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What Does It Take? A Cross-National Study Exploring Drivers for Willingness to Engage in Effortful Climate Action

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ABSTRACT

While much is known about what drives general participation in climate action, less is known about the drivers of actions that are explicitly linked to time, resource, or convenience constraints (i.e., effortful climate action). Understanding what drives effortful climate action is important to effectively tackle climate change, as many high impact actions will most likely require additional effort. In this cross-sectional study (N = approx. 4000), the theoretical framework of climate literacy is used to examine how knowledge, skills, value orientations, and risk perception help explain people's willingness to take effortful climate action in Germany and Sweden. The results of the sequential regression analyses indicate that risk perception (i.e., "How concerned are you about global warming?") is the strongest relative predictor of willingness to engage in effortful climate action in both countries. In contrast, the explanatory potential of knowledge about climate change and data analysis and interpretation skills is rather weak.

1 | Introduction

Human-induced climate change and the resulting rise in global surface temperature are increasingly affecting life on Earth, and further warming will continue to have severe and irreversible impacts on natural and human systems (IPCC 2021, 2022). There is genuine concern, both in the scientific community and among much of the public, that climate change poses a serious threat to contemporary life (IPCC 2022; for the U.S. public, see Leiserowitz et al. 2023; for the European public, see European Union 2023; for parts of the Global South, see Lee et al. 2015). Given this urgency, policymakers, scientists, educators, and many more are calling for immediate and comprehensive climate action to reduce future emissions (e.g., 13th Sustainable Development Goal; United Nations 2015). But how can this endeavour be supported at an individual level?

Although limiting global warming will require policy-supported systemic change (e.g., Wuppertal Institut 2020), it is widely recognised that individuals can contribute to reducing emissions to some extent (e.g., through consumption patterns; Carrico 2022; see also Engels et al. 2023). In 2023, nearly two-thirds of the European population claimed that they have recently taken action to mitigate climate change (European Union 2023). In the U.S., many citizens are similarly engaged in a range of activities to limit their emissions (Carman et al. 2021). However, a closer look at these reports shows that the most frequently cited climate actions include, for example, reducing waste and

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separating it for recycling, reducing the use of disposable items such as plastic bags, and installing energy-efficient lightbulbs. Not only do these measures have very low mitigation potential (Ivanova et al. 2020), but they also seem to require relatively little effort. In contrast, many climate actions with higher mitigation potential, such as limiting one's air travel or meat consumption (Wynes and Nicholas 2017), appear less likely to be implemented (see Dechezleprêtre et al. 2022). This may reflect that many of these high-impact measures involve constraints or costs, such as the additional time required to use public transportation or the additional financial resources required to make certain consumption decisions (see also 'extra mitigation behaviour'; Ortega-Egea et al. 2014). This raises the more specific question of what motivates people to take actions aimed at mitigating climate change, even if these actions can be considered rather effortful. The present work takes this question as its starting point.

Research, particularly in the field of environmental psychology, has examined a range of factors to determine drivers for climate actions. In examining their relationship, conceptual models such as the value-belief-norm theory (VBN; Stern 2000), the theory of planned behaviour (Ajzen 1991), and the norm activation model (NAM; Schwartz 1977) were often used. While these frameworks provide a strong and well-established basis for explaining engagement in climate actions, they often do not explicitly consider the role of climate change knowledge—a variable that has been shown in previous studies to be inconclusive in terms of its impact on climate actions (for a positive influence e.g., Bord et al. 2000; for a less significant influence e.g., Whitmarsh and O'Neill 2010).[1] To address this gap, the concept of climate literacy could provide a useful framework, as it explicitly considers both cognitive and more psycho-social factors that can contribute to climate engagement (see Azevedo and Marques 2017). Being climate literate entails making well-informed and responsible decisions about actions that can affect our climate (USGCRP 2009; 2024). In the field of educational research, climate literacy is usually operationalised in terms of three core components: (1) a basic understanding of how the climate system works and how climate science is done (e.g., knowledge about the causes and consequences of climate change), (2) related practical skills for accessing, analysing and communicating climate change-related information (e.g., skills to analyse climate change-related data), and (3) aspects of a personal stance toward climate change such as value orientations (Azevedo and Marques 2017). In addition to these three core components, climate change-related risk perception is increasingly being considered in the context of climate literacy (e.g., Kolenatý et al. 2022).

In recent years, studies have begun to successfully apply the climate literacy framework to study people's engagement in climate actions (e.g., Kolenatý et al. 2022). To the best of our knowledge, however, no study to date has used this specific framework to examine climate actions that explicitly require more time and resources or are associated with greater inconvenience. The added value of applying the framework of climate literacy for examining actions that require greater effort seems fairly evident, as it allows for the integration of both cognitive and motivational aspects and thus covers a wider range of possible drivers. For the quantitative cross-sectional study presented here, the framework was therefore used to answer the research question: "To what extent do the components of climate literacy (i.e., knowledge, skills, value orientations, and risk perception) explain participants' willingness to engage in climate actions, even if it explicitly requires an investment in terms of time, resources, or convenience?"

2 | Theoretical Background

2.1 | Effortful Climate Actions Seem Crucial to Address Climate Change Effectively

Although much of the work in the field of environmental psychology focuses on environmental behaviour, which encompasses a wide range of actions aimed at human-environment interactions (see Steg and Vlek 2009), this research specifically addresses climate actions as they relate to the effects of human activities on the global climate. Compared to mere behaviour, climate *actions* are understood as actively initiated, purposeful, and consciously self-selected activities (see Jensen and Schnack 1997). In terms of their primary objective, two different types of climate actions can be distinguished: actions that focus on how to reduce greenhouse gases to limit further warming, and thus aim to mitigate climate change, and actions that focus on responses to climate change impacts, such as greening in response to extreme rainfall, and thus aim to adapt to climate change (Engels et al. 2023). However, many adaptation actions take the form of legal and policy changes (e.g., urban planning in response to urban heat islands), while individual actions are rather limited (e.g., purchasing insurance to cover risks to properties), which is why the present work focuses specifically on climate change mitigation actions. A further distinction can be made between collective (i.e., acting as part of a group to achieve common group goals; Bamberg et al. 2015) and individual action (i.e., individual decision-making directed toward the private sphere; see Wallis et al. 2021). As collective climate action tends to be taken less frequently (e.g., Thaller et al. 2020), the present work focuses on individual climate actions in the private sphere (e.g., reducing one's energy consumption). While there is evidence that the public primarily adopts climate actions such as recycling and reducing plastic bags (e.g., European Union 2023; Carman et al. 2021), which we would argue tend to require less effort, this study focuses explicitly on *effortful* climate actions that is, climate actions that involve explicit constraints in terms of time, resources, or convenience.

