

**Influencing Factors in Public Acceptability of DACCS: The Role of Group
Identification, Group Biospheric Values and Political Orientation**

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Abstract

Public support can play a pivotal role in the extent to which technologies and policies that mitigate climate change are implemented. Negative Emission Technologies (NETs) have been considered as necessary by the Intergovernmental Panel on Climate Change (IPCC) to reduce carbon dioxide (CO₂) emissions. In this study we discuss several variables that may influence public acceptability of one specific NET known as Direct Air Capture with Carbon Storage (DACCS). Currently, there is limited research on DACCS and therefore this study provides insight into the variables that may influence public acceptability. We used a cross-sectional study design to test the effect of political orientation, perceived group (i.e. the political wing's) biospheric values, and identification with their political group on the acceptability of DACCS. We found that both political orientation and group identification do not influence public acceptability of DACCS. Perceived group biospheric values were found to strengthen the level of acceptability among left-wing group members. Importantly, this provides support for the current literature on the influence of group values, particularly biospheric values. Policy makers can use these findings, specifically in order to appeal to the values of members of the public across all parts of the political spectrum garnering support for DACCS, which will take a step towards achieving the current climate goals.

Keywords: Negative Emission Technology, Direct Air Capture with Carbon Storage, Public acceptability, Political Orientation, Perceived Group Biospheric Values, Group Identification

Influencing Factors in Public Acceptability of DACCS: The Role of Group Identification, Group Biospheric Values and Political Orientation

With the climate responding rapidly to the emissions that we pump into the air on a daily basis, mitigating and adapting to climate change has never been more important. The effects of climate change are already evident around the world and the majority of people are aware climate change is happening, with most accepting the anthropogenic causes (Reynolds et al., 2010; Milfont et al., 2017). The current focus in climate mitigation is to reduce the amount of carbon dioxide (CO₂) emitted into the atmosphere, particularly in the energy sectors (Earth et al., 2019). So far however, countries have failed to implement policies that would lead to a radical change in CO₂ emissions. Due to the lack of effective policies, with each year it has resulted in diminishing chances to reach the climate goals set out in the Paris Agreement in 2015, including the 1.5-degree Celsius limit. However, with the ever-increasing rate of development of Negative Emission Technologies (NETs), which have the potential to take harmful levels of CO₂ out of the atmosphere, solutions to the climate problem are emerging. The Intergovernmental Panel on Climate Change (IPCC, 2022) states that in order to keep to the agreed 1.5-degree Celsius limit, the deployment of NETs is now required. If this technology works effectively then it may be able to reduce CO₂ levels on a large scale, which makes it vital to combatting climate change. However, not all of this artificial technology is without ramifications, therefore the question remains whether people will accept this technology and what variables may influence its acceptability?

Negative Emission Technology: Direct Air Capture with Carbon Storage

What is Direct Air Capture with Carbon Storage?

There are several types of NETs, and one very recent development is called Direct Air Capture with Carbon Storage (DACCS). DACCS works by capturing CO₂ from the

atmosphere using a system of fans and converting it into a liquid form. This is then injected into geological reservoirs where it mineralises over time, turning into carbonate rock (Satterfield et al., 2023). The advantages are that it can quickly remove CO₂, it doesn't take up a lot of space, and it can be stored safely with low risk of leakage. However, there are high financial costs involved with this type of technology, and perhaps most importantly, it requires a substantial amount of energy which may initially come from fossil fuels. This means it will emit CO₂ as well as take it in, with one analysis estimating up to 90% of CO₂ equal to that captured by the technology could be returned to the atmosphere (Gambhir & Tavoni, 2019). This poses a significant problem as it may sustain a dependence on fossil fuels which could be avoided if the funding was instead invested in renewable energy sources. Ideally this technology would run entirely on renewable energy which has been shown to be theoretically possible by using wind farms (Ishaq & Crawford, 2022). This would solve the issue of indirect CO₂ emissions however; at the moment this may not be feasible in every country.

Current Literature on DACCS

Although DACCS seems promising, not everyone may agree that it should be an environmental priority or that it should be implemented at all. Studies about NET acceptability are only just emerging and so far, research has shown that support for this type of NET is polarised due to the various trade-offs (Satterfield et al., 2023; Cox et al. 2020). Due to the limited NET literature, the evidence used to generate the hypotheses for this paper draws on studies that measure a range of related dependent variables, such as attitudes and acceptability towards climate policy in general as well as towards nuclear energy.

These dependent measures have been selected because the underlying factors influencing their support are also likely to influence support for DACCS. For example,

climate policy support reflects public support for environmental initiatives which is comparable to public support for DACCS. Environmental values have also been shown to be relevant to predict support or rejection of DACCS. At the moment DACCS technology is considered controversial as there are risks involved, for example with leakage during underground storage (Satterfield et al., 2023; Cox et al., 2020; Dütschke, 2011). Therefore, this paper specifically considers nuclear technology in predicting acceptability of DACCS as it is also known to be controversial for this reason (Franchino, 2014).

