Comparing attitudinal structures between political orientations: A network analysis of climate change attitudes

Lind, A.V.; Morton, T.A.; Dalege, J.

DOI
10.1016/j.jenvp.2024.102370
Publication date
2024
Document Version
Final published version
Published in
Journal of Environmental Psychology

Citation for published version (APA):
Lind, A. V., Morton, T. A., & Dalege, J. (2024). Comparing attitudinal structures between political orientations: A network analysis of climate change attitudes. *Journal of Environmental Psychology*, *97*, Article 102370. https://doi.org/10.1016/j.jenvp.2024.102370

Journal of Environmental Psychology 97 (2024) 102370

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

Comparing attitudinal structures between political orientations: A network analysis of climate change attitudes

Andrea Veggerby Lind [a,d,*], Thomas A. Morton [b], Jonas Dalege [c]

[a] University of Copenhagen, Department of Communication, Karen Blixens Vej 8, 2300, Copenhagen S, Denmark
[b] University of Copenhagen, Department of Psychology, Øster Farimagsgade 2A, 1353, Copenhagen K, Denmark
[c] Santa Fe Institute, 1399 Hyde Park Rd, Santa Fe, NM, 87501, USA
[d] University of Copenhagen, Queen Mary's Center, Øster Farimagsgade 3, 1353 Copenhagen K, Denmark

ARTICLE INFO

Handling Editor: W. Schultz

Keywords:
Climate change
Attitudes
Political orientation
Network analysis

ABSTRACT

Research into climate change attitudes consistently and across countries finds ideologically and worldview-determined differences in threat perceptions and policy endorsements. To further our understanding of these ideological differences, the current study explores the underlying structure of climate attitudes across right- and left-oriented individuals. Based on survey data from a representative sample from Denmark ($N = 1365$) we deployed the Causal Attitude Network model to formalize attitudes as networks of interacting attitude elements. We compare the networks of different ideological groups and relate the observed patterns to previous findings and theories within the environmental and political psychology literatures. Overall, the two networks were found to be characterized by many similarities, for example, in global connectivity and patterns of node strength. Yet, the results also revealed differences in the most central nodes of right and left networks, as well as theoretically interesting differences in the predictors of important nodes. We discuss the implications of the findings for communication and engagement efforts.

1. Introduction

Through their guiding role in private, collective, and democratic behavior, attitudes play a central role in human responses to climate change. Understanding why attitudinal positions might differ across groups of people, even against the same informational backdrop, requires a deeper understanding of the nature of attitudes and how they form and change. Climate attitudes, ranging from acceptance of climate science, through concern, to policy acceptance, have consistently been linked to political orientations, including ideologies, worldviews, and partisanship (McCright, Dunlap, & Marquart-Pyatt, 2016; Hornsey, Harris, Bain, & Fielding, 2016; McCright & Dunlap, 2011). Responding to these patterns, some have argued that is there nothing inherent to conservative ideology which should lead people to reject climate science (Hornsey, Harris, & Fielding, 2018), but instead that ideological differences reflect the cultural coding of climate as a politicized issue (Kahan et al., 2012). Irrespective of origin, given the existence of a relationship between ideology and climate positions, it has been argued – and demonstrated – that the drivers of attitude change should also vary across ideologically-defined sections of the population (Kahan et al., 2012; Wolsko, Ariceaga, & Seiden, 2016; Zhou, 2016). The practical implication of this understanding is that generic strategies for promoting climate action should be less effective than messages tailored specifically to the concerns of the audience in question (Goldberg, Gustafson, Rosenthal, & Leiserowitz, 2021; Noar et al., 2007). Such tailoring requires a deep understanding of the exact basis of the attitudes held by different groups.

The present study contributes to this understanding by exploring the underlying network structures of climate attitudes and comparing these across ideologically-defined groups. This differs from the more typical approach that compares mean-level endorsement of overall attitudes across groups and the predictors of these overall attitudes. We instead investigate differences in the associations among the specific beliefs, opinions, and perceptions from which the individual's overall attitude emerges. The primary objective of the study was to identify potential structural discrepancies underling the commonly observed differences in overall climate attitudes across the political left-right spectrum. Understanding structural differences in attitudes gives further clues both to the theorizing about ideologically-based differences in climate attitudes and to the likely effectiveness of different communication and

* Corresponding author. University of Copenhagen, Department of Communication, Karen Blixens Vej 8, 2300, Copenhagen S, Denmark.
E-mail address: avl@samf.ku.dk (A.V. Lind).

https://doi.org/10.1016/j.jenvp.2024.102370
Received 26 September 2023; Received in revised form 7 June 2024; Accepted 27 June 2024
Available online 28 June 2024
0272-4944/

engagement strategies across these groups. We also hope to demonstrate the specific utility of network methodology to climate attitude research.

1.1. Background

1.1.1. Political orientation and climate attitudes

In the field of climate change psychology, a persistent question has been how to understand the ideological gap between those who believe in climate change and support measures to stop it versus those who do not (Jacquet, Dietrich, & Jost, 2014). Although political polarization around climate change is especially pronounced in the United States of America, political ideologies, related worldviews, and political partisanship have been found to be important predictors of individual attitude across multiple nations (Hornsey et al., 2018). Multiple explanations have been offered for why political orientation maps onto disagreement on climate change. For example, some of the most promising current mitigation solutions (such as carbon taxes) may conflict with conservative free-market preferences (Hornsey, 2021). However, the ideological gap (Dunlap & McCright, 2008) often extends beyond policy preferences and even predicts whether people accept the reality of anthropogenic climate change (Hornsey et al., 2018).

The above observation has led to the alternative explanation that individual ideologically-defined climate positions are, at least partially, grounded in group identity (Kahan et al., 2012). If – for example, through political rhetoric and public discourse – the issue of climate change has become strongly associated in the public's mind with, say, progressive or left-wing identity, this may lead to heightened skepticism towards the topic among conservatives as a way of expressing their opposing political identity. Beyond signifying group identity through expressed beliefs, researchers have also pointed to the role of motivated identity-protective reasoning (Kahan, 2012) as a driver of the selective acceptance or rejection of climate-relevant information. Additional factors, not directly related to ideology, may further account for the observed ideological differences in climate attitudes, such as differences in information exposure (e.g., Ehret, Sparks, & Sherman, 2017; Gustafson et al., 2019). Although there are ongoing debates about the prominence of each of these different mechanisms (Tappin, Pennycook, & Rand, 2021), it also seems plausible to conclude that various cognitive, emotional, and identity-related mechanisms would work in concert to create and sustain politically-charged disagreement (Hornsey, 2020).

Yet, disagreement might also be underscored by more complex patterns of understanding and association, not just information, knowledge and expressed belief. When groups of people with different political outlooks discuss climate change, it is likely that they will draw on different repertoires of narratives, words, and perspectives. People from different groups may therefore come to form different patterns of association that connect specific aspects of the overall issue of climate change. For example, political orientation has been found to moderate the relationship between belief in climate change and worry (Gregersen, Doran, Böhm, Tvinnereim, & Poortinga, 2020), indicating that it is not just the mean level of acceptance that differs between political groups but also the emotional or cognitive distress that connects to this acceptance. Said differently, if a hypothetical conservative endorsed climate change to the same degree as a hypothetical liberal, they might still feel quite differently when they think about this issue. Moreover, research suggests that it is not just the emotional connotations of climate change that differ across political groups. For example, Feinberg and Willer (2013) found that US liberals, but not conservatives, see environmental issues in moral terms – specifically in terms of the morals of harm and care. Thus, when a hypothetical liberal and hypothetical conservative are confronted with the same evidence for climate change, they may still interpret this evidence with reference to different moral frameworks. Taken collectively, such findings suggest that people identifying with the political Left and Right might have different underlying attitudinal structures. They may not only display different levels of belief, concern, and support, but also draw on different associations when they think through the many facets of climate change.

In making the case for plausible politically-defined attitude networks, the above discussion draws largely from research conducted in the United States of America, which as noted is a context where polarization around climate change is pronounced (Hornsey et al., 2018). Indeed, much of the research on ideological differences in climate attitudes relies on subjects from English speaking nations – again representing national contexts where polarization is relatively high (Hornsey et al., 2018). The current study instead draws from data on climate attitudes in Denmark. Like the USA, and other typically-studied English-speaking contexts, Denmark is a wealthy, Western nation with high standards of living and high per capita emissions. Yet, Denmark differs politically from more t ypically studied contexts like the US and UK, by having a multi-party system and by being a relatively egalitarian welfare state with a very wide middle class (Kjærsgård, 2015). Despite the uniqueness of this political context, and an overall political consensus in support of climate action, there is evidence for differentiation in the climate attitudes of Danes according to political orientations and related worldviews (Bellers Madsen & Skou Fertin, 2022; Lind, Hallsson, & Morton, 2023). These features make Denmark an interesting context to explore the potential for further nuance and complexity in the underlying structure of politically-defined attitudes about climate change.