Not surprisingly, studies have shown that perceived effort or cost (e.g., in terms of additional time, resources, or convenience) predicts whether or not one engages in climate actions. For example, Cologna et al. (2022) found that the lower the perceived effort, the higher the willingness of Swiss citizens to engage in climate actions. Similar findings were provided by other studies (e.g., Mäkiniemi and Vainio 2014; Tobler et al. 2012), which showed that the perception of sacrificing time, money, or convenience when participating in climate actions negatively influences their enactment. These observations are worrisome on two counts: first, while these studies suggest that climate actions should be considered in a more nuanced way, most studies to date do not meet this call (see Whitmarsh et al. 2021). Second, many of the more effective climate actions will most likely require greater effort (e.g., a plant-based diet, see Ivanova et al. 2020), but most people seem reluctant to make these efforts. Thus, if one aims

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to figure out how to effectively address climate change, it seems crucial to also understand the predictors of climate actions that involve greater effort.

2.2 | Sociodemographic Data: Gender Identification and Years of Education Can Influence Engagement in Climate Actions

To gain an understanding of what drives engagement in climate actions, most studies have examined or controlled for sociodemographic factors, primarily gender and years of education. In terms of gender, most studies agree that women seem to be more willing to engage in climate actions than men (e.g., Bruderer Enzler et al. 2019; for climate actions that require additional effort, see Ortega-Egea et al. 2014). However, if one takes a closer look at the type of climate action, first indications of a difference can be found: While men are more likely to get involved at the societal level (e.g., with their vote or signing petitions), women seem to be more active in the private sphere when it comes to conservation behaviour (e.g., through conscious consumerism and travel) (Thaller et al. 2020). The level of education is also identified as a positive influence on an individual's commitment to climate action (e.g., Meyer 2015). However, following the narrative of human capital theory (Becker 1964; for a critical analysis, see Marginson 2019), the number of years of education could serve as a proxy measure for greater opportunities to score a better-paying job that allows individuals to engage in certain climate actions that require financial resources.

While there is some evidence on the role of gender and educational attainment in participation in climate actions, much less is known about how these variables play out regarding climate actions that require additional effort. Initial indications of a possible connection already exist: In their study of low- and high-impact climate actions, Cologna et al. (2022) found that men were less likely than women to participate in high-impact actions (which we argue tend to be more effortful), while they found no difference in low-impact actions.

2.3 | Cognitive Factors: Climate Knowledge and Analysing Data Can Affect Engagement in Climate Actions

Despite the ongoing debate about the specific role of knowledge in mitigating climate change—ranging from being one of the most important predictors (e.g., Bord et al. 2000) to having little to no influence on respondents' willingness to take climate action (e.g., Kolenatý et al. 2022; Tolppanen et al. 2022; Whitmarsh and O'Neill 2010)—meta-analytic evidence suggests that there may well be an indirect relationship between the two variables (Bamberg and Möser 2007; for adapting to climate change see Van Valkengoed and Steg 2019). Indeed, climate change-related knowledge is an important starting point for understanding *why* and *how* our actions need to change. However, the indecisive manner in which climate change-related knowledge is operationalised and measured across studies likely contributes to the rather ambivalent findings in the research field (e.g., use of proxy measures as in Malka et al. 2009). A few studies have examined the relationship between knowledge and engagement in different types of climate actions. For example, Thaller et al. (2020) found climate change-related knowledge to be (weakly) related to climate actions in the public sphere, such as engagement in a local climate group, but not to activities aimed at conservation in the private sphere (e.g., recycling, heating) or related to climate citizenship (e.g., voting, petitions, donations). These insights suggest that knowing about the causes and consequences of climate change may play a role in deciding which actions to participate in.

While much of the research examining cognitive factors focuses on climate change-related knowledge, the importance of associated skills that enable individuals to acquire, assess, and use climate change-related information is often overlooked. These skills are undoubtedly important for dealing with climate trends, as most scientific reports, such as the IPCC (2021), typically present data in tables, graphs, and bars. To date, there have been very few studies that examine working with climate change-related data as part of climate literacy (e.g., Mateus et al. 2021), and –as far as we know– there have been no studies examining the impacts of these skills on willingness to engage in climate action. Nonetheless, it seems worthwhile to further explore the role of data-related skills in the context of climate change: For example, McMahon et al. (2015) found evidence that many individuals who were less familiar with climate science had difficulty interpreting an IPCC graphic, leading to confusion and a misjudgement of the uncertainties presented. We therefore argue that considering the role of related practical skills for analysing climate change-related information represents a novel and promising approach to studying drivers of climate action.

2.4 | Risk Perception Can Influence Engagement in Climate Actions

While climate change is (objectively) a serious threat to life on Earth as currently known, the extent to which individuals view these climatic trends as risky can vary widely—even within a single country (e.g., for the U.S. public, see Leiserowitz et al. 2023). However, when climate change is perceived as a risk, this can be an important driver to participate in climate actions (e.g., Brügger et al. 2020; Xie et al. 2019).

Risk perception is defined as the subjective assessment of a (future) harm in the context of a person's social and cultural environment (Slovic 1999; Denney 2005). Although risk perception is usually described as a cognitive process, these assessments may be driven by affect (see Loewenstein et al. 2001). To understand what drives risk perception in the particular context of climate change, van der Linden (2015) proposed a four-factor model on climate change risk perception. The four factors describe cognitive, experiential, socio-cultural, and socio-demographic aspects. This model has been successfully used in different studies across multiple countries, typically explaining more than 50% of the variance examined (e.g., Gilbert and Lachlan 2023). Given the different geographical scales at which climate change-related risks can be perceived, van der Linden (2015) further distinguishes two components of risk perception: a broader, more global perception of risk (i.e., climate change impacts are perceived at a societal and global level) and a personal, more local risk perception (i.e.,

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climate change impacts are perceived for oneself and one's immediate surroundings).