Public support has been shown to greatly constrain or facilitate whether climate policies are implemented and to what extent they are enforced (Leiserowitz, 2006). This will likely be the same when implementing NETs such as DACCS. The current literature shows mixed support for DACCS, hence determining what influence's public acceptability is important for predicting whether large-scale implementation of DACCS will be successful (Wenger et al., 2021).

Political Orientation as a Variable Influencing Acceptability

Research has shown that political orientation can predict whether people are more likely to believe in climate change, understand the anthropogenic causes, and support climate policies (Hornsey et al., 2016; Mortoja & Yiğitcanlar, 2022; Dunlap & McCright., 2008; Gregerson et al., 2020; Ziegler, 2015; Stoutenborough et al., 2014). Political orientation is described as the extent to which one identifies as left or right-wing. The political spectrum of left- and right-wing, also known as liberal and conservative in countries like the US, is a well-known continuum that has been shown to correlate well with major issues (Arian & Shamir, 1983). One issue which has been shown to split opinions along the political spectrum is environmental beliefs and values, which have also been positively associated with climate policy support (Neumayer, 2004; Bouman et al., 2020; Harring et al., 2017; Satterfield, 2023).

This would imply that political orientation may also play a role in the acceptability of DACCS.

However, previous research shows contradictory findings regarding political orientation as an explanatory variable. Therefore, the hypothesis is split into two to form a competing hypothesis. The first part of the hypothesis predicts that the left-wing will have higher acceptability of DACCS and the second part predicts the right-wing to have higher acceptability based on different literature.

Does the Left-Wing Support DACCS More Than the Right?

In the US, Democrats and liberals expressed stronger support for climate policies, were more likely to believe in the anthropogenic causes, and were more likely to see climate change as a current threat compared to Republicans and conservatives (Leierowitz, 2006.; Dunlap & McCright, 2008). Belief in anthropogenic causes as well as higher levels of climate risk perception were also associated with climate policy support. This has been found to be more prevalent amongst those of left-wing or central orientation compared to right-wing orientation (Drews & Van Den Bergh, 2015; Mortoja & Yigitcanlar, 2022). The climate policy support that was measured in these various studies included a measure of possible financial costs that people were willing to incur, the extent of the effort and inconvenience that people would go to, as well as acceptability of national and international climate policies such as CO₂ regulation (Leierowitz, 2006.; Drews & Van Den Bergh, 2015). Similarly, it has been shown that those who consider themselves liberal, consistently support more restrictive yet effective climate policies compared to right-leaning individuals (Harring et al., 2017). Liberals were found to be more likely to support policies that taxed industry, increased spending on renewable energy, and increased fossil fuel prices (Harring et al., 2017; Stoutenborough et al., 2014). Furthermore, in the US, right-wing individuals are less likely to support climate policies due to higher levels of climate change scepticism (Knollenborg &

Sommer, 2022; Haltinner & Sarathchandra, 2021; Drews & Van Den Bergh, 2015). This would imply that right-wing individuals will be less supportive of technology like DACCS which intends to combat climate change.

Overall, this research suggests that being inclined to the left-wing is linked to higher levels of support for DACCS because they have higher climate policy support, awareness and concern for the climate. It also suggests that right-wing individuals are less likely to support DACCS, since right-wing inclination is linked to climate change scepticism.

Does the Right-Wing Support DACCS More Than the Left?

Research has shown that individuals who identify with the right-wing are more likely to express support for nuclear technology, continuation of fossil fuel energy and NETs (e.g. DACCS) than left-wing individuals (Clulow et al., 2021). One prominent disadvantage of DACCS is the reliance on fossil fuel use in order to provide the energy the technology requires. Given that right-wing individuals do not necessarily support phasing out of fossil fuels, this disadvantage may not be as significant for them, as long as the technology works effectively by removing more CO₂ than it produces. Therefore, they are less likely to be opposed to DACCS. Left-wing individuals high in environmental values are also less likely to support DACCS as they were found to prefer renewable energies over NETs (Clulow et al., 2021).

As mentioned, studies also indicate that right-wing individuals tend to have higher levels of support for nuclear technology compared to left-wing individuals. For instance, in the US, conservatives were found to have a higher positive emotional response to nuclear energy than liberals, who were generally less supportive (McBeth et al., 2022; Besly & Oh, 2013). Similar findings have been found in a longitudinal analysis of surveys across Europe where left-wing exhibited much more critical attitudes towards nuclear technology than right-

wing individuals due to the associated risks (Franchino, 2014). Support for nuclear energy may be applicable to the support for DACCS as both allow a maintenance of the status quo. For example, nuclear technology provides enough energy to sustain the way people currently live without having to make sacrifices to their daily habits. This is not guaranteed with renewable energy because it is less reliable (Bowen, 2011). Conservatives were found to be more likely to justify the status quo (McCright & Dunlap, 2011). Therefore, they will be more inclined to support DACCS as it provides a means to continue emitting the same level of CO₂, without adapting daily routines to reduce the individual carbon footprint.