1.1.2. Network analysis of attitudes as complex systems

Most attitude research focuses on how a few concepts (e.g., beliefs, attitudes, intentions) relate to one another (i.e., correlationally), and whether change in one element is associated with change in another (e.g., via comparison of mean differences). However, to gain proper insight into the underlying structure of individual attitudes, it is useful to move beyond statistical methods that focus on summary scales and their means. Commonly used analyses like linear regression are simple and highly interpretable, but they are also ill-suited for exploring the complexity of how attitude elements interrelate and contribute to the global attitudinal whole. In the current research, we sought to demonstrate the utility of network methodology for circumventing the typical shortcomings of attitude research. Here, we formalize the individual's attitude about climate change as a complex system of interacting evaluative reactions rather than a singular mean value. Before applying a network model to an attitudinal dataset, we first explain its important features to readers for whom this approach may be less familiar.

Network models of psychological data usually represent variables from a dataset as nodes connected by lines which represent the relationship between them while simultaneously accounting for the remaining variables (Borsboom et al., 2021). Such approaches offer intuitive visualizations for exploring a large number of relationships between variables that might be drawn from multiple different theories of (climate) attitude formation (Bhushnan et al., 2019; Dalege et al., 2016). The Causal Attitude Network Model (CAN; Dalege et al., 2016) inspired by the Ising (Epskamp et al, 2018b, Maris, Waldorp, & Borsboom, 2018; Ising, 1925) model from statistical physics and formalizes attitudes as complex systems of interacting parts. The CAN model represents psychologically relevant variables (e.g. survey items) as nodes connected through the (directed or undirected) associations between the variables (edges). Edges represent either the positive or negative direct influence exerted between two nodes, or partial correlations of the undirected relationship between the two. As such, the model reflects a prevalent view in the attitude literature, which holds that an attitude is a general evaluative summary of our beliefs, feelings, and behaviors related to a certain topic (or attitude elements; Fabrigar, MacDonald, & Wegener, 2005; Cacioppo, Petty, & Geen, 1989; Crites, Fabrigar, & Petty, 1994).

Just as surface attitudes (represented by mean levels of endorsement) may differ between people, the underlying structures might also differ in important ways – for example, in terms of the degree of consistency and interconnectivity among specific attitude elements. Below we summarise some of the structural variations in attitudes that can be revealed through application of the CAN model. For an elaborate walkthrough of the CAN model features and assumptions, we refer to Dalege et al. (2016).

In the CAN model, some attitude elements might have positive connections, reinforcing one-another, whereas others might be negatively related and thus inhibit one-another. As an example, two people may frequently learn about the risks of climate change from trusted friends, which positively influences their own concern; but exactly how much it does so may differ between the two individuals. It is from the specific interaction between multiple evaluative elements (e.g. social evaluations of friends and scientists, individual feelings of concern, and beliefs about climate change and mitigation strategies) that the global attitude arises. In the CAN model, the most central nodes represent variables that are most influential on the overall state of the attitude. These nodes may have many and strong connections to other aspects of the individual attitude, may bridge connections between many other variables, or may differ from others in how readily information can spread from this node to the rest of the network.

With the plethora of often contradictory information, and competing interests, to which individuals are exposed in daily life, attitudes are rarely unequivocally positive or negative (Jonas, Broemer, & Diehl, 2000). Accordingly, we may think positively about some aspects of climate change or its mitigation and negatively about others, rendering our overall attitude ambivalent. For example, we might be concerned about emissions from traffic in the cities, yet reluctant to give up commuting alone in our car. Still, people have a basic need for coherence between cognitions (Heider, 1946), particularly if the issue is cognitively, affectively, or behaviorally salient to them. In such cases, ambivalence might cause discomfort and trigger pressures towards realignment (Festinger, 1964).Strong attitudes tend to be more consistent, more resistant to change, and more strongly connected to behavior, whereas weaker attitudes may be more characterized by ambivalence or indifference, more amenable to change, and less strongly related to behavior (for a thorough review of the causes and effects of ambivalence, see van Harreveld, Nohlen, & Schneider, 2015). With this in mind, attitude strength is an important dimension to consider when exploring the structures underlying individual attitudes.

In the CAN model the strength of the attitude (and the related degree of consistency) is captured by the global connectivity of the network. Just as strong attitudes are more likely to result in behavior than weak attitudes, the predictive value of an attitude network depends on its level of connectivity (Dalege, Borsboom, van Harreveld, Waldorp, & van der Maas, 2017). In a highly connected network (as opposed to a network characterized by fewer and weaker connections), attitudinal ambivalence is less likely, while it is more like that the attitude is a resistant to change, and will result in corresponding behavior (Dalege, Borsboom, van Harreveld, & van der Maas, 2018). Finally, similar evaluative reactions or attitude elements tend to cluster together (with only weak connections to other attitudes), and the CAN model formalizes this phenomenon as community structures within the network. Nodes within these communities will tend to show higher consistency than with nodes in other communities.

Network approaches have gained traction in various fields of psychology, such as modeling mental disorders and their comorbidity (Cramer, Waldorp, van der Maas, & Borsboom, 2010; Fried et al., 2017), general intelligence (van der Maas et al., 2006), and in social science in general (Borgatti, Mehra, Brass, & Labianca, 2009). The CAN model has also shown promising applications, for example helping to understand the impact of attitude structure on voting decisions (Dalege, Borsboom, van Harreveld, & van der Maas, 2017). To date, however, the CAN model has only a few applications relating to environmental psychology, and the use of network analyses in this domain is still in its infancy (Bhushan et al., 2019). For example, network approaches have been applied to investigate the interrelations between climate change attitudes and energy preferences in EU citizens (Verschoor, Albers, Poortinga, Böhm, & Steg, 2020) and to assess differences in science interest between Dutch and Colombian students (Sachisthal et al., 2019). Yet, despite being a persistent question in climate psychology, the role of ideological differences (and other important social group differences) in the formation of climate attitudes have yet to be investigated using network analysis. As such, it remains unclear if and how the attitude structure, including measures of centrality, connectivity and communities – not just overall levels of attitude endorsement or action readiness – differ between those who identify with the political left or the political right. The current research opens up the exploration of this important question.

1.2. *The current study*

The current research sought to understand potential attitudinal differences between individuals aligned with the political left versus political right and demonstrate the value of applying a network model to characterize climate attitudes. As a first step towards opening up the field of climate attitude research to network models, this exploratory study makes use of undirected networks, since the data in question is cross-sectional (without proof of the causal directions) and because it is not reasonable for attitude data to assume no reciprocity between variables, which is necessary for a directed network (Costantini et al., 2015). As such, our goals here are primarily hypothesis-generating rather than hypothesis-testing.

Yet we also believe that the information generated by network models can usefully inform communication efforts to engage change within each of these different audiences. In line with the CAN framework, we assume that a person's attitude toward climate change arises from an underlying structure of interactions between specific beliefs, emotions, and behaviors related to climate change (Dalege et al., 2016). The causal connections between these evaluations (attitude elements), imply that manipulation of one can have direct (and indirect) influence on other evaluations, where some will be more influential than others (e.g. reinforcing a belief that climate scientists are trustworthy might lead to stronger belief in the anthropogenic causes of climate change provided that trust is central to the attitudinal network). As such, by exploring attitude networks we aim to identify potential leverage points for communication. Despite this goal, it is however important to note that the results of the analyses we report below cannot conclusively prove the causal centrality of specific mechanisms for creating change, and as such cannot be used to anticipate the effects of interventions based on this knowledge. Confirmatory tests of that kind await future research – but demonstrations of the applicability of attitude networks to group differences in climate change positions is an important first step towards that goal. In the analysis we report below, each network consists of approximately 400 edges, leaving much space for possible foci and interpretations. We therefore focus on the most salient differences and theoretically interesting points. Possible interpretations of these will be discussed.

2. Methods

We used survey data from a representative sample of the Danish population, collected in April 2021 (N = 1365; 51% women; mean age = 51.3, SD = 17.3). These data have been previously used to conduct a segmentation study on the Danish population's climate attitudes (Lind et al., 2023). For details on data collection, exclusion, and demographic distributions, please see Lind et al. (2023).