2.5 | Value Orientations Can Have a Mixed Effect on Engagement in Climate Actions

An important driver of climate action is an individual's set of values (e.g., van der Werff et al. 2013). Based on two prominent frameworks, Schwartz's norm-activation model (Schwartz 1977) and Stern's value-belief-norm theory (Stern 2000), most studies in environmental psychology examine the prominence of four distinct value orientations: biospheric values (i.e., reflecting the perceived importance to care for the natural environment), altruistic values (i.e., reflecting the perceived importance of helping others in terms of social justice), hedonic values (i.e., reflecting the perceived importance to experience pleasure and reduced effort), and egoistic values (i.e., reflecting the perceived importance to experience power and status) (e.g., de Groot and Steg 2008; Steg et al. 2014). Not surprisingly, the debate about the importance of biospheric values relative to other values seems to play a major role in explaining climate action (e.g., Bouman et al. 2021). Moreover, studies have found a link between people's willingness to engage in climate action and their altruistic values, possibly because many climate-related activities also benefit society (e.g., de Groot and Steg 2008). In contrast, the picture for the other two value orientations—egoistic and hedonic values—is more mixed. While most studies indicate that people who regularly engage in climate actions are less likely to hold egoistic and/or hedonic values (e.g., Howell 2013), or even show a negative correlation between these value orientations and certain activities such as car use (Steg et al. 2014), other studies suggest that these value orientations more likely underpin climate action more indirectly, such as when climate action leads to a financial return (e.g., reducing car use to save money in the long run; for a critical discussion see de Groot and Steg 2009) or improves their social status (e.g., solar panels as luxury items; e.g., Noppers et al. 2014).

3 | Research Objective

To effectively combat climate change, it is proposed to engage in high-impact (i.e., low emission) climate actions to significantly reduce individual greenhouse gas emissions (e.g., limiting air travel; Wynes and Nicholas 2017). However, we argue that these high-impact actions usually come at a higher cost (e.g., in terms of additional time to get from one place to another), which may be one reason why many people seem hesitant to implement such actions (see Dechezleprêtre et al. 2022). This inevitably leads to the question of what drives people to 'do more' (see also Ortega-Egea et al. 2014). Despite the extensive research on climate action in general, the review of literature shows that studies dealing with effortful climate actions that is, climate actions that involve explicit constraints in terms of time, resources, or convenience, are rare. Furthermore, the models and theories that have been commonly used to address questions related to climate action often do not explicitly consider knowledge and skills (e.g., the theory of planned behaviour; Ajzen 1991), which have been argued as an important starting point for understanding why and how our actions need to change. The present work aims to address both issues: Building upon the framework of climate literacy (Azevedo and Marques 2017), this study was undertaken to examine how knowledge, skills, value orientations, and risk perception can act as drivers for people's willingness to engage in climate actions, even when these actions are explicitly associated with costs or greater effort. To add another layer of validity and increase the overall generalisability of the results, this study was conducted in two different countries.

4 | Materials and Methods

4.1 | Design and Procedure

This study was conducted across two countries (Germany and Sweden) in a cross-sectional design. We chose Germany and Sweden as countries of interest, as both are located in Northern Europe and are reasonably comparable in terms of educational structure (i.e., both follow K-12 school systems) and economic prosperity. Furthermore, both countries are striving to implement education for sustainability (see European Commission 2023), and it can be assumed that citizens of both counties are committed to individual climate action to a roughly comparable extent (see European Union 2023). In addition to these content-related considerations, conducting this study in two different but comparable countries can support the validation of our results, if similar patterns are found in both samples. An online questionnaire, which was based on the variables presented in the theoretical background (i.e., knowledge, skills, value orientations, and risk perception) and used across different target groups, was compiled from established instruments to assure a certain degree of validity. All items were professionally translated from English into German and Swedish by the same professional translator to maximise comparability. To ensure that the items in the translated questionnaires were both clear and unambiguous, a pilot study was conducted with 428 students (upper secondary and university) from both countries. Feedback from the pilot study was used to refine the questionnaire at the linguistic level and to review the reliability of the chosen instruments. The adjustments to the items resulting from the pilot study are described in the respective sections. The main data collection was conducted in early 2022 and participation in the survey lasted about 25 min on average. All studies reported in the present work were approved by the Ethics Committee at the Leibniz Institute for Science and Mathematics Education (reference number: 2020_GA39) for the data collection in Germany and by the Research Ethics Committee at Karlstad University (reference number: 'HS' 2020/786) for the collection of data in Sweden.

4.2 | Samples

In this study, two independent datasets based on nationwide samples from Germany and Sweden collected by two survey sampling companies are presented (respondi AG and Kantar Sifo). In each country, a national quota sample based on gender, age, and geographical location (i.e., federal state in Germany) was drawn from a panel of individuals who volunteered to take part in surveys for financial compensation. The Swedish dataset was provided without missing data and consists of 2000 respondents (49% identified as female; age: $M = 46.58$; $SD = 16.21$). For the German dataset, individuals missing either 15% or more of the

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total dataset or 25% or more of each variable investigated in this study (except the instruments used to measure cognitive factors) were dropped, resulting in a total number of 2122 respondents (50% identified as female; age: $M = 44.88$; SD = 14.27). According to post-hoc power analysis performed with the G*Power 3.1.9.7 software (Faul et al. 2009), the studies had sufficient statistical power (0.997) to detect even a small effect size ($f^2 = 0.02$; with $\alpha = 0.05$, a total sample size of 2000 and a maximum of 12 predictors).

4.3 | Measures

For an overview of selected instruments please also see Table S1.

4.3.1 | Background Information

Based on theoretical grounds, respondents' gender and highest level of education (school education, vocational education, university degree) were of interest. In addition, current engagement in environmental activities (no engagement, voluntarily or through work/school) was queried and used as a control variable.

4.3.2 | Cognitive Factors

Regarding the cognitive factors, the study focused on participants' climate change-related content knowledge and their skills to analyse and interpret data. To measure participants' knowledge on climate change, an instrument developed by Libarkin et al. (2018) that includes single- and multiple-response items on aspects such as radiation and greenhouse gases was adapted. Of the 21 items proposed in the original instrument, six items were deleted based on Rasch-analysed results from the German pilot study to reduce the overall processing time. To elicit respondents' data analysis and interpretation skills, an instrument from the Stanford NGSS Assessment Project (2023) with five items was used. This instrument (SNAP Natural Hazards short-response items for Earth Science; MS-ESS3-2) evaluates respondents' skills to analyse and interpret data in the context of natural hazards (i.e., landslides and volcanos). The respondents had the opportunity to indicate if they had technical problems viewing the charts or maps. For reasons of clarity, the final task of the instrument was adjusted from the original table to six individual sub-questions, which created the additional answer option 'none of the statements is correct'. As a result of this re-structuring, participants' data analysis and interpretation skills were assessed with 10 items in total.

4.3.3 | Risk Perception

To measure participants' risk perception in the context of climate change, this study drew on two instruments by Leiserowitz (2006) and van der Linden (2015) and asked 21 items in total. One set of items (16 items in total) assessed participants' local and global risk perceptions by asking them to rate on a four-point Likert scale how likely it is that various negative events (e.g., water scarcity) will occur in their immediate area and globally over the next 50 years due to global warming. From these 16 items, six items were provided by the original instrument (Leiserowitz 2006), six items (forest fires, storms, flooding; global and local, respectively) were added by the authors of the present work based on their relevance for the countries where this study was conducted, and four items (climate migration and societal conflicts; global and local, respectively) were added as a result of the pilot study. Another set of items (five items, adopted from the original instruments by Leiserowitz (2006) and van der Linden (2015), partially on a five-point Likert scale) asked respondents how concerned they are about global warming and how severe they think the effects of global warming and climate change will be on plants and animals, on themselves and their own health, and on the country in which they live.