Overall, these findings suggest that being right-wing is linked to stronger levels of support for DACCS because they support nuclear energy, have less inclination to reduce fossil fuel consumption and have higher support for NETs in general. It also suggests that left-wing are less likely to support DACCS because of the associated risks, and because they are less likely to support nuclear technology and the continuation of fossil fuel use.

Hypothesis 1a. Those who perceive themselves as left-wing in political orientation have stronger support for Direct Air Carbon Capture and Storage compared to those who perceive themselves as right-wing in political orientation.

Hypothesis 1b. Those who perceive themselves as right-wing in political orientation have stronger support for Direct Air Carbon Capture and Storage compared to those who perceive themselves as left-wing in political orientation.

Perceived Group Biospheric Values as a Moderator

The current research on political orientation and climate policy support suggests that those of left-wing orientation are more likely to accept climate policies and be more concerned about the environment than the right-wing (Gregersen et al., 2020; Harring et al., 2017). However, these studies are for the most only moderately significant, with research in

the US displaying higher levels of predictive power for political orientation than in Europe (Ziegler, 2015; Gregersen et al. 2020). There is also limited research on right-wing political orientation and acceptability of nuclear technology or acceptability of NETs, meaning there may be a different variable that adds to this explanation. This paper proposes that perceived group biospheric values may play a role in influencing the acceptability of DACCS across the political spectrum.

Perceived group biospheric values are the extent to which individuals view the ingroup as endorsing values that promote and care for the environment and nature (Bouman & Steg, 2020; De Groot & Steg, 2007). In this case the ingroup would be the political wing the individual identifies with. It is anticipated that perceived group biospheric values will moderate, i.e. strengthen or weaken, the effect of political orientation on acceptability of DACCS.

Previous research suggests that people are more likely to change their behaviour and opinions in order to align with their group's values, if they perceive these values to be important to their ingroup (Bouman & Steg, 2019). People who identify strongly with their group and perceive their group to have strong biospheric values have higher levels of pro-environmental behaviour themselves (Wang et al., 2021; Bouman et al., 2020). This was found to be particularly influential amongst individuals who do not value nature and the environment (Bouman et al., 2020). This would suggest that if the individual does not care so much about the environment or support climate policies, the stance they perceive their group to take on the environment may influence their own level of support.

One study found that environmental values weaken the differences between political orientation and climate change beliefs. They found that if one perceives the group to have high environmental or biospheric values, it may moderate the effect of political orientation on

climate change beliefs (Ziegler, 2017). This relates to DACCS in that perceived group biospheric values are predicted to act as a moderator. Specifically, it may act as a moderator on certain political orientations like left-wing where environmental values are usually more prominent (Dunlap & McCright, 2008).

In relation to DACCS, hypothesis 1a. suggests that left-wing individuals are more likely to view DACCS positively and to accept it than right-wing individuals due to underlying environmental values. Hypothesis 1b. predicts that the right-wing are more likely to see DACCS positively and therefore accept it than left-wing individuals due to reasons besides pro-environmental ones, such as their preference to maintain the status quo. As previous research indicates that environmental values seem more important to the left-wing, it is proposed that perceived group biospheric values will only influence the left-wing (Harring et al., 2017; Hornsey et al., 2016). Therefore, the moderation effect will only be witnessed amongst the left-wing political orientation. So following hypothesis 1a., those who identify with the left, who perceive the left-wing to have high group biospheric values will have stronger acceptability of DACCS than those who perceive their group to have low biospheric values. Or following hypothesis 1b., those in the left-wing who perceive their group to have high biospheric values are even less likely to support DACCS than the left-wing individuals who perceive their group to have low biospheric values. This will make the differences in acceptability between the left- and right-wing greater when perceived biospheric values are high.

Hypothesis 2. Perceived group biospheric values moderate the relationship between political orientation and acceptability of DACCS.

Group Identification as a Secondary Moderator

Group identification can be very influential in determining behaviour outcomes. It is defined as the extent to which we perceive ourselves as belonging to part of the ingroup, in this case the political wings. This involves the level of commitment to, satisfaction with and centrality in the ingroup (Leach et al., 2008).

People tend to categorise themselves as part of a group which forms part of their social identity (Tajfel, 1978). This has been shown to be significant in social influence studies where people are swayed into executing a certain behaviour or holding certain opinions because they are a member of a certain group. For example, previous research found that when people had strong identification with the group, they were more influenced by the group norms (Terry et al., 1999). Furthermore, in the US, political identification has been shown to be, amongst many, an important part of identity. Research suggests that this can lead to partisan identities where identification with a group can lead to taking on its values, also influencing policy acceptance (Mayer 2020). This shows that within a political orientation the extent to which one identifies with the ingroup can be very important. Taken together, this supports the idea that for highly politically identified individuals, the perceived ingroup biospheric values may be more influential.