2.1. *Groups*

Political orientation: To investigate the structural differences in attitudes of those who lean toward the political left and those who lean toward the political right, we divided our sample in two. All respondents answered a question of "*In politics, people often speak of Left and Right; where would you place yourself?*" (1 = Left, 11 = Right). People who responded lower than the neutral mid-value (6) were ascribed to the Left group ($N = 571$), and those who responded higher, to the Right group ($N = 521$). The networks estimated from these groups correlated strongly with networks estimated from groups based on the extreme values of the left-right scale (see SM 1). Respondents, who responded with the neutral mid-value or who did not provide a response to the political orientation item were excluded from this analysis. The groups were similar on demographic dimensions and only the gender distribution deviated substantially between the groups (see Table 1).

2.2. Variables

As input into our network analysis, we draw on previous survey data that included a range of questions relevant to climate attitudes and opinions – covering beliefs, emotions, policy preferences, social network norms, and efficacy of climate mitigation efforts. For a full list of items, see Table 2. Respondents indicated their agreement with each statement on a 5-point Likert scale from completely disagree (1) to completely agree (5). All items were included in the analysis in their original valence, that is, no items were reversed in this analysis. In Table 2 in the Short Variable column, (R) for reversed refers only to the short variable name (e.g. government response efficacy was negatively phrased in the survey).

2.3. Analytical procedure

Networks for each data subset were estimated using the EBICglasso method from the R package *qgraph* (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). This technique is an appropriate way to limit spurious edges (false positives) in networks based on ordinal data (Epskamp & Fried, 2018). The result was a network where edges are partial correlation coefficients, representing the direct links between variables after controlling for all other connections that might explain the relationship. These coefficients are closely related to multiple regression coefficients, except that using this method also gives information about the predictors of each predictor variable (i.e., the interconnections among predictors; Epskamp & Fried, 2018).

Communities were detected through short random walks using the cluster_walktrap function from the *igraph* R package (Csárdi et al., 2023), which uses absolute edge weights. Communities can indicate that the nodes involved may be influenced by a shared latent variable (Epskamp & Fried, 2018). Toidentify the nodes of greatest importance for the respective networks, we focused on the centrality measure *node strength* from the *qgraph* package, defined as "the sum of absolute edge weights connected to each node" (Epskamp & Fried, 2018). We chose to focus on node strength as the primary centrality measure for ease of interpretability and due to its illustrated stability in simulation studies compared to other centrality measures (Epskamp et al., 2018b). Global connectivity was derived using shortest path lengths (SPL), and conceptually reflects attitude strength (see section 1.1.2; Dalege et al., 2016).

For assessing the differences and similarities between the networks, we used the Network Comparison Test by van Borkulo and colleagues (2017; R package: *NetworkComparisonTest;* NCT) which tests invariance hypotheses by means of permutation tests. We compared the left and right, each comparison with 5000 permutations. This allows us to, for example, test whether the groups have (1) invariant network structure,

Table 1
Group demographics. For political orientation: left = 1, right = 11.

	Left		Right	
	M	SD	M	SD
Age	51.74	17.57	52.51	16.71
Political orientation	3.14	1.37	8.76	1.34
Sex (% male)	46		60	

Table 2
Descriptive statistics of each group for every item.

Code	Short variable	Item	Left		Right	
			M	SD	M	SD
BC	Belief in climate change	"Human activity is the main cause of climate change."	4.30	0.71	3.76	1.03
SC	Perceived scientific consensus	"Nearly all climate scientists agree that the climate is changing due to human activity."	4.23	0.74	3.74	0.93
PC	Perceived public consensus	"Nearly everyone in Denmark agrees that the climate is changing due to human activity."	3.72	0.83	3.53	0.91
CST	Climate scientists trust.	"Climate scientists are trustworthy."	4.18	0.78	3.53	1.00
FI	Subjective knowledge	"I feel well informed about climate change."	3.86	0.74	3.55	0.85
ICR	Industrial countries responsible	"The lifestyle in industrialized countries like Denmark is the most important cause of climate change."	3.94	0.84	3.36	1.04
DCR	Developing countries responsible	"Population growth and increasing wealth in developing countries is the most important cause of climate change."	3.66	0.96	3.68	0.96
ST	Self threat	"To which extent do you agree that climate change will have serious consequences for the following: Yourself"	3.56	0.95	3.20	1.06
TA	Transition advantageous	"Overall, climate transition would be advantageous to the people of Denmark."	3.48	1.25	3.15	1.10
PT	Perceived threat	"Global climate change is a serious threat."	4.40	0.74	3.89	0.95
TPO	Transition postponed	"Climate transition could be postponed a little without having serious consequences."	2.10	0.97	2.77	1.10
AS	Attitude strength	"I have strong attitudes towards climate change."	3.63	0.93	3.17	0.99
S	Shame	"I often feel ashamed about my consumption or lifestyle not being climate friendly."	2.84	1.04	2.20	0.97
QL	Quality of life	"The things, I would have to give up to live in a more climate friendly way, are important to my quality of life."	2.89	0.86	3.06	0.98
DF	Discussion frequency	"I often discuss climate matters with family and friends."	3.18	1.00	2.84	1.15
SE	Social circle engaged	"People in my social circles are highly engaged in the climate debate."	2.89	0.89	2.60	0.90
CRF	Climate change removes focus	"Large climate efforts remove focus and resources from more	2.48	0.98	3.11	1.11

(*continued on next page*)

Table 2 (*continued*)

Code	Short variable	Item	Left		Right	
			M	SD	M	SD
		important and urgent matters."				
WTO	Welfare trade-off	"Denmark should make an effort to mitigate climate change, even if it means fewer resources to welfare areas like health and elderly care."	3.03	1.10	2.51	1.06
ETO	Economy trade-off	"Denmark should make an effort to mitigate climate change, even if it means less economic growth and fewer jobs."	3.44	1.04	2.70	1.12
IR	Individual responsibility	"Citizens themselves should do more in order to mitigate climate change."	4.10	0.82	3.72	0.97
CTI	Climate taxing industry (R)	"Danish companies should not be burdened with climate taxes."	2.07	1.01	3.12	1.26
IF	Freedom over emission reduction	"The freedom to lead the life you want to is more important than reducing Denmark's carbon footprint."	2.00	0.96	2.87	1.16
UNR	Urgent national reductions	"Denmark should reduce its emissions of greenhouse gasses as fast as possible, regardless of when other countries will."	3.98	1.02	3.10	1.23
TO	Technological optimism	"New technologies will be able to solve climate change without individuals having to make significant changes to their lifestyles."	2.69	0.98	3.21	1.00
RE	Response efficacy (R)	"My actions as a single person have no impact on climate change."	2.31	1.08	2.89	1.27
CE	Collective efficacy	"I am certain that together we can find a solution to climate change."	3.72	0.79	3.55	0.95
GRE	Government response efficacy (R)	"It has no impact on climate change whether the Danish government makes an effort to lower CO2 emissions."	2.16	1.09	3.00	1.30
V	Voting preferences	"In order to get my vote, a political party must have a clear and ambitious plan for tackling climate change."	3.71	1.06	2.89	1.16

which evaluates the null-hypothesis that all edges are equal across the two networks; (2) invariant edge strength, which compares every edge across the two networks; and (3) invariant global strength which compares overall connectivity across the networks (weighted absolute sum of all edges), which all would indicate that the groups do not differ in the underlying structure of their climate change attitudes.

We were also interested in whether the connection between communities differed between the groups, as this indicates how much information can flow between the communities. For example, this could indicate if there were a stronger connection between social factors and policy preferences in the right-oriented compared to left-oriented. To this end, we designed a permutation test which estimates networks for two random groupings of the respondents 5000 times. It then tests the difference between the groups in the average edge strength for all edges connecting nodes in one community of interest to those in another. Finally, it compares the extremity of the difference in the tested networks with the distribution of mean differences from the random groups (permutations).

To test the stability of the estimated networks we used bootstrapping from the *bootnet* R package (1.5; Epskamp et al., 2018a). Resultsfrom these tests can be found in the supplementary materials, along with a full list of edges and NCT results.

3. Results

The estimated networks for the left and right group are visualized in Fig. 1a and b. The NCT showed that the two networks are significantly different structurally (max = 0.19, p = 0.035). Visually, the most striking structural difference between the networks is the differences in communities that were detected and their integration in each network. At the same time, the networks show many structural similarities. Global connectivity of the Left network was 18.228 and on the Right it was 18.482. The NCT did not show significant difference in connectivity between the two networks, indicating similar global strength (difference = 0.11, p = 00.826).