4.3.4 | Value Orientations

To measure participants' value orientations, this study used an instrument developed on the basis of Schwartz's (1992) and Stern et al.'s (1999) work, which was further conceived and empirically validated by Steg and colleagues (de Groot and Steg 2008; Steg et al. 2011; Steg et al. 2014). The instrument, as displayed in de Groot and Steg (2008) and Steg et al. (2014), asks participants to rate 16 different values (items) on a nine-point Likert scale in order of importance to their own lives ranging from −1 ('opposed to my values') to 7 ('extremely important'). Each value (item) can be theoretically assigned to one of four value orientations: biospheric (e.g., respecting the earth), altruistic (e.g., social justice), hedonic (e.g., enjoying life), and egoistic (e.g., social power). In the instruction, participants were asked to rank only two values (items) as extremely important. The 16 values were displayed in random order.

4.3.5 | Willingness to Engage in Effortful Climate Actions

To measure how committed individuals are to climate action, this study employed an instrument developed by Boyes and Stanisstreet (2012). Of the original instrument, which contains items assessing the believed usefulness of specific climate actions and items assessing the degree of willingness to implement those actions, only the latter items were used. These items explicitly mention potential costs associated with the climate action (e.g., "Even if it took me longer and was more inconvenient, I would try to use buses and trains instead of a car"), and respondents were asked to indicate how likely they would be to undertake these actions on a five-point Likert scale ranging from 'I would probably not do it' to 'I would definitely do it'. As a result of the pilot study, one of the endpoints was adjusted to 'I would definitely do it/I already do it'. Of the original 16 items, some were adapted to current technological developments (e.g., smart technologies), and items on voting behaviour were reworded to meet ethical regulations. Since the survey was also distributed to students as part of another study, some items were adjusted in terms of content and language (e.g., laptops and televisions instead of refrigerators and washing machines), and one item on nuclear energy was deleted. One item was not considered in the analysis as it did not address potential inconveniences explicitly. Thus, a total of 14 items were included in the analysis, all of which display explicit constraints in terms of time, resources, or inconvenience,

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ranging from largely minor (e.g., recycling, more efficient devices) to moderate and a few higher-impact measures (e.g., following a vegetarian diet) (see Ivanova et al. 2020).

4.4 | Handling Data Before Analysis

Due to the nature of the project and the country-specific guidelines for data management, the German and Swedish datasets were treated and analysed separately. However, both the data cleaning measures and the analysis steps were carried out in close cooperation and can therefore be considered comparable.

4.4.1 | Missing Data

The Swedish dataset was provided without missing data. Regarding the handling of missing data in the German dataset, two measures were taken: First, all cases in which more than 15% of the total dataset was missing were deleted ($n = 21$ cases). Second, cases in which 25% or more of the data of a variable investigated in the present study were missing were deleted ($n = 74$; with the exception of the items measuring cognitive factors, where missing data, 'I don't know' and 'I have technical issues' were treated as incorrect answers).

4.4.2 | Rescoring of Items

For the variable 'education', the open-ended responses in the 'other' section were assigned to one of three levels of education: school education, vocational education, and university degree. The item capturing participants' current engagement in environmental activities was checked for unreasonable combinations (e.g., 'no involvement' and 'involvement' at the same time), and such combinations were recoded as missing. Participants' gender was dichotomised into female and male, which resulted in missing data in two cases in the German dataset.[2] Items measuring participants' climate change-related knowledge and skills (i.e., cognitive factors) were rescored in dichotomous items to indicate (in)correct responses. Two of the 21 items assessing respondents' risk perception were measured on a five-point Likert scale rather than a four-point Likert scale. These two items were rescored so that all items measuring risk perception covered the same range of 0–4. Mean scores were calculated for each dimension of value orientation and risk perception, and willingness to engage in climate action. Sum scores were calculated for both cognitive factors that is, climate change-related content knowledge, and data analysis and interpretation skills.

4.4.3 | The Variable Analysing Data

In the Swedish dataset, the variable measuring participants' data analysis and interpretation skills was excluded due to a programming error in which the response option "I don't know" was added.

4.5 | Method of Data Analysis

Before analysis, all continuous scales (i.e., risk perception, value orientations, willingness to engage in effortful climate action) and their sub-dimensions have been checked for reliability (results can be interpreted as acceptable, ranging from $\alpha = 0.75$ to 0.93 in the German dataset and $\alpha = 0.77$ to 0.93 in the Swedish dataset). To test for (theoretical) dimensionality, principal component analyses were conducted for the respective variables (i.e., risk perception, value orientations, and willingness to engage in effortful climate action). By applying the method of sequential regression analysis, the predictive power of these variables was systematically investigated. Data has been analysed using R Statistical Software (R Core Team 2021).

5 | Results

5.1 | Preparatory Work and Descriptive Insights

5.1.1 | Principal Component Analysis

To test for (theoretical) dimensionality of the assessed constructs, principal component analyses were conducted. In both datasets, the results suggested that willingness to engage in effortful climate action should be used as a one-dimensional construct, and risk perception should be used as a two-dimensional construct. However, with regard to the latter, both principal component analyses showed that one item that was theoretically assumed to be part of the local/personal dimension was perceived by respondents in both countries as a global risk and was therefore considered part of the global/societal dimension in the following. Results of the principal component analyses suggested that in the German dataset, value orientations should be used as a three-dimensional construct, as the altruistic and the biospheric dimensions fall together (therefore, a combined mean score was calculated). In the Swedish dataset, value orientations should be considered as a two-dimensional construct, as the altruistic and the biospheric as well as the egoistic and hedonic dimensions fall together (therefore, combined mean scores were calculated).

5.1.2 | Analysis of Variance for the Variable of Risk Perception

While the reliabilities of the indices created were good (e.g., global risk perception $\alpha = 0.93$ and local risk perception $\alpha = 0.88$ in the German dataset; global risk perception $\alpha = 0.95$ and local risk perception $\alpha = 0.89$ in the Swedish dataset), the analysis of variance revealed that more than one-third of the variance (35%) in German participants' willingness to engage in effortful climate action and almost half of the variance (46%) in Swedish participants' willingness to engage in effortful climate action was explained by solely one item: "How concerned are you about global warming?"[3] (Leiserowitz 2006). Therefore, it was decided to use this single item for statistical analyses rather than the entire instrument.