Research also identified perceived group biospheric values as influential on group members pro-environmental behaviour, particularly when individuals were highly identified with the group (Bouman et al., 2020). This quite clearly shows that the level of affiliation with the ingroup can determine the influence of perceived group values. Applying this to DACCS, this would suggest that a strong affiliation to a political wing strengthens the influence of perceived group biospheric values on the relationship between political orientation and acceptability of DACCS; and weakens the effect if group identification is low.

Hypothesis 3. Strength of group identification moderates the moderation between perceived group biospheric values, political orientation and acceptability of DACCS.

Methods

Research Design and Procedure

This study was approved by the Ethical Committee of the Faculty of Behavioural and Social Sciences at the University of Groningen (EC-BSS). Participants were gathered through convenience sampling, which involved inviting individuals from the researchers' social networks and social media circles to participate in an online survey administered through Qualtrics survey software. This was done by sharing the link to the online questionnaire which was available in English, Dutch, or German. Participation in the study was completely voluntary and participants received no compensation for their participation in the study. The survey took 10 to 15 minutes to complete. The data collection was conducted over the course of a week beginning on the 17th of May 2024 and ending on the 27th May 2024.

The questionnaire started with demographic information such as age, gender and nationality. The first part of the survey began with questions regarding values including: political orientation, environmental values of individuals political group, political group identification, environmental identity, and perceptions of climate change. Additionally, it incorporated information on DACCS technology, administered on two levels: one group who only knew the basic workings of DACCS technology and another group who also knew about pros and cons of DACCS technology.

The survey continued with multiple questions regarding the risk and benefit perception of DACCS, followed by the perceived effectiveness of DACCS. Finally, participants answered questions about the acceptability of DACCS. At the end of the questionnaire a debriefing was provided, informing the participants that they had been assigned to one of the

two knowledge conditions, either having received only basic knowledge or basic knowledge and a list of pros and cons. Lastly, contact details of the research team and a box for general comments were provided, giving the participant the opportunity to contact the research team for any further questions or concerns.

Participants

A priori power analysis was conducted using the software G-Power, which is based on Linear Multiple Regression. The results indicated that for this study design 89 participants were required to achieve a medium effect size ($f^2 = .15$) and power .95%. In total 203 participants took part in the study. After cleaning the data 150 participants were included in the analysis (100 females, 46 males, 1 unknown and 3 non-binary, $M_{\text{age}}=31.39$, $SD =16.13$). Among them, 22 were Dutch, 61 were German, 29 were British, and 38 identified with another nationality. Participant exclusion occurred in several situations. Firstly, participants were not included in the sample when there was no consent given at the beginning and at end of the study. Secondly, participants who failed attention checks were excluded, this occurred 53 times. The age range of participants was between 18 and 87 years old.

Measures

Independent variables

Political orientation was measured by one item on a six-point Likert scale ranging from one (left-wing) to six (right-wing). The participants were asked the following: “it is sometimes said that political opinions can be placed on a left-right scale. This is also known in some countries, like the US, as a liberal-conservative scale. Please indicate your general political opinions on the scale from Left-wing (1) to Right-wing (6).” 127 participants identified as left-wing and 20 identified as right-wing ($M=2.47$, $SD=.917$). For 3 people the data was missing.

Political wing identification was measured by three items to which the participants indicated their level of agreement on a six-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (6) (Cronbach’s alpha = .875, $M=10.53$ $SD=3.58$). Statements for the political wing identification scale were adapted from Leach et al. (2008) who identified specific variables for ingroup identity. People identified moderately with their political wing but this varied significantly between participants ($M=3.5$ $SD=1.1$).

Perceived group biospheric values were also measured by three items to which the participants indicated their level of agreement on a six-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (6) (Cronbach’s alpha = .819, $M=13.86$ $SD=2.42$). Participants were first asked to respond to the statement: “I believe the political wing I associate myself with, prioritises nature and the environment.” Then: “someone from my political wing would want the government to invest in environmental technology.” Lastly: “someone from my political wing would want the government to take measures to reduce CO₂ emissions.” Statements for perceived group biospheric values were adapted from Bouman et al. (2020). Most people perceived their political wing to moderately support the reduction of atmospheric CO₂ ($M= 4.62$, $SD=.807$).

Dependent Variable

Acceptability of DACCS was measured by four items on a six-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (6), (Cronbach’s alpha = .931, $M= 17.12$, $SD=3.40$). Here participants provided information on the extent to which they find DACCS acceptable for use in their own country, in order to reach climate goals, and whether its use should be increased beyond current levels. A copy of the questionnaire with all the relevant questions can be found in Appendix A.

Data Analysis

For the main analysis of political orientation on acceptability of DACCS a linear regression analysis was used to test the effect. The moderation of perceived group biospheric values on political orientation and acceptability of DACCS was analysed using PROCESS macro (model 1) and the moderated moderation of group identification on the moderation model was analysed using PROCESS macro (model 3) (Hayes, 2022).