3.1. Node strength

Again, the examination of nodes between the two ideological groups revealed some differences, but also a high level of similarity (Fig. 2). In fact, there were no significant differences in node strength according to the NCT. In the Left-oriented network, belief in human causes of CC (BC), valuing personal freedom above emission reduction (IF), believing Denmark should reduce emissions as soon as possible (UNR), and threat perception (PT) were the four strongest nodes (all more than 1SD above the average node strength).

For the right-oriented group the strongest nodes were perceived threat (PT), low government efficacy (GRE), valuing personal freedom over emission reduction (IF), trust in climate scientists (CST). In this group PT was remarkably strong (+2 SD) (Fig. 2). The NCT results showed that only PT differed significantly in strength between the networks (difference = −0.24, p = 0.043), and feeling informed about CC (FI) approached significance (difference = −0.19, p = 0.059). In both networks, perceiving transition as advantageous for the people of Denmark (TA) and perceiving low-emission lifestyle as requiring big compromise (QL) were the nodes of lowest strength.

3.2. Differences in edges

20 edges differed significantly in the NCT with $p < 00.05$ (Fig. 3)

Comparing the networks showed large differences in a few particular edge weights:

Firstly, the right group shows a 0.24 stronger positive partial correlation between belief in anthropogenic climate change (ACC; BC) and believing that CC is primarily caused by Western lifestyle (ICR). Secondly, in the right group there is a substantial positive link (0.15) between public consensus perception (PC) and perceived personal risk of CC (ST), while this link is absent on the left. Thirdly, on the left, there is a stronger negative partial correlation (.-15) between believing that citizens should do more themselves to combat CC (IR) and valuing individual freedom over emission reduction (IF). Fourthly, some network measures, like global connectivity, are descriptive of the specific networks in question rather than interpretable relative to alternative networks (e.g., as an effect size would be). There are, for example, currently

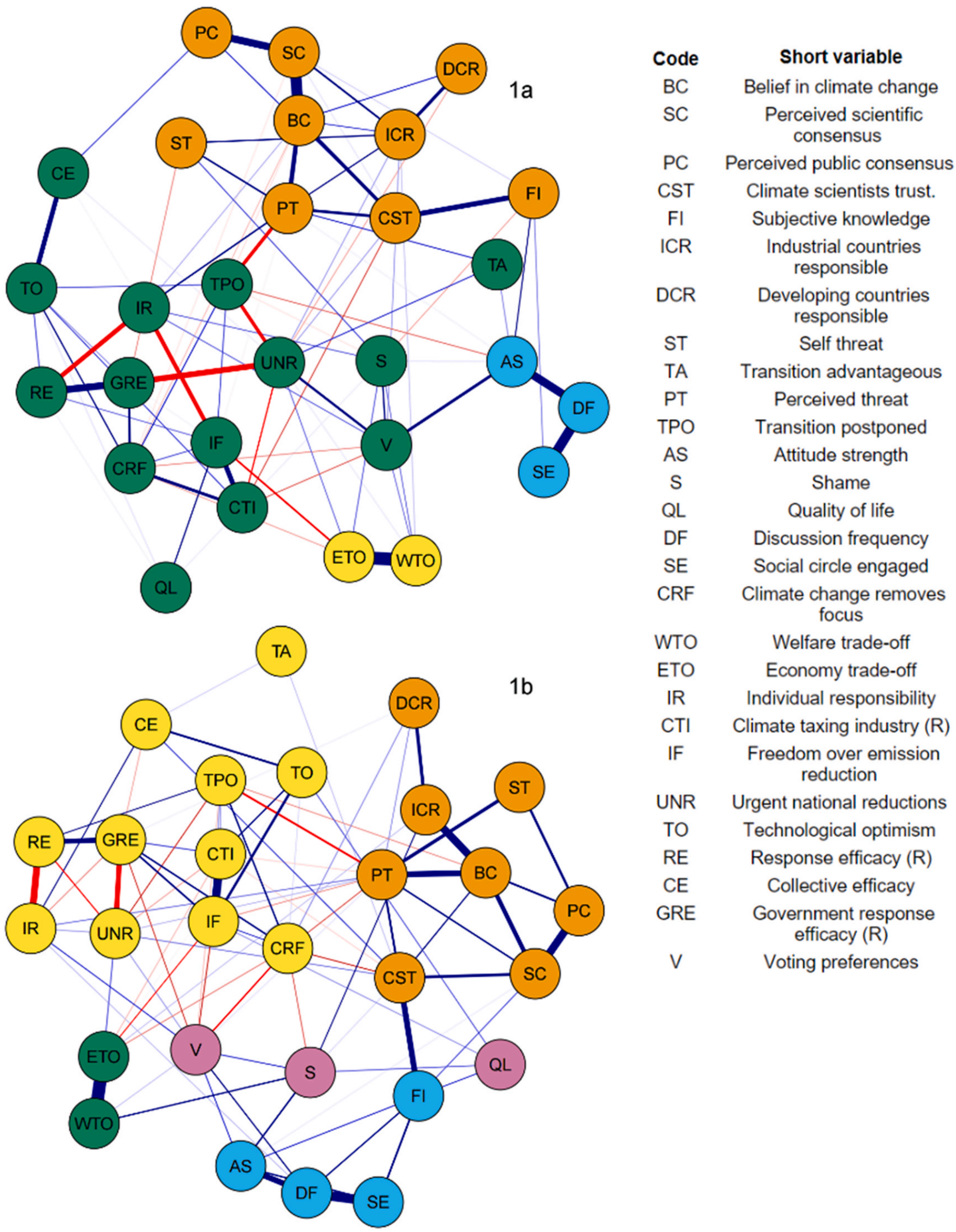

Fig. 1a and b. Visualizations of the Left (a) and Right (b) networks. The circles represent each node, where color indicates the detected communities (see section 3.4.) to which that node belongs. The lines connecting the nodes represent edges, where a blue (red) node signifies a positive (negative) partial correlation and the width, the strength of the correlation. For reference, the widest edge is a partial correlation of 0.51 and the thinnest 0.05. Colored figures available in online version. Please consult Table 2 to see which items are reversed.

no reliable heuristics as to what constitutes a strong connectivity within this method, making it difficult to interpret the relative magnitude of this measure.

3.3. Connections to individual nodes

To examine individual connections, we focus on four nodes only, either because of their particular centrality to the attitude networks of right and left (PT and BC, respectively) or because of their theoretically interesting differences (Table 3).

Perceiving climate change as a serious threat (PT) had a number of stronger connections on the Left and Right, most notably belief in ACC (BC), then low urgency for transition (TPO), and trust in climate scientists (CST), and perception of personal risk (ST).

Belief in ACC (BC) in the Left group was, in turn, connected very strongly to perceiving scientific consensus (SC). Although the partial correlation was substantially weaker, SC was also an important connection in the Right group, where BC was mostly strongly connected

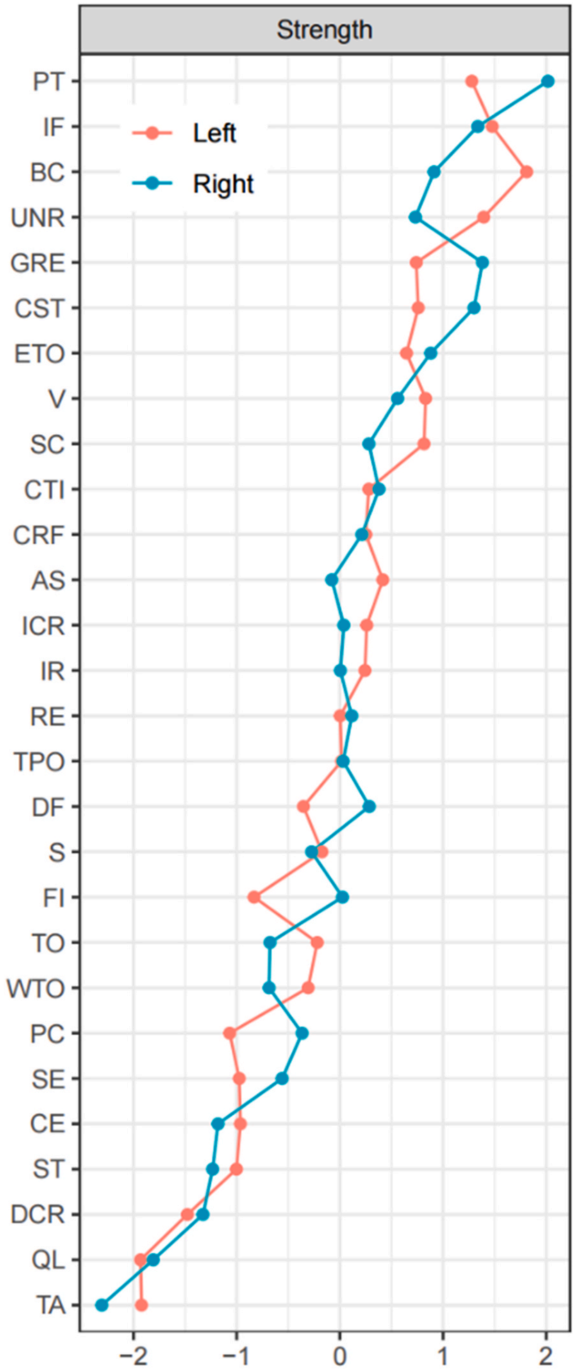

Fig. 2. z-scores of centrality indices for both networks.

to seeing Western lifestyle as the primary cause for CC (ICR).