5.1.3 | Descriptive Insights

An overview of the descriptive insights is presented in Table 1 (for the German dataset) and Table 2 (for the Swedish dataset). For the dependent variable (i.e., willingness to engage in effortful climate

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TABLE 1 | Descriptive statistics and correlations in the German dataset.

Variable	Mean	SD	1	2	3	4	5	6	7
1. Value orientation altruistic	5.14	1.26							
2. Value orientation biospheric	5.19	1.41	0.65***						
3. Value orientation hedonic	4.63	1.39	0.26***	0.19***					
4. Value orientation egoistic	2.43	1.45	0.06**	0.03	0.40***				
5. Risk perception (rp_glob12)	3.10	0.86	0.34***	0.48***	−0.04	−0.07***			
6. Climate-related content knowledge (sum)	4.98	2.69	0.06**	0.12***	−0.10***	−0.13***	0.20***		
7. Skills to analyse data (sum)	4.82	1.91	0.01	0.04	−0.03	−0.23***	0.11***	0.39***	
8. Willingness to engage in effortful climate action	3.35	0.88	0.38***	0.48***	−0.10***	−0.04	0.59***	0.22***	0.12***

Note: Sample size for almost all variables is 2122, except for the item assessing risk perception which has a sample size of 2084.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

TABLE 2 | Descriptive statistics and correlations in the Swedish dataset.

Variable	Mean	SD	1	2	3	4	5	6
1. Value orientation altruistic	5.16	1.19						
2. Value orientation biospheric	5.03	1.32	0.51***					
3. Value orientation hedonic	4.35	1.28	0.09***	0.09***				
4. Value orientation egoistic	2.40	1.25	−0.02	0.01	0.41***			
5. Risk perception (rp_glob12)	3.02	0.95	0.35***	0.46***	−0.10***	−0.20***		
6. Climate-related content knowledge (sum)	6.01	2.94	−0.06**	0.03	−0.09***	−0.18***	0.13***	
7. Willingness to engage in effortful climate action	3.58	0.87	0.44***	0.50***	−0.17***	−0.25***	0.68***	0.18***

Note: Sample size for all variables is 2000.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

action), around 37% of the Swedish and 27% of the German population stated that –on average– they would almost certainly participate in climate actions, even if they come with greater effort (i.e., had a mean score of four or higher on a five-point Likert scale).

Most of the predictor variables are significantly correlated with participants' willingness to engage in effortful climate action, ranging from $r = -0.10$ to $r = 0.59$ in the German sample and from $r = -0.25$ to $r = 0.68$ in the Swedish sample. In the German dataset, the strongest correlation was found between the altruistic value orientation and the biospheric value orientation ($r = 0.65$). With regard to willingness to engage in effortful climate action, risk perception is most strongly correlated ($r = 0.59$) and egoistic value orientation least ($r = -0.04$). In the Swedish dataset, the strongest correlation was found between willingness to engage in effortful climate action and risk perception ($r = 0.68$). Conversely, hedonic value orientation is the least correlated with regard to willingness to engage in effortful climate action ($r = -0.17$).

5.2 | Sequential Regression Models

The method of sequential regression analysis was used to examine the extent to which the different aspects of climate literacy can explain participants' willingness to engage in effortful climate action. Results can be found in Table 3 (for the German dataset) and Table 4 (for the Swedish dataset). For full information display, both unstandardised coefficients (b), as dichotomous variables were assessed, and standardised coefficients (β), to assess the relative importance of predictors, are reported. Direct comparison of unstandardised coefficients should be avoided.

The first model serves as a base model and displays the influence of background information. In the German dataset, results for model 1 show that gender (i.e., identifying as female), holding a university degree and current engagement are significant predictors, explaining about 5% of the variance in participants' willingness to engage in effortful climate action ($F(4, 1998) = 26.87$, $p < 0.001$, adj. $R^2 = 0.05$). In the Swedish dataset, the same three variables are found to be significant predictors, explaining a total of 11% of the variance ($F(4, 1995) = 62.5$, $p < 0.001$, adj. $R^2 = 0.11$).

The second model examined whether cognitive factors explain additional variance in participants' willingness to engage in effortful climate action, while controlling for the background information. In the German sample, climate change-related content knowledge and data analysis and interpretation skills were identified as significant predictors ($F(2, 1996) = 48.56$, $p < 0.001$,

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TABLE 3 | Results of the sequential regression analysis of the German dataset.

Independent variables	Background information		Cognitive factors			Risk perception			Value orientation		
	Model 1		Model 2			Model 3			Model 4		
	b	SE	*b*	SE	*β*	*b*	SE	*β*	*b*	SE	*β*
Gender[a]	0.16***	0.04	0.21***	0.04	(0.12***)	0.11***	0.03	(0.06***)	0.08**	0.03	(0.05**)
Education level 1[a]	0.12*	0.05	0.04	0.05	(0.02)	0.08*	0.04	(0.05*)	0.14***	0.04	(0.07***)
Education level 2[a]	−0.01	0.05	−0.02	0.05	(−0.01)	0.003	0.04	(0.002)	0.01	0.04	(0.003)
Engagement[a]	0.49***	0.06	0.45***	0.06	(0.17***)	0.31***	0.05	(0.12***)	0.29***	0.04	(0.11***)
Climate knowledge			0.06***	0.01	0.19***	0.03***	0.01	0.08***	0.02**	0.01	0.06**
Data analysis skill			0.03*	0.01	0.06*	0.01	0.01	0.03	0.02*	0.01	0.04*
Risk perception						0.58***	0.02	0.56***	0.44***	0.02	0.42***
Value orientation altruistic/biospheric									0.22***	0.01	0.30***
Value orientation hedonic									−0.11***	0.01	−0.17***
Value orientation egoistic									0.02	0.01	0.04
Adj. R^2	0.05 [0.0492]		0.09 [0.0924]			0.39 [0.3917]			0.46 [0.4644]		
(Multiple) R^2	0.05 [0.0511]		0.10 [0.0951]			0.39 [0.3938]			0.47 [0.4671]		
ΔAdj. R^2			0.04			0.30			0.07		
F_{change}	26.87***		48.56***			983.01***			91.36***		

Note: Dependent variable is willingness to engage in climate action, even if these activities explicitly mention additional costs in terms of time, effort or resources. Education level 1 = university degree; education level 2 = vocational; only complete cases ($N = 2003$).

[a]These are dichotomous variables; for all entries.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Δadj. $R^2 = 0.04$). Climate change-related content knowledge also emerged as a significant predictor in the Swedish dataset, explaining a further 4% of the variance ($F(1, 1994) = 80.14$, $p < 0.001$, Δ adj. $R^2 = 0.03$).