After data cleaning, we checked the assumptions of multiple linear regression. Linearity and homogeneity of variance were checked through plotting the standardised residuals against the standardised predicted values (as shown in Figure 4). Normally distributed residuals were checked using a histogram of standardised residuals and a Normal P-P Plot (as shown in Figures 2 and 3). Multicollinearity was checked through VIF scores (Table 1). The assumptions were all met and no obvious outliers were present in the analysis of the histogram and scatterplot graphs. Outliers were then measured using Mahalanobis distance, Cook's distance, and Leverage. The results of this analysis indicated that 16 participants could be considered as outliers in two out of three of these outlier measures. As there was no significant change in the results regardless of the inclusion of the outliers, the outliers are included in the reporting of the results. Knowledge was manipulated as part of a different study design. Therefore, it will be used as a covariate within this analysis so that any deviations between the two groups in acceptability of DACCS can be accounted for.

Results

Effect of Political Orientation on Public Acceptability of DACCS

The first hypothesis predicted that either right or left-wing will be more likely to accept DACCS as part of a competing hypothesis. Political orientation was measured as a continuous variable to account for the small number of right-wing respondents. The regression model is not significant ($F(2,144) = .666, p = .515$). The regression analysis showed no main effect for political orientation ($B = -.071, SE = .076, t(146) = -.936, p = .351$),

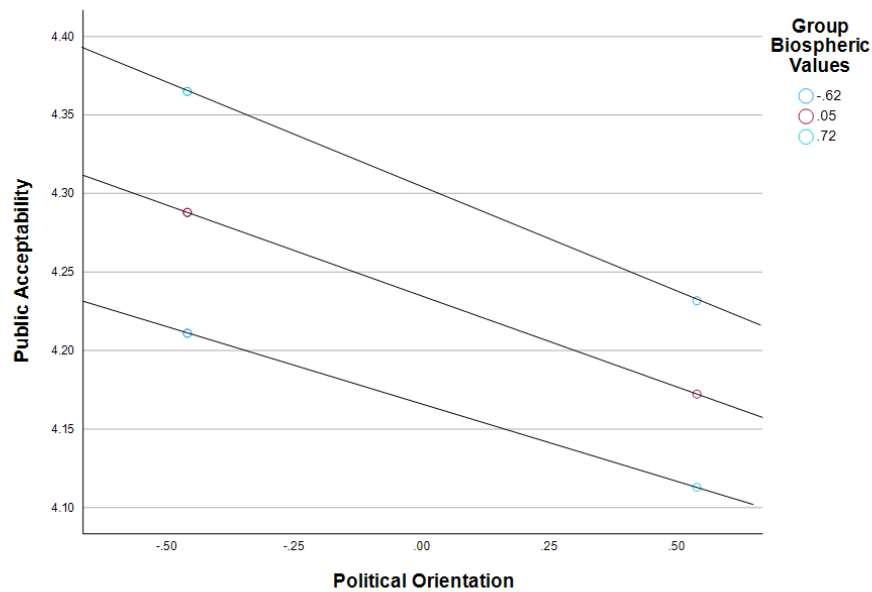
suggesting that political orientation has no significant influence on the acceptability of DACCS. This suggests that there was no difference in the acceptability of DACCS between the left-wing and the right-wing political groups and thus, hypothesis 1a and 1b were rejected.

Perceived Group Biospheric Values as a Moderator

The second hypothesis predicts perceived group biospheric values will moderate the relationship between political orientation and acceptability of DACCS. The moderation model as a whole was shown to not be significant ($F(4,140) = 1.87, p = .120, R^2 = .051$). Perceived group biospheric values were shown to be significant as a moderator on political orientation and acceptability of DACCS, as seen through the interaction effect ($\beta = -.205, t(140) = -2.47, p = .015, 95\% CI = [-.368, -.041], R^2 = .042$). Further analysis showed that only when perceived group biospheric values were high, was there a significant difference in acceptability of DACCS between left- and right-wing participants ($\beta = -.252, t(140) = -2.22, p = .028, 95\% CI = [-.476, -.0278]$). Specifically, left-wing have statistically significant higher levels of acceptability of DACCS than right-wing when perceived group biospheric values are high. This supports the second hypothesis. There was no significant difference between political orientations when perceived group biospheric values were low ($\beta = .021, t(140) = .239, p = .811, 95\% CI = [-.151, .192]$). Figure 1 below shows the results of political orientation on public acceptability of DACCS at different levels of the perceived group biospheric values.

Figure 1.

Effect of Perceived Group Biospheric Values as a Moderator



Secondary Moderation Analysis

Finally, the moderated moderation model was tested, that is the influence of group identification on the moderation between perceived group biospheric values, political orientation and acceptability of DACCS. The hypothesis predicted that high levels of group identification would strengthen the moderation of perceived group biospheric values, political orientation and acceptability of DACCS. The results indicated that the moderated moderation is not significant ($F(8,135) = 1.5905, p = .133, R^2 = .086$). Group identification was found to be not significant as a second moderator as shown through the interaction effect ($\beta = .0516, t(135) = .792, p = .430, 95\% CI = [-.359, .206], R^2 = .004$). This suggests that group identification has no influence on the moderation of perceived group biospheric values, political orientation and acceptability of DACCS, and thus hypothesis 3 was rejected.