Technological optimism (TO) was on the Left most strongly connected to collective efficacy (CE), which was also an important connection on the Right. On the Right, however, technological optimism was most strongly connected to valuing personal freedom over reducing emissions (IF).

Prioritizing ambitious climate agendas when voting (V) was on the Left most connected to perceived attitude strength (AS) and thinking that Denmark should reduce emissions now regardless of when other countries do it (UNR). On the Right group, voting priority was most connected to whether individuals think CC is being exaggerated (CRF), and secondly the frequency of conversations about CC (DF).

3.4. Community detection

In both groups, communities were detected that broadly covered:

Beliefs & threat perception (BTP): BC, SC, PC, CST, ICR, DCR, ST, PT.

Openness to societal trade-offs (OST): WTO, ETO.

Social salience (SS): AS, DF, SE.

Policy & action attitudes (PAA): TA, TPO, CRF, IR, CTI, IF, UNR, TO, RE, CE, GRE.

But their network communities also differed in several ways. First, whereas 'feeling informed about climate change' (FI) was associated with the beliefs and threat perception community on the left, it belonged to the social salience community on the right. Second, feeling ashamed about one's own emission heavy consumption (S), believing that living in a climate friendly manner would compromise one's quality of life (QL), and prioritizing climate agendas when voting, formed their own community on the right, whereas on the left, these were integrated in the policy attitudes community.

Permutation tests revealed no significant differences in the two groups in how the communities were connected internally or between one another.

4. Discussion

The current study had two inter-related goals. First, we sought to demonstrate the applicability of network approaches, which formalize attitudes as complex systems, to modelling climate attitudes, and secondly, we used these networks to deepen current understandings of the persistent ideological gap that has been observed in relation to climate change. From a network perspective, an individual's global attitude toward climate change is seen as arising from the interaction between relevant attitude elements. The underlying structure of those elements tells us something important about attitudes beyond the surface summary. Interestingly, although comparison of global attitudes highlights differences between left and right, in our comparison of the attitudinal structures of these groups we found as many commonalities as we found differences.

In this discussion we will draw out salient attitudinal patterns, similarities and differences between the networks, and relate these to prominent theories of environmental and climate attitudes. Since we used a conservative method for comparing network structures (as shown by simulation studies; van Borkulo et al., 2023), we will also consider differences that did not reach significance in the NCT but that might nonetheless be informative. We will also consider how the patterns identified in the attitude networks relate to existing literature and their possible implications for tailored climate communication directed towards each of the ideologically defined groups (Tappin et al., 2021).

4.1. Connectivity

The networks showed comparable levels of global connectivity. In the CAN model, global connectivity can be seen as a measure of attitude strength, stability, and (lower) likelihood of ambivalence (Dalege et al., 2018; see Krosnick & Petty, 1995 for an theoretical overview of attitude strength). Global connectivity is relevant for how malleable an attitude is in response to persuasion, and for the predictive value that an attitude network has for behavior (e.g., voting: Dalege, Borsboom, van Harreveld, Waldorp, & van der Maas, 2017). Moreover, it has been argued that lower ambivalence (or a stronger attitude) might be associated with more dependance on motivated reasoning (Taber & Lodge, 2006). On a positive note, this finding may therefore suggest that there are no major ideological differences in how open Danes are to new climate information nor how susceptible they are to motivated reasoning about climate evidence.

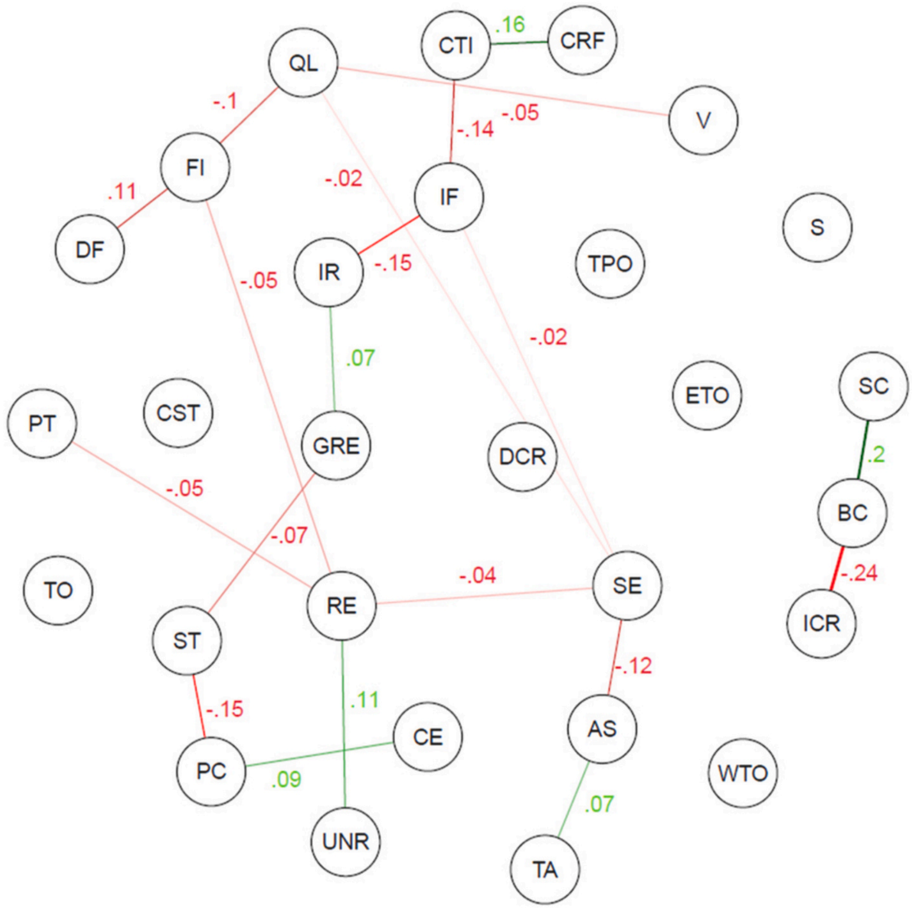

Fig. 3. The differential structure of the two networks, shown as the differences in partial correlations (edges) where p < 00.05 in the NCT. The coefficients indicate the Left edge minus Right edge. A green line with a positive coefficient indicates that the edge is more positive in the Left network than in the Right (whereas a red line with a negative coefficient indicates that the edge is more positive on the Right than Left). As such, a green line can cover both a stronger positive edge on the left as well as a weaker negative edge compared to the right. We refer to Fig. 1a and b to assess edge directions and strength. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 3
Only including strong connections defined here as 0.1. Ordered from the strongest (absolute) connection.

PT Perceived threat				BC belief in anthropogenic climate change				TO technological optimism				V prioritizing CC agendas when voting			
Left		Right		Left		Right		Left		Right		Left		Right	
BC	0.21	BC	0.27	SC	0.41	ICR	0.33	CE	0.22	IF	0.15	AS	0.16	CRF	−0.12
TPO	−0.18	ST	0.18	PT	0.21	PT	0.27	CRF	0.11	CE	0.14	UNR	0.14	DF	0.11
CST	0.16	TPO	−0.14	CST	0.18	SC	0.22			CTI	0.11	S	0.11	AS	0.1
ST	0.12	CST	0.14	DCR	0.1	PC	0.13							IF	−0.1
IR	0.12	SC	0.12			CST	0.11								
ICR	0.11														
TA	0.1														

4.2. Beliefs and threat at the center

In both groups, the networks were best described by nodes from the "beliefs and threat perception" community, which encompasses beliefs in the existence and human causes of climate change and the risks involved. More socially-oriented beliefs, or policy-oriented preferences, were less central to attitude networks. This finding is in line with previous evidence suggesting that threat appraisal is indeed pivotal for individual receptivity to climate action, and that this is the case across the political spectrum, particularly if the risks are made concrete (as opposed to abstract; Schwaller, Kelmenson, BenDor, & Spurlock, 2020). Verschoor and colleagues similarly found that concern was the most central node in attitude energy networks across 22 European countries (2020).

