's lay beliefs about whether willpower is a limited capacity or unlimited on engagement in pro-environmental behavior. Believing that willpower is unlimited was related to more everyday pro-environmental behavior, especially on more demanding days. It was also related to more engagement in a task that offered an environmental donation (in terms of task performance and cardiovascular measures of effort). However, evidence for a causal effect of lay beliefs about willpower was mixed. Taken together, this dissertation shows that lay beliefs play a role in people's perception of and reaction to global social problems, although results differed between the climate change and Covid-19 contexts. Still,

these findings deepen our understanding of context-independent factors that can foster or hinder action on global social problems. Future research can build on this by creating and testing persuasive messages that change people's lay beliefs long-term and may complement existing interventions that target problem-specific beliefs.

German Abstract

Globale gesellschaftliche Probleme wie der Klimawandel und Covid-19 sind ernsthafte Bedrohungen für die menschliche Gesundheit und Lebensgrundlage und erfordern rasches, umfassendes Handeln. Ihr globale Ausmaß erschwert es jedoch, Menschen zum Handeln zu bewegen. Zum einen werden diese Probleme möglicherweise als weniger schwerwiegend wahrgenommen, weil ihre Folgen eher abstrakt und diffus sind oder noch in der Zukunft liegen. Zum anderen kann das Gefühl entstehen, dass das eigene Verhalten wenig wirksam ist, um Probleme auf globaler Ebene anzugehen. Außerdem setzen selbst Menschen, die diese Probleme angehen wollen, ihre Absichten nicht immer in die Tat um. Individuelle Grundüberzeugungen über bestimmte Aspekte der Welt (sogenannte Laintheorien) können sowohl (1) die wahrgenommene Problemschwere und eigene Wirksamkeit als auch (2) die erfolgreiche Umsetzung von Verhaltensabsichten beeinflussen. In Paper 1 und 2 wurde untersucht, wie sich Laintheorien darüber, ob die Welt veränderbar oder unveränderlich ist, auf die Wahrnehmung und Verhaltensabsicht in Bezug auf den Klimawandel und Covid-19 auswirken. Die Laintheorie, dass die Welt veränderbar ist, steigerte bei den Teilnehmenden die Wirksamkeitserwartung in Bezug auf umweltfreundliches Verhalten (in drei Studien) und die Verhaltensabsichten (allerdings nur in einer von zwei Studien). Analog dazu korrelierte die Laintheorie einer veränderbaren Welt mit höherer wahrgenommener Schwere, höherer Wirksamkeitserwartung und größerer Verhaltensabsicht im Pandemiekontext. Hier konnte allerdings kein kausaler Effekt gezeigt werden. In Paper 3 und 4 wurde untersucht, wie sich Laintheorien darüber, ob Willenskraft eine begrenzte Ressource oder unbegrenzt ist, auf die Umsetzung von umweltfreundlichem Verhalten auswirken. Die Überzeugung, dass Willenskraft unbegrenzt ist, hing mit mehr umweltfreundlichem Verhalten im Alltag zusammen, insbesondere an anstrengenderen Tagen. Sie korrelierte außerdem mit besserer Leistung und größerer (kardiovaskulär

gemessener) Anstrengung in einer Aufgabe, die eine umweltfreundliche Spende beinhaltete. Hinweise auf einen kausalen Effekt von Laintheorien über Willenskraft waren jedoch uneinheitlich. Insgesamt zeigt diese Dissertation, dass Laintheorien eine Rolle bei der Wahrnehmung globaler sozialer Probleme und dem entsprechenden Verhalten spielen. Die Ergebnisse unterschieden sich allerdings zwischen den Kontexten Klimawandel und Covid-19. Dennoch erweitern sie das Verständnis von kontextunabhängigen Faktoren, die das Angehen globaler sozialer Probleme fördern oder behindern können. Zukünftige Forschung kann darauf aufbauen, indem sie Interventionen entwickelt und testet, die Laintheorien langfristig verändern und bestehende problemspezifische Interventionen ergänzen könnten.