Discussion

This study examines the relationships between political orientation, perceived group biospheric values, and group identification on the public's acceptability of DACCS. The first hypothesis predicted that there would be a difference in people's acceptability of DACCS based on their political orientation. However, political orientation was found to have no

influence on the acceptability of DACCS, rejecting the first hypothesis. The second hypothesis predicted that perceived group biospheric values would act as a moderator on the relationship between political orientation and acceptability of DACCS. This was found to be the case for left-wing participants who perceived their group to have high biospheric values. Finally, the secondary moderation of group identification on perceived group biospheric values, political orientation, and acceptability of DACCS was found to be not significant.

Political Orientation

Despite the literature review suggesting that political orientation can influence the acceptability of nuclear energy and climate change policies, the results suggest that this is not applicable to the acceptability of DACCS. One explanation for these non-significant results could be due to the underlying motivations for acceptability of DACCS. Previous research indicated that both left-wing and right-wing could support DACCS but for varying reasons: right-wing individuals might view DACCS as risky but useful technology, and left-wing might view it as an effective way to mitigate climate change (Clulow et al., 2021). These differing motivations could lead to a similar level of support for DACCS across the political spectrum.

Another explanation could be that the effect of political orientation is overstated in the previous literature. Much of the literature in this field cites similar papers to support the initial claim that political orientation is an important variable worth investigating. Although these papers do show statistically significant results, research has shown that European samples often have small significant effects compared to the more commonly used US samples (Ziegler, 2017). Therefore, those larger significant findings from the US may not reflect the influence of political orientation on policy acceptance in the wider population. The results of this study demonstrate that perhaps the focus on political orientation should shift to other variables which may better explain acceptance of climate policies, and particularly of NETs.

Political ideology itself is also quite a vague concept. It is made up of certain values and beliefs of how a government should run but these do not necessarily stand for everyone in that political wing. Furthermore, depending on which country one is from, the left and right-wing may stand for different ideologies. Therefore, asking members of the public about their political orientation rather than the values they hold, may not result in any significant findings because of the rather loose concept of political orientation.

Finally, DACCS is a very new concept that many people may not have previously heard of. Plenty of people are aware of the stereotypes and ideologies that represent certain sides of the political spectrum and these are likely to influence the general opinions of those who identify with a political wing. However, because DACCS has not been implemented long enough, there is no polarisation effect within the political spectrum. Therefore, once people have more knowledge on this technology, they might be more easily influenced by the political wings.

Group Biospheric Values

The second hypothesis investigated the impact of perceived group biospheric values as a moderation on the relationship between political orientation and acceptability of DACCS. Perceived group biospheric values were shown to have a significant moderation effect on the relationship between political orientation and acceptability of DACCS, indicating support for the second hypothesis. The results suggest that higher levels of perceived group biospheric values increase the acceptability of DACCS among left-wing individuals. Among lower levels of perceived group biospheric values and right-wing individuals this interaction did not occur, as hypothesised.

Although political orientation was shown to not be a significant factor in attitudes towards DACCS, the results suggest that perceptions of group biospheric values are involved. The findings from this study show the importance of social identity theory. When people are

made to focus on their group values, they use it as guidance in forming their own opinions.

This supports previous literature which concluded that enhancing the visibility of groups biospheric values is important for engaging individuals in pro-environmental action (Bouman & Steg, 2019).

Group Identification

The third hypothesis predicted that group identification would have a moderating effect on the moderation. Specifically, an increase in group identification will strengthen the effect of perceived group biospheric values and a decrease will weaken it. Interestingly, there was no moderation effect found indicating that the extent to which one identified with their political wing did not change the influence of the perceived group's biospheric values.

One argument for the lack of significant interactions could link back to the idea that the concept of political orientation is fairly vague. This makes it harder for people to identify with, as it encompasses many different values and ideologies which vary per person and across countries. Additionally, we measured individual's political wing rather than the political group itself. This is also fairly broad as people may not identify or agree with all the concepts in the left or right-wing. For example, there are extremes on both sides of this spectrum that most people don't identify with and this could reduce their overall identification with the entire political wing. Therefore, it could be the case that if identification with a political group itself was measured, people may have greater identification as political groups usually stand for clearly defined values.

The non-significant results could also imply that political orientation is not as relevant as first thought. Perhaps measuring the group identification of more relevant variables could lead to significant results. For example, identification with environmental groups may be a more important variable as it relates directly to environmental values which have been shown to influence pro-environmental behaviour (De Groot & Steg, 2007). Another relevant variable

could be the level of identification with ingroup members with whom we interact with on a daily basis. These group members may also have different views about certain topics, such as the environment. Research has found that in cases where environmental values are already high, these conflicting views in groups can increase pro-environmental behaviour intentions (McDonald et al., 2012). This may be a more relevant variable to investigate given the prominence of these groups in our daily lives.