4.3. Threat perception

While the central nodes of the two networks belonged to the same community, there was a significant difference in the centrality of the threat perception node. Threat perception was most central in the right network, whereas belief in anthropogenic climate change was most central to the left-oriented network. Previous research has noted complex political asymmetries in responsiveness to threat (Choma & Hodson, 2017), where right-wing ideology can both exacerbate and downplay perceived threat. It has been a long-standing assumption that threat perceptions are more central to right-wing ideology than to the left (Jost, Glaser, Kruglanski, & Sulloway, 2003, 2017), but more recent research suggest that threat is an important aspect of both right- and left-orientation and that these relationships may be highly contingent on the kind of threat at hand (Brandt et al., 2021; Brandt & Bakker, 2022, section 4.5.). Where conservative individuals have been found to be more sensitive to personal risks, and less to competitive risks, liberal individuals have shown sensitivity particularly towards collective risks (Choma, Hanoch, Gummerum, & Hodson, 2013). This speaks to our findings that (while slightly more central on the right), threat perception was structurally important to both the right and left-oriented networks. Moreover, the similarity of the predictors of threat perceptions across networks indicated that, at least within the nodes included in these networks, threat perception is not determined by very different mechanisms in the two groups.

4.4. Attitudinal patterns: belief in anthropogenic climate change

On the left, belief was associated very strongly with the perceived scientific consensus. The role of scientific consensus in climate communication has received considerable attention, in particular in relation to the Gateway Belief Model (GBM) by van der Linden, Leiserowitz, Feinberg, and Maibach (2015). These authors have argued, and shown, that increasing perceptions of scientific consensus acts as a gateway to stronger belief in human caused-climate change, higher concern, and higher levels of policy support. Where our data suggests that such a connection is particularly strong among left-oriented people, van der Linden's research observes significant interactions among consensus messages, partisanship, and climate beliefs. In this work, consensus messaging was particularly effective among (right-oriented) Republicans compared to (left-oriented) Democrats (van der Linden et al., 2015, 2019). Speculatively, this could be related to country differences in the historic connection between conservatism and denial of anthropogenic climate change and mistrust in scientists, connections that have been more marginal in Denmark compared to the USA (Eskjær, 2017). The finding that that subjective knowledge (FI) is strongly predicted by trust in scientists further speaks to a picture where the left, to a large degree, tracks the scientific community when forming climate beliefs. Of course, these being correlational data, it is equally possible that the association arises from left-oriented individuals being more inclined to project their own beliefs onto the scientific community. We cannot adjudicate between these possibilities, but nonetheless note the theoretical relevance of perceived scientific consensus in the attitude networks of especially left-oriented individuals.

In the right-oriented network, subjective knowledge was also predicted by trust in scientists. In contrast to the left network, however, subjective knowledge was part of the social salience community. Adding to this, scientific consensus perception was a less strong predictor of belief in climate change among this group compared to the left. Goldberg et al. (2019) found evidence of a reciprocal causal relationship between discussing climate change with friends and family, learning important scientific facts, and worrying about climate change. The current data compliments this finding by suggesting that social salience factors might be particularly influential for scientific beliefs on people who identify with the political right. Aside from highlighting the importance of trust in scientists, this also may suggest that while social influence generally is important for beliefs and (subjective) knowledge, the right-oriented may be tracking particularly closer social sources, whereas left-oriented individuals may to a higher degree look to the scientific community.

The strongest contrast in edges was the remarkably strong association on the right, but not left, between belief in anthropogenic climate change and attributing this to industrialized countries. This difference is not straightforward to interpret, but it may be consistent with mechanisms of motivated reasoning. Clarke et al. (2019) found evidence that right-orientation was associated with climate change denial partially because climate change mitigation strategies are seen as threatening to the current socio-economic system. This societal status quo is generally more appreciated by right-oriented individuals, who may in turn be more motivated to defend it as more dismissive of its adverse consequences, such as climate change (McCright & Dunlap, 2016). Accepting the disproportionate role of the industrialized countries in causing climate change also implies substantial societal changes in these countries. Consistent with theories of motivated reasoning, rejecting the reality of human caused climate change may therefore be a way for right-oriented individuals to downplay responsibility, which in turn would imply less need for structural changes to society.

4.5. Attitudinal patterns: restrictive policies, costly action, and technology

The general tendencies of right-oriented individuals to defend social systems (as opposed to general tendencies among the left to challenge these) can also be traced in the attitudinal patterns regarding restrictive policies and costly behavior change. The IF node can be seen as an expression of reluctance toward individuals being expected to engage in costly behavior in order to mitigate climate change (e.g., decreasing consumption, carbon taxes, changing traveling and commuting practices). On the right, this resistance to costly individual climate action is associated (significantly more than on the left) with resistance to placing carbon taxes on industry. At the same time, IF is the strongest predictor of technological optimism: the belief that climate change can be solved solely through technological fixes without a need to restructure current systems or private consumption practices (Alexander & Rutherford, 2019). Pushing this sentiment has often been criticized as delaying sufficient climate change mitigation measures (Allwood, 2018; Lamb et al., 2020), and has been associated with increased opposition to adaptation measures (Gardezi & Arbuckle, 2020). Perhaps techno-optimism is a strategy for right-oriented to reconcile a concern about climate change and a resistance towards restrictive measures and governmental involvement. It may also be that the overlap between political conservatism and Social Dominance Orientation (Sidanius & Pratto, 1999, p. 403), leads some right-oriented individuals to see climate change hazards as less risky (Choma et al., 2013) and more as a competitive challenge with the opportunity of hierarchical advancement. Such a perspective on climate change would certainly align with faith in technological advancements rather than restricting individual consumption to reduce emissions.

By contrast, on the left technological optimism is closely connected to collective efficacy (the belief that collectively, people will be able to solve climate change). This paints a picture that technological optimism may reflect a general optimism about the development of climate change, either because people become optimistic about the technologies or because they, in their optimism, assume that the problem is solvable with technology. Additionally the IF node, related to reluctance to costly individual change, is associated with perceived responsibility of individuals on the left. That is, the degree to which left-oriented people will accept costly behavior change from individuals is attached to the degree they think the responsibility of climate change falls on individuals. This stands in contrast to the right-network, where costly action (for individuals as well as industry) is rejected when the faith in technology is high.

Again, this underscores the value of examining attitudes as networks - the same attitudinal element (technological optimism) can have very different patterns of association within the overall network of different groups.

4.6. Importance of efficacy beliefs

It is also worthwhile noting that we included three measures of efficacy beliefs, and that of these three governmental response efficacy has much higher structural importance in both networks (0.7–2 SDs in node strength). This suggests that the trust a government can muster in its abilities to reduce emissions is highly important for people when they make up their minds about climate change, and much more so than their beliefs in the impacts of their own actions and in groups.

4.7. Contributions, limitations and future directions

We want to draw out a number of potential limitations of the current analysis and data. Firstly, we observed an uneven gender distribution in the two groups, such that around 60% in the right group are men and only 46% on the left. It is possible that this has influenced the results, however, also reflects a commonly reported 'gender gap' in political preferences (Hansen, 2019; Pratto, Stallworth, & Sidanius, 1997). Secondly, the CAN model reveals the structural importance of the nodes included in the network; while we have tried to include the dimensions that are most commonly reported as essential for climate attitudes, it is possible that we have missed other, equally important, aspects. Thirdly, the discussion presented here rests on a very large and complex set of results. In our attempt to distill the most interesting results we have undoubtedly omitted other potentially interesting perspectives. Fourthly, some network measures, like global connectivity, are descriptive of the specific networks in question. There are, for example, currently no reliable heuristics as to what constitutes a strong connectivity within this method, making it difficult to interpret the magnitude of the measure.