Model 3 assessed the influence of risk perception. In both countries, risk perception (i.e., the item: "How concerned are you about global warming"; Leiserowitz 2006) was found to be a significant predictor for participants' willingness to engage in effortful climate action, explaining an additional 30% of the variance in the German dataset ($F(1, 1995) = 983.01$, $p < 0.001$, Δ adj $R^2 = 0.30$) and an additional 34% of the variance in the Swedish dataset ($F(1, 1993) = 1346$, $p < 0.001$, Δadj $R^2 = 0.35$).

The final model explored the explanatory power of value orientations on willingness to engage in effortful climate action, while controlling for all other variables. In the German dataset, altruistic/biospheric value orientation (as suggested by results of the principal component analysis) as well as a hedonic value orientation were found to be significant predictors, explaining an additional 7% of the variance ($F(3, 1992) = 91.36$, $p < 0.001$, Δ adj $R^2 = 0.07$). In the Swedish dataset, both dimensions (as suggested by results of the principal component analysis) were significant predictors, explaining a further 8% of the variance ($F(2, 1991) = 194.9$, $p < 0.001$, Δadj $R^2 = 0.08$). In total, our final models account for 47% of the variance in German participants' willingness to engage in effortful climate action and 57% of the variance in Swedish participants' willingness to engage in effortful climate action, whereas gender (both datasets), a university degree (both datasets), previous engagement (both datasets), climate change-related knowledge (both datasets), data analysis and interpretation skills (only German dataset), risk perception (i.e., the item: "How concerned are you about global warming"; Leiserowitz 2006) (both datasets), altruistic/biospheric (both datasets), as well as hedonic/egoistic (Swedish dataset) and hedonic (German dataset) value orientations emerge to be significant predictors.

To detect potential multicollinearity, the variance inflation factor (VIF) was calculated. Neither for the Swedish data nor for the German data was the VIF coefficient for any predictor greater than 5 (ranging between 1.07 and 1.63 in the German dataset and 1.04 and 1.43 in the Swedish dataset considering all predictors), which is considered a common cut-off level for potentially severe correlations between predictors (for a critical discussion, see Vatcheva et al. 2016).

6 | Discussion and Implications

The present study examines the extent to which components of climate literacy explain German and Swedish adults'

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TABLE 4 | Results of the sequential regression analysis of the Swedish dataset.

Independent variables	Background information		Cognitive factors			Risk perception			Value orientation		
	Model 1		Model 2			Model 3			Model 4		
	b	SE	*b*	SE	*β*	*b*	SE	*β*	*b*	SE	*β*
Gender[a]	0.40***	0.04	0.47***	0.04	(0.27***)	0.18***	0.03	(0.10***)	0.09***	0.03	(0.05***)
Education level 1[a]	0.33***	0.04	0.26***	0.04	(0.15***)	0.18***	0.03	(0.10***)	0.18***	0.03	(0.10***)
Education level 2[a]	0.07	0.06	0.08	0.06	(0.03)	0.10*	0.05	(0.04*)	0.05	0.04	(0.02)
Engagement[a]	0.33***	0.05	0.29***	0.05	(0.11***)	0.14***	0.04	(0.06***)	0.11**	0.04	(0.05**)
Climate knowledge			0.06***	0.01	0.19***	0.03***	0.005	0.10***	0.03***	0.005	0.09**
Risk perception						0.57***	0.02	0.62***	0.42***	0.02	0.46***
Value orientation altruistic/biospheric									0.25***	0.01	0.32***
Value orientation hedonic/egoistic									−0.12***	0.01	−0.15***
Adj. R^2	0.11 [0.1096]		0.14 [0.1435]			0.49 [0.4885]			0.57 [0.5718]		
(Multiple) R^2	0.11 [0.1114]		0.15 [0.1457]			0.49 [0.4900]			0.57 [0.5735]		
ΔAdj. R^2			0.03			0.35			0.08		
F_{change}	62.5***		80.14***			1346***			194.9***		

Note: Dependent variable is willingness to engage in climate action, even if these activities explicitly mention additional costs in terms of time, effort, or resources. Education level 1 = university degree; Education level 2 = vocational; only complete cases ($N = 2000$).

[a]These are dichotomous variables; for all entries.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

willingness to engage in climate action, even if these actions explicitly require an investment in terms of time, resources, or convenience (i.e., effortful climate action). The results of the two sequential regression analyses conducted show that risk perception (i.e., the item: "How concerned are you about global warming"; Leiserowitz 2006) is the strongest relative predictor of participants' willingness in both countries. Similarly, the results indicate that cognitive factors play a rather limited role in explaining willingness to engage in effortful climate actions, while a biospheric/altruistic value orientation is positively and hedonic and egoistic value orientations are negatively (or not at all) associated with participants' willingness.

6.1 | Identifying as Female, Higher Level of Education and Current Engagement in Environmental Activities Are Positively Related With Willingness to Engage in Effortful Climate Action

In line with our expectations, gender (i.e., identifying as female), higher education level (i.e., holding a university degree) and recent participation in environmental activities were identified as significant predictors in both datasets. While identifying as female has repeatedly been shown to be a predictor of willingness to engage in climate action (e.g., Bruderer Enzler et al. 2019), the present results complement this finding by indicating that this also applies to effortful climate actions. According to Ortega-Egea et al. (2014), who found similar results, this is likely related to prevailing gender roles, as women are traditionally portrayed as empathetic caregivers (see also Zelezny et al. 2000). Another explanation can be derived from Swim et al. (2020), who suggest that men tend to refrain from climate actions that have a feminine connotation (e.g., activities that are consumption-oriented) in order to protect their masculinity. Since about one third of our instrument consisted of items related to consumption in a broader sense (e.g., recycling, conscious shopping, eating less meat), these choices may have been less appealing to men. In addition, since consumption-related measures are usually associated with additional financial costs, this could explain why a higher level of education, as a potential indicator of financial stability (see Becker 1964), is a significant but weak predictor in our model. In sum, these findings point to the existing inequalities that are still linked to the questions of who is provided with meaningful opportunities to engage in climate action, who is held responsible to engage in climate action and how to address climate change in general.

Finally, the study found that pre-existing engagement in environmental activities is positively associated with participants' willingness to engage in effortful climate action. One explanation could be that if one identifies as an environmentally-friendly person, continued engagement may aim to avoid the cognitive dissonance that would result from refraining from further pro-environmental action, or it may help to avoid appearing hypocritical (see Truelove et al. 2014). Thus, an earlier, relatively effortless commitment to climate action could potentially pave the way for future commitment, even if this potentially requires

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greater effort (i.e., foot-in-the-door effect; for a critical discussion, see Arnold and Kaiser 2018).