Limitations

Although this research has provided useful insights into the factors that influence people's acceptability of DACCS, it is not without limitations. The spectrum that was used to measure political orientation consisted of a six-point scale with no possibility of identifying as central. We received several comments regarding this measure, as people preferred to have a central option because they did not consider themselves either left-wing or right-wing but rather somewhere in the middle. This could mean that the true left-or-right-wing values are being distorted by the central respondents. Therefore, it may have been better to include a central measure and either disregard their results as this was not part of the hypothesis, or to implement central voters in the hypothesis.

Furthermore, most of the participants whose data was used were young and identified with the left-wing. There were only 20 right-wing respondents out of the 150 which can lead to a number of statistical and generalisability problems. The likelihood of detecting a significant result for the right-wing group decreases substantially with such a small sample and therefore the non-significant results could be a result of an unbalanced sample. However, because there was also no effect found in the larger sample of the left-wing group, the chance that a type two error occurred is less probable. Even so, the right-wing respondents are still unlikely to reflect the actual population parameters due to the small sample size and therefore

these results are unlikely to be generalisable to the wider population, reflecting low external validity. The problem of generalisability is further exacerbated by the young sample.

Finally, given the technology's recent emergence, people's attitudes towards it may not be fully formed yet. This was evident in our study as several participants commented that they did not know enough about the technology to feel comfortable giving a response so if there had been an 'I don't know' option they would have clicked this. Therefore, providing enough information about DACCS beforehand, about the pros and cons, the costs and effectiveness, would have meant a greater understanding of the technology and an ability to apply the values they hold to the questions more effectively.

Future Research and Practical Implications

There is still far more room for research in this field. Future studies can focus on different variables besides political orientation such as the trust in the government's ability to carry out the implementation of DACCS. Previous research has indicated that trust in politicians increases support for certain climate policies (Hammer & Jagers, 2006). Even if the technology is perceived on a group or individual level as useful, effective, and necessary, there may still be barriers to public acceptability if there is no confidence in governmental ability. Another aspect which may be interesting to research instead is whether vulnerability to global warming influences the likelihood that an individual may accept the implementation of DACCS within their own neighbourhood. Previous research has found that in the US individuals sometimes feel unaffected by climate change and therefore do not perceive it as an immediate risk. Rather it is perceived as a risk for others geographically distant to themselves (Leiserowitz, 2006). This could negatively influence their perceptions towards environmental technology like DACCS as it may be deemed unnecessary. Therefore, feelings of vulnerability or personal experiences with climate change may influence how people react to NETS.

Trust in the technology itself may also be relevant for future research. Individuals may also not see DACCS as a trustworthy solution to the climate problem. One respondent in the survey mentioned that reduction of CO₂ using technology should not be a priority, instead schemes to reduce consumption and waste need to be implemented to combat climate change. The participant elaborated by adding that reduction in CO₂ is already tackled through nature and therefore spending excessive time and money into building this technology and implementing it is not necessary.

Future research can also further investigate this study's significant finding. Perceived group biospheric values can be manipulated and this would measure whether making it salient changes the acceptability of DACCS. This tests causation and strengthens the credibility of this finding.

This study adds to the existing literature on public acceptability of DACCS and reveals relevant factors that influence acceptability. The IPCC (2022) has already stated that NETs will be fundamental in realising the global climate goals yet so far there is limited support for this type of technology (Ashworth et al., 2019). The results can prove important for policy makers and governments who may need to implement DACCS in the near future. For example, politicians may adjust their policies accordingly by placing emphasis on various values (i.e. ingroup biospheric values), in order to garner more public support for this technology. This study's results also suggest that there is not yet a split in opinions on DACCS across the political spectrum. This means there may be less opposition to the technology within governments, and policy makers are more likely to be able to appeal to a wider audience through drawing on the various values people hold. Framing political messages in a certain way has been shown to increase support for some climate policies (Lockwood, 2011). This can be used in the implementation of DACCS by highlighting the

importance of different values such as investment rather than saving the environment, meaning this technology will be accepted by a larger proportion of the public.

Conclusions

In conclusion, the results provide a novel insight into the variables influencing public acceptability of DACCS. We investigated how political orientation, perceived group biospheric values and group identification may play a role in public acceptability of DACCS. We argue that political orientation is not such an important variable as the previous literature implies, particularly concerning DACCS. Perceived group biospheric values may influence individual's opinions but the level of identification with the group does not influence the extent to which group values shape individuals' acceptability. Taken together, these results reveal the importance of certain variables in acceptability of DACCS and minimise the relevance of others, providing vital information for policy makers when implementing NETs.