Some of the above limitations reflect the fact that this work is fundamentally exploratory. It offers a new way of visualizing the differences in how right- and left-oriented individuals construe the topic of climate change. The aim with the discussion was therefore largely to reduce complexity of our findings. As it was not possible to give an exhaustive account of possible interpretations, we have focused on making sense of the identified structures through narratives relating them to existing theories and evidence. We want to again underscore that these explorations are based on cross sectional data, and that node centrality in itself does not prove causal importance (Dablander & Hinne, 2019). Any implied causal mechanisms discussed here are therefore meant as constructive speculation to inspire future research.

One such narrative emerging from our results was that there are ideology-dependent differences in how people perceive the role of technology in solutions to climate change, and that this in some cases relate to their openness to costly individual change. The respective roles of technological solutions and structural changes in transitioning to a carbon neutral future is a central question for climate policy development, yet largely unexplored. To increase the practical utility of this study, it would be valuable to conduct studies aiming to test the causal mechanisms behind the most salient connections explored here.

It would also be important that future research investigates the robustness and generalizability of these results in Denmark and internationally. It could be highly informative to investigate the ideologically dependent structural differences in attitudes in a context such as the USA, where the public is more polarized and where the political left-right spectrum maps more clearly onto partisanship. Additionally, since the history of partisan media coverage of climate change has looked different in the USA (and other nations), more pronounced differences in the networks would presumably be observable.

5. Conclusion

This exploratory study formalized climate change attitudes as networks of interacting attitude elements, revealing the structural differences in how climate change is perceived among those who identify with the political left and right. Threat perception was most central to the right-oriented network, while belief in anthropogenic climate change was central to the left. We further identified different structural patterns in how left- and right-oriented individuals inform their beliefs, construe costly climate action and policy, and interpret the role of technology. Still, the networks of the two ends of the left-right spectrum share many similarities on the global level. Global connectivity was comparable, and no node was structurally important in one network and peripheral in the other. Ultimately, although we have highlighted differences, it is the similarity that is most promising for interventions: it suggests that, in the Danish context at least, communicative efforts to target the central nodes would meet similar reactions across the two groups rather than contributing to further polarization.

CRediT authorship contribution statement

Andrea Veggerby Lind: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Thomas A. Morton:** Writing – review & editing, Supervision. **Jonas Dalege:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2024.102370.

References

Alexander, S., & Rutherford, J. (2019). A critique of techno-optimism: Efficiency without sufficiency is lost. In *Routledge handbook of global Sustainability governance*. Routledge.

Allwood, J. M. (2018). Unrealistic techno-optimism is holding back progress on resource efficiency. *Nature Materials, 17*(12). https://doi.org/10.1038/s41563-018-0229-8. Article 12.

Bellers Madsen, M., & Skou Fertin, R. (2022). *Klimabarometeret 2022*.

Bhushan, N., Mohnert, F., Sloot, D., Jans, L., Albers, C., & Steg, L. (2019). Using a Gaussian Graphical model to explore relationships between items and variables in environmental psychology research. *Frontiers in Psychology, 10*, 1050. https://doi.org/10.3389/fpsyg.2019.01050

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science, 323*(5916), 892–895. https://doi.org/10.1126/science.1165821

Borsboom, D., Deserno, M. K., Rhemtulla, M., et al. (2021). Network analysis of multivariate data in psychological science. *Nat Rev Methods Primers, 1*, 58. https://doi.org/10.1038/s43586-021-00055-w

Brandt, M. J., & Bakker, B. N. (2022). The complicated but solvable threat–politics relationship. *Trends in Cognitive Sciences, 26*(5), 368–370. https://doi.org/10.1016/j.tics.2022.02.005

Brandt, M. J., Turner-Zwinkels, F. M., Karapirinler, B., Van Leeuwen, F., Bender, M., van Osch, Y., et al. (2021). The association between threat and politics depends on the Type of threat, the political domain, and the country. *Personality and Social Psychology Bulletin, 47*(2), 324–343. https://doi.org/10.1177/0146167220946187

Cacioppo, J. T., Petty, R. E., & Geen, T. R. (1989). Attitude structure and function: From the tripartite to the homeostasis model of attitudes. In *Attitude structure and function* (pp. 275–309). Lawrence Erlbaum Associates, Inc.

Choma, B. L., Hanoch, Y., Gummerum, M., & Hodson, G. (2013). Relations between risk perceptions and socio-political ideology are domain- and ideology- dependent. *Personality and Individual Differences, 54*(1), 29–34. https://doi.org/10.1016/j.paid.2012.07.028

Choma, B. L., & Hodson, G. (2017). Right-wing ideology: Positive (and negative) relations to threat. *Social Cognition, 35*(4), 415–432. https://doi.org/10.1521/soco.2017.35.4.415

Costantini, G., Epskamp, S., Borsboom, D., Perugini, M., Mõttus, R., Waldorp, L. J., et al. (2015). State of the aRt personality research: A tutorial on network analysis of personality data in R. *Journal of Research in Personality, 54*, 13–29. https://doi.org/10.1016/j.jrp.2014.07.003

Cramer, A. O. J., Waldorp, L. J., van der Maas, H. L. J., & Borsboom, D. (2010). Comorbidity: A network perspective. *Behavioral and Brain Sciences, 33*(2–3), 137–150. https://doi.org/10.1017/S0140525X09991567. discussion 150-193.

Crites, S. L., Fabrigar, L. R., & Petty, R. E. (1994). Measuring the affective and cognitive properties of attitudes: Conceptual and methodological issues. *Personality and Social Psychology Bulletin, 20*, 619–634. https://doi.org/10.1177/0146167294206001

Dablander, F., & Hinne, M. (2019). Node centrality measures are a poor substitute for causal inference. *Scientific Reports, 9*(1), 6846. https://doi.org/10.1038/s41598-019-43033-9

Dalege, J., Borsboom, D., van Harreveld, F., van den Berg, H., Conner, M., & Maas, H. (2016). Toward a formalized account of attitudes: The causal attitude network (CAN) model. *Psychological Review, 123*. https://doi.org/10.1037/a0039802

Dalege, J., Borsboom, D., van Harreveld, F., & van der Maas, H. L. J. (2017). Network analysis on attitudes: A Brief tutorial. *Social Psychological and Personality Science, 8*(5), 528–537. https://doi.org/10.1177/1948550617709827

Dalege, J., Borsboom, D., van Harreveld, F.&L. J., & van der Maas, H. (2018). The attitudinal Entropy (AE) framework as a general theory of individual attitudes.