6.2 | Climate Change-Related Knowledge and Data Analysis and Interpretation Skills Are Weak Predictors of Willingness to Engage in Effortful Climate Action

In both datasets, the results indicate that climate change-related knowledge is positively associated with willingness to take effortful climate action. In the German dataset, a positive relationship between the ability to analyse and interpret data and participants' willingness has also been found. However, all predictors seem to be weak in strength and their influence thus marginal.

One explanation for the subordinate role of knowledge could be that this study only measured knowledge about the climate system, for example in relation to the greenhouse effect or carbon dioxide concentration. In addition to knowledge about the causes and consequences of climate change (i.e., descriptive knowledge), knowledge about the ways to combat climate change (i.e., procedural knowledge) and knowledge about the effectiveness of certain climate measures (i.e., effectiveness knowledge) are also considered relevant for engagement in climate action (e.g., Kolenatý et al. 2022). In a study by Shi et al. (2015), for example, knowledge about effectiveness appeared to have a positive influence on participants' willingness to engage in climate actions. Unfortunately, various studies show that knowledge about the effectiveness, that is, how different climate actions can mitigate climate change to varying degrees, seems to be limited (e.g., Tolppanen et al. 2021). Particularly in the case of effortful climate actions, knowledge of their effectiveness could be important in deciding whether additional constraints in terms of time, resources, or convenience are worthwhile: Cologna et al. (2022) found that a higher level of knowledge about the effects of certain actions (in terms of CO_2-equivalent reduction potential) positively predicted participants' willingness to participate in high-impact climate actions.

Regarding the variable 'data analysis and interpretation skills', the results show from a purely descriptive point of view that the German participants were only able to answer about half of the items correctly. This could be due to the general difficulties that many people perceive when evaluating and interpreting data (e.g., among teachers teaching data literacy; Shreiner and Dykes 2021). On the other hand, the position of the instrument within the questionnaire must be considered: Since the items measuring participants' data analysis and interpretation skills were placed last, participants' performance in data analysis and interpretation could be underestimated due to time and concentration constraints.

6.3 | Risk Perception (i.e., "How Concerned Are You About Global Warming?") is a Strong Predictor for Willingness to Engage in Effortful Climate Action

While several studies have already shown that risk perception is a key variable for participation in climate action (e.g., Brügger et al. 2020; Xie et al. 2019), much less is known about this relationship when it comes to actions that require more than the usual effort. In sum, the results of our study demonstrate significant and strong effects for the relationship between risk perception and effortful climate actions in both countries.

Risk perception is commonly labelled as a cognitive assessment process about the seriousness of a danger, although these processes are assumed to be influenced by affect (see Loewenstein et al. 2001). The two instruments originally implemented in this study therefore included items that targeted the likelihood and severity of consequences (e.g., likelihood of certain consequences here or elsewhere in the next 50 years due to global warming), as well as elicited affect (e.g., concern about global warming). In the initial stages of analysis, an analysis of variance revealed that more than a third of the variance in participants' willingness to get involved in effortful climate action was explained by a single item: "How concerened are you about global warming?" (Leiserowitz 2006). This finding not only had an impact on the present study in that this item alone was used for the subsequent calculations, but it also has important consequences for the interpretation of the overall results: Although risk perception was the strongest predictor in our final models, the analysis involved merely a single item, that essentially asked about participants' *concern*. Constructs such as concern and worry are related to risk perception in some ways, for example, in terms of the negative connotation of a situation, but differ significantly in nature (see Wolff et al. 2019): They are categorised as feelings and can be understood as components of anxiety, which in turn can be associated with severe distress (for the context of climate change, see Clayton 2020). It is therefore important to explicitly state that risk perception in this study was not examined in all its complexity, but was reduced to its affective component. Our results might therefore add to the question already raised in the field: How and to what extent do the (more) cognitive and (more) affective constructs interact to explain climate action? (see, for example, van der Linden 2017).

6.4 | Value Orientations Are Medium to Strong Predictors for Willingness to Engage in Effortful Climate Action

In both datasets, an altruistic/biospheric value orientation is positively associated, while a hedonic value orientation (in the German dataset), and a hedonic/egoistic value orientation (in the Swedish dataset) are negatively associated with willingness to engage in effortful climate action. Our results thus confirm the prevailing picture, namely that stronger endorsement of self-transcendent values (i.e., altruistic and biospheric value orientations) is associated with greater willingness to take climate action (e.g., de Groot and Steg 2008), even when these actions involve some sort of investment or cost. In contrast, stronger endorsement of self-enhancement values (i.e., egoistic and hedonic value orientations) is associated with less willingness to engage in climate action (e.g., Steg et al. 2014), and this tendency also appears to hold for effortful climate actions in our study.

Together with the previous section, our findings are somewhat in contrast to those of Steg et al. (2011), who examined the predictive power of values, ecological worldviews, and environmental

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concern for personal norms and energy policy acceptance and willingness to engage in a non-activist environmental movement. Interestingly, values were found to be more powerful in explaining environmental activism (which we would consider as effortful climate action) and acceptability of energy policies than environmental concern. In the present study, concern about global warming was found to be the strongest relative predictor of willingness to engage in effortful climate action in both countries; although value orientations were also identified as considerable predictors. Ultimately, this finding calls for more mixed-methods research such as the study by Howell (2013), which investigated how the interplay of altruistic values and justice-related concerns can influence the willingness to participate in local climate action.

6.5 | The Bigger Picture: Climate Literacy and Effortful Climate Action

In this work, the framework of climate literacy was applied to examine how knowledge, skills, value orientations, and risk perception explain people's willingness to engage in effortful climate action. While this framework was primarily chosen to account for cognitive factors that might matter, the results of our study show that the explanatory potential of descriptive knowledge about climate change and data analysis and interpretation skills is rather weak. However, the descriptive results also show that on average only around a third of the knowledge items were answered correctly, which makes it difficult to interpret the effects in general. Other studies have identified climate change-related knowledge as a relevant factor that can influence our handling of climate change-related (dis)information (Lutzke et al. 2019), and with regard to climate action, as a relevant predictor of risk perception (e.g., Aksit et al. 2018; Shi et al. 2015). Further studies should therefore investigate the extent to which (different types of) knowledge has a more indirect relationship with effortful climate action, with the relationship being at least partially mediated by risk perception (see Stevenson et al. 2018).

Identifying risk perception (i.e., a single item titled: "How concerned are you about global warming?"; Leiserowitz 2006) as a strong predictor of effortful climate action also inevitably leads to the question of whether it is ethically justifiable to emphasise or reinforce the perception of risk (e.g., in educational contexts), as studies have also revealed negative effects. For example, focusing on the threats posed by climate change in the form of visual representations can evoke defensiveness or a feeling of helplessness (e.g., O'Neill and Nicholson-Cole 2009). Further research is therefore needed to explore how risk perception can be dealt with constructively so that it supports climate action rather than hinders it.