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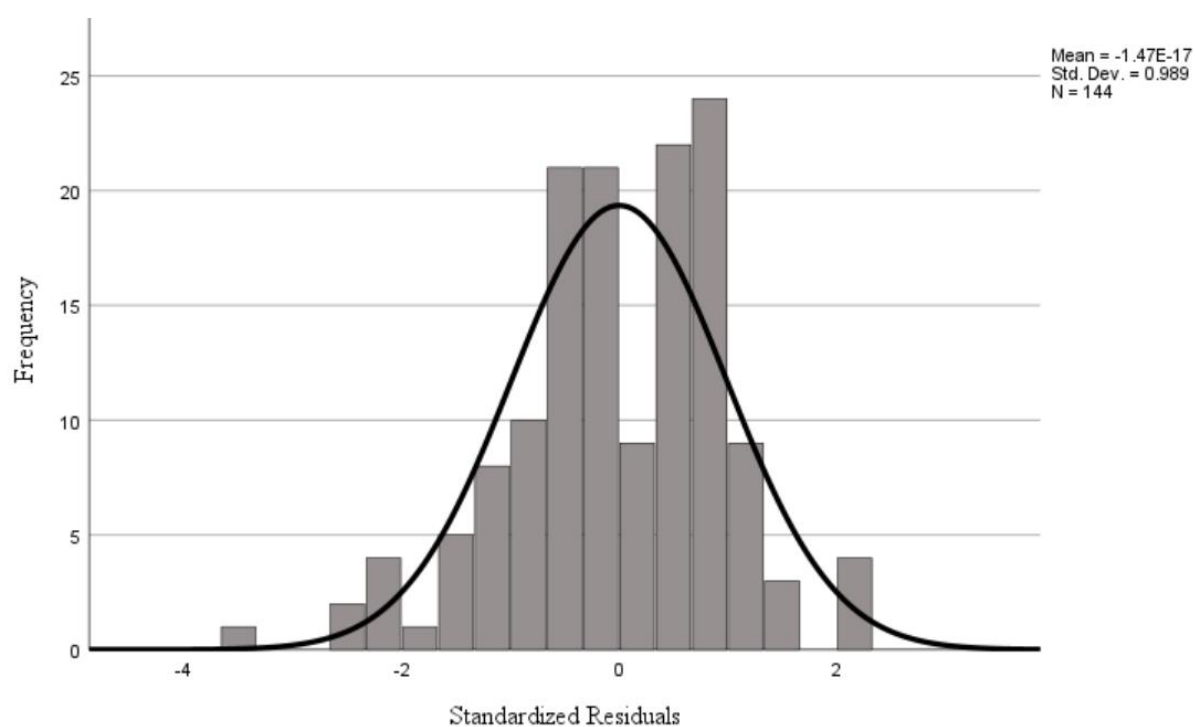
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Table 1*Table Displaying Multicollinearity Test Results*

Model		Unstandardized Coefficients		Standardized Coefficients		Collinearity Statistics		
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	3.893	.593		6.563	<.001		
	Political Orientation Knowledge (covariate)	.010	.088	.011	.114	.909	.757	1.321
	Group Identification	-.059	.144	-.035	-.409	.683	.964	1.037
	Group Biospheric Values	.153	.071	.214	2.163	.032	.704	1.420
	Group Biospheric Values	-.031	.100	-.029	-.308	.759	.757	1.320

a. Dependent Variable: Public Acceptability of DACCS

Figure 2*Histogram of Standardised Residuals Displaying Normality***Figure 3***Normal P-P Plot of Regression Standardised Residual*

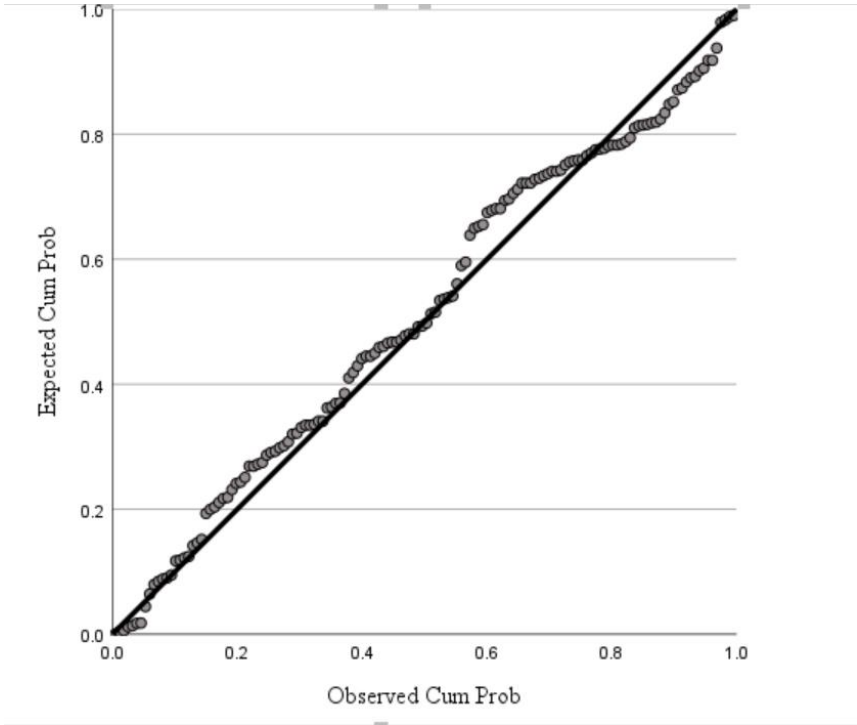