Psychological Inquiry, 29(4), 175–193. https://doi.org/10.1080/1047840X.2018.1537246
Dalege, J., Borsboom, D., van Harreveld, F., Waldorp, L. J., & van der Maas, H. L. J. (2017). Network structure explains the impact of attitudes on voting decisions. *Scientific Reports, 7*(1), 4909. https://doi.org/10.1038/s41598-017-05048-y
Dunlap, R., & McCright, A. (2008). A Widening gap: Republican and democratic views on climate change. *Environment: Science and Policy for Sustainable Development, 50*, 26–35. https://doi.org/10.3200/ENVT.50.5.26-35
Ehret, P. J., Sparks, A. C., & Sherman, D. K. (2017). Support for environmental protection: An integration of ideological-consistency and information-deficit models. *Environmental Politics, 26*(2), 253–277. https://doi.org/10.1080/09644016.2016.1256960
Epskamp, S., Borsboom, D., & Fried, E. I. (2018a). Estimating psychological networks and their accuracy: A tutorial paper. *Behav Res, 50*, 195–212. https://doi.org/10.3758/s13428-017-0862-1
Epskamp, S., Cramer, A. O., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in Psychometric data. *Journal of Statistical Software, 48*(4), 1–18. https://doi.org/10.18637/jss.v048.i04
Epskamp, S., & Fried, E. I. (2018). A tutorial on Regularized partial correlation networks. *Psychological Methods, 23*(4), 617–634. https://doi.org/10.1037/met0000167
Epskamp, S., Maris, G., Waldorp, L. J., & Borsboom, D. (2018b). Network Psychometrics. In *The Wiley handbook of Psychometric testing* (pp. 953–986). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118489772.ch30.
Fabrigar, L. R., MacDonald, T. K., & Wegener, D. T. (2005). The structure of attitudes. In *The handbook of attitudes* (pp. 79–125). Lawrence Erlbaum Associates Publishers.
Feinberg, M., & Willer, R. (2013). The moral roots of environmental attitudes. *Psychological Science, 24*(1), 56–62. https://doi.org/10.1177/0956797612449177
Fried, E. I., van Borkulo, C. D., Cramer, A. O., Boschloo, L., Schoevers, R. A., & Borsboom, D. (2017). Mental disorders as networks of problems: A review of recent insights. *Soc. Psychiatry Psychiatr. Epidemiol., 52*, 1–10. https://doi.org/10.1007/s00127-016-1319-z
Gardezi, M., & Arbuckle, J. G. (2020). Techno-optimism and Farmers' attitudes toward climate change adaptation. *Environment and Behavior, 52*(1), 82–105. https://doi.org/10.1177/0013916518793482
Goldberg, M. H., Gustafson, A., Rosenthal, S. A., & Leiserowitz, A. (2021). Shifting Republican views on climate change through targeted advertising. *Nature Climate Change, 11*(7). https://doi.org/10.1038/s41558-021-01070-1. Article 7.
Gregersen, T., Doran, R., Böhm, G., Tvinnereim, E., & Poortinga, W. (2020). Political orientation moderates the relationship between climate change beliefs and worry about climate change. *Frontiers in Psychology, 11*. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01573.
Gustafson, A., Rosenthal, S. A., Ballew, M. T., Goldberg, M. H., Bergquist, P., Kotcher, J. E., et al. (2019). The development of partisan polarization over the Green New Deal. *Nature Climate Change, 9*(12), 940–944. https://doi.org/10.1038/s41558-019-0621-7
Hansen, K. M. (2019). *Kønsforskellene vokser: Mænd og kvinder stemmer "historisk*. Christiansborg: forskelligt, 2019, August 29 https://www.altinget.dk/christiansborg/artikel/koensforskellene-vokser-maend-og-kvinder-stemmer-historisk-forskelligt.
Heider, F. (1946). Attitudes and cognitive Organization. *Journal of Psychology, 21*(1), 107–112. https://doi.org/10.1080/00223980.1946.9917275
Hornsey, M. J. (2020). Why facts are not enough: Understanding and managing the motivated rejection of science. *Current Directions in Psychological Science, 29*(6), 583–591.
Hornsey, M. J. (2021). The role of worldviews in shaping how people appraise climate change. *Current Opinion in Behavioral Sciences, 42*, 36–41. https://doi.org/10.1016/j.cobeha.2021.02.021
Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change. *Nature Climate Change, 6*(6), 622–626.
Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). Relationships among conspiratorial beliefs, conservatism and climate scepticism across nations. *Nature Climate Change, 8*(7). https://doi.org/10.1038/s41558-018-0157-2. Article 7.
Ising, E. (1925). Beitrag zur Theorie des Ferromagnetismus. *Zeitschrift für Physik, 31*(1), 253–258. https://doi.org/10.1007/BF02980577
Jacquet, J., Dietrich, M., & Jost, J. T. (2014). The ideological divide and climate change opinion: "Top-down" and "bottom-up" approaches. *Frontiers in Psychology, 5*. https://www.frontiersin.org/articles/10.3389/fpsyg.2014.01458.
Jonas, K., Broemer, P., & Diehl, M. (2000). Experienced ambivalence as a moderator of the consistency between attitudes and behaviors. *Zeitschrift für Sozialpsychologie, 31*, 153–165. https://doi.org/10.1024/0044-3514.31.3.153
Jost, J. T., Glaser, J., Kruglanski, A. W., & Sulloway, F. J. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin, 129*(3), 339–375. https://doi.org/10.1037/0033-2909.129.3.339
Jost, J. T., Stern, C., Rule, N. O., & Sterling, J. (2017). The politics of fear: Is there an ideological asymmetry in existential motivation? *Social Cognition, 35*(4), 324–353. https://doi.org/10.1521/soco.2017.35.4.324
Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., et al. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*, 732–735.
Kjærsgård, A. P. (2015). Scandinavian egalitarianism: Understanding attitudes towards the level of wage Inequality in Scandinavia. https://doi.org/10.5278/vbn.phd.socsci.00028.
Krosnick, J. A., & Petty, R. E. (1995). Attitude strength: An overview. In R. E. Petty, & J. A. Krosnick (Eds.), *Attitude strength: Antecedents and consequences* (pp. 1–24). Hillsdale, NJ: Lawrence Erlbaum.
Lamb, W. F., Mattioli, G., Levi, S., Roberts, J. T., Capstick, S., Creutzig, F., et al. (2020). Discourses of climate delay. *Global Sustainability, 3*. https://doi.org/10.1017/sus.2020.13
Lind, A. V., Hallsson, B. G., & Morton, T. A. (2023). Polarization within consensus? An audience segmentation model of politically dependent climate attitudes in Denmark. *Journal of Environmental Psychology, 89*, Article 102054.
McCright, A. M., & Dunlap, R. E. (2011). Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environmental Change, 21*(4), 1163–1172. https://doi.org/10.1016/j.gloenvcha.2011.06.003
McCright, A. M., Dunlap, R. E., & Marquart-Pyatt, S. T. (2016). Political ideology and views about climate change in the European Union. *Environmental Politics, 25*(2), 338–358. https://doi.org/10.1080/09644016.2015.1090371
Pratto, F., Stallworth, L. M., & Sidanius, J. (1997). The gender gap: Differences in political attitudes and social dominance orientation. *British Journal of Social Psychology, 36*(Pt 1), 49–68. https://doi.org/10.1111/j.2044-8309.1997.tb01118.x
Sachisthal, M. S. M., Jansen, B. R. J., Peetsma, T. T. D., Dalege, J., van der Maas, H. L. J., & Raijmakers, M. E. J. (2019). Introducing a science interest network model to reveal country differences. *Journal of Educational Psychology, 111*(6), 1063–1080. https://doi.org/10.1037/edu0000327
Schwaller, N. L., Kelmenson, S., BenDor, T. K., & Spurlock, D. (2020). From abstract futures to concrete experiences: How does political ideology interact with threat perception to affect climate adaptation decisions? *Environmental Science & Policy, 112*, 440–452. https://doi.org/10.1016/j.envsci.2020.07.001
Sidanius, J., & Pratto, F. (1999). *Social dominance: An intergroup theory of social hierarchy and oppression*. Cambridge University Press. https://doi.org/10.1017/CBO9781139175043
Taber, C. S., & Lodge, M. (2006). Motivated skepticism in the evaluation of political beliefs. *American Journal of Political Science, 50*(3), 755–769.
Tappin, B. M., Pennycook, G., & Rand, D. G. (2021). Rethinking the link between cognitive sophistication and politically motivated reasoning. *Journal of Experimental Psychology: General, 150*, 1095–1114. https://doi.org/10.1037/xge0000974
van Borkulo, C. D., van Bork, R., Boschloo, L., Kossakowski, J. J., Tio, P., Schoevers, R. A., et al. (2023). Comparing network structures on three aspects: A permutation test. *Psychological Methods, 28*(6), 1273–1285. https://doi.org/10.1037/met0000476
van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: Experimental evidence. *PLoS One, 10*(2), Article e0118489. https://doi.org/10.1371/journal.pone.0118489
van der Linden, S., Leiserowitz, A., & Maibach, E. (2019). The gateway belief model: A large-scale replication. *Journal of Environmental Psychology, 62*, 49–58. https://doi.org/10.1016/j.jenvp.2019.01.009
van der Maas, H. L. J., Dolan, C. V., Grasman, R. P. P. P., Wicherts, J. M., Huizenga, H. M., & Raaijmakers, M. E. J. (2006). A dynamical model of general intelligence: The positive manifold of intelligence by mutualism. *Psychological Review, 113*, 842–861. https://doi.org/10.1037/0033-295X.113.4.842
van Harreveld, F., Nohlen, H. U., & Schneider, I. K. (2015). Chapter five - the ABC of ambivalence: Affective, behavioral, and cognitive consequences of attitudinal conflict. In J. M. Olson, & M. P. Zanna (Eds.), *Advances in Experimental social psychology, 52* pp. 285–324). Academic Press. https://doi.org/10.1016/bs.aesp.2015.01.002.
Verschoor, M., Albers, C., Poortinga, W., Böhm, G., & Steg, L. (2020). Exploring relationships between climate change beliefs and energy preferences: A network analysis of the European social survey. *Journal of Environmental Psychology, 70*, Article 101435. https://doi.org/10.1016/j.jenvp.2020.101435
Wolsko, C., Ariceaga, H., & Seiden, J. (2016). Red, white, and blue enough to be green: Effects of moral framing on climate change attitudes and conservation behaviors. *Journal of Experimental Social Psychology, 65*, 7–19. https://doi.org/10.1016/j.jesp.2016.02.005
Zhou, J. (2016). Boomerangs versus Javelins: How polarization Constrains communication on climate change. *Environmental Politics, 25*(5), 788–811. https://doi.org/10.1080/09644016.2016.1166602