7 | Limitations and Further Research

Although this study represents a novel examination of the driving forces behind the willingness to engage in effortful climate action, some shortcomings should be considered. First, this study only captured self-reported intention to act. As discussed extensively in other studies, the relationship between intentions and actual behaviour might be limited (e.g., Kollmuss and Agyeman 2002), and this of course might be the case in the present study. For example, a recent study on the relationship between climate change perception and engagement in climate action showed that while risk perception was positively related to participants' intentions to engage in climate adaptation measures, no relationship was found with whether participants actually implemented these actions in the following year (Van Valkengoed et al. 2024). To investigate the extent to which risk perception predicts the actual implementation of effortful climate action, future research should take account of both longitudinal studies (e.g., across participation in an educational intervention to better understand how the different aspects of climate literacy develop over time and how these changes influence willingness to engage in effortful climate action) and experimental designs (e.g., the use of systematically varied scenarios involving different levels of effortful action). Furthermore, the instrument for assessing willingness to engage in effortful climate action covers a mix of measures ranging from low to medium to, in some cases, high impact. Yet, as we assume that most high-impact actions are associated with some sort of inconvenience, and such inconveniences were explicitly expressed in the items, the instrument was considered particularly useful for this study.

Second, some factors that have been described as promising in the literature were not taken into account in this study for reasons of test economy. Above all, this includes a sense of efficacy (Bandura 1978). Especially with regard to effortful climate action, the interaction of these two variables seems promising, as it has already been shown that perceived efficacy can bridge the gap between concern and climate action (Bradley et al. 2020). In future studies, self-efficacy should therefore be assessed alongside risk perception to determine whether it can help overcome potential motivational barriers that may be associated with specifically those actions that involve explicit constraints in terms of time, resources, or convenience.

Third, the residual diagnostic for both datasets revealed that the residuals were not evenly (and randomly) distributed across the range of fitted values, and the pattern exhibited systematic effects at the upper and lower ends. For the regression analyses this means that the models overestimate those individuals scoring high on the scale assessing willingness to engage in effortful climate action (except for those that have higher values) and underestimate those scoring low on the scale assessing willingness to engage in effortful climate action (except for those that have lower values). For this reason, the regression results should be interpreted with caution. In addition, we assume a linear relationship between risk perception and engagement in climate action, although this assumption should be critically examined in further studies. Moreover, it is important to highlight that while the method of sequential regression analysis is suitable for determining the additional variance explained by new variables (and thus satisfies our research question), it may not fully capture the complex relationships and interactions that may exist between the predictors. For future work, it is strongly recommended that these complex relationships be brought into the focus of investigations.

Fourth, while the idea (and narrative) that everyone can easily participate in climate action is still prevalent (e.g., in the media; see Kessler 2022), not everyone has the same

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opportunities and holds equal privilege to engage in such actions in terms of access, financial resources or time (e.g., Gibson-Wood and Wakefield 2013). In addition, like many other studies in this field, the present work focuses on two affluent countries located in the Global North, both of which are engaged in public discourse on climate change. Further studies with a more balanced selection in terms of the diversity of countries chosen therefore appear crucial in order to examine the international applicability of the study's findings.

Fifth, for reasons of study design and available instruments, climate action was conceptualised from a rather narrow and individualistic perspective (e.g., focusing on people's capacity as consumers), thus neglecting people's actions in their role as, for example, citizens (Kenis and Mathijs 2012). In addition, focusing on individual action oversimplifies the problem and how to tackle it, and further distracts from the need for far-reaching changes to larger socio-political structures (see, for example, Shove 2010). These contextual factors, such as access to sustainable and reliable public infrastructure, could provide a substantial part of the underlying reasons for people's decisions on whether or not to take effortful climate action and should be given greater consideration in further studies.

Finally, it should be critically noted that risk perception in this study was not treated in all its complexity. Rather, due to the scale being limited to a single item focusing on participants' concerns about climate change, only the affective component was addressed.

8 | Conclusions

As the time available to combat climate change becomes increasingly limited, it is becoming more important than ever to understand what drives climate action. In the present work, a more nuanced perspective on engagement in climate action has been taken by focusing on those actions that are explicitly associated with constraints in terms of time, resources, or convenience (i.e., effortful climate actions), as we argue that this is the case for many of the high-impact measures (e.g., a plant-based diet; see Ivanova et al. 2020). In addition, the novel approach of using the specific framework of climate literacy has been taken to investigate willingness to engage in effortful climate action in two countries; Germany and Sweden. Using this cross-national approach allowed us to compare if patterns emerged across both datasets and thus allowed for greater validity and generalisability of the overall results. Using the method of sequential regression analysis, the results revealed that being concerned about climate change is the strongest relative predictor of people's willingness to engage in effortful climate action in both countries. Furthermore, a biospheric/altruistic value orientation and an existing environmental commitment, at least in the German dataset for the latter, were also identified as important predictors.

Author Contributions

Carola Garrecht: conceptualisation, methodology, formal analysis, investigation, writing – original draft, writing – review and editing, visualisation, project administration. **Nina Christenson:** conceptualisation, methodology, investigation, writing – review and editing, project administration, funding acquisition. **Niklas Gericke:** conceptualisation, methodology, investigation, writing – review and editing. **Jesper Haglund:** conceptualisation, methodology, investigation, writing – review and editing. **Jari Appelgren:** formal analysis, writing – review and editing, visualisation. **Ute Harms:** conceptualisation, methodology, writing – review and editing, project administration, funding acquisition.

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Ethics Statement

Studies reported in this paper were approved by the Ethics Committee at IPN Kiel (reference number: 2020_GA39) for the data collection in Germany and by the Research Ethics Committee at Karlstad University (reference number: HS 2020/786) for the collection of data in Sweden.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Raw data of the present study are available upon reasonable request. For the German raw data, please refer to the corresponding author garrecht@leibniz-ipn.de. For the Swedish raw data, please refer to nina.christenson@kau.se.

Endnotes

[1]While some of these models refer to some form of awareness (e.g., awareness of consequences), declarative content knowledge about climate change tends not to be taken into account.

[2]We have operationalised the gender of the participants as a dichotomous variable for reasons of data analysis, although gender is not a binary category. For a critical examination of this common practice, see Lindqvist et al. (2021).

[3]This was the item that was considered to be part of the global dimension of risk perception as a result of the principal component analyses in both countries.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Brief description of the original instruments on which the questionnaire is based on.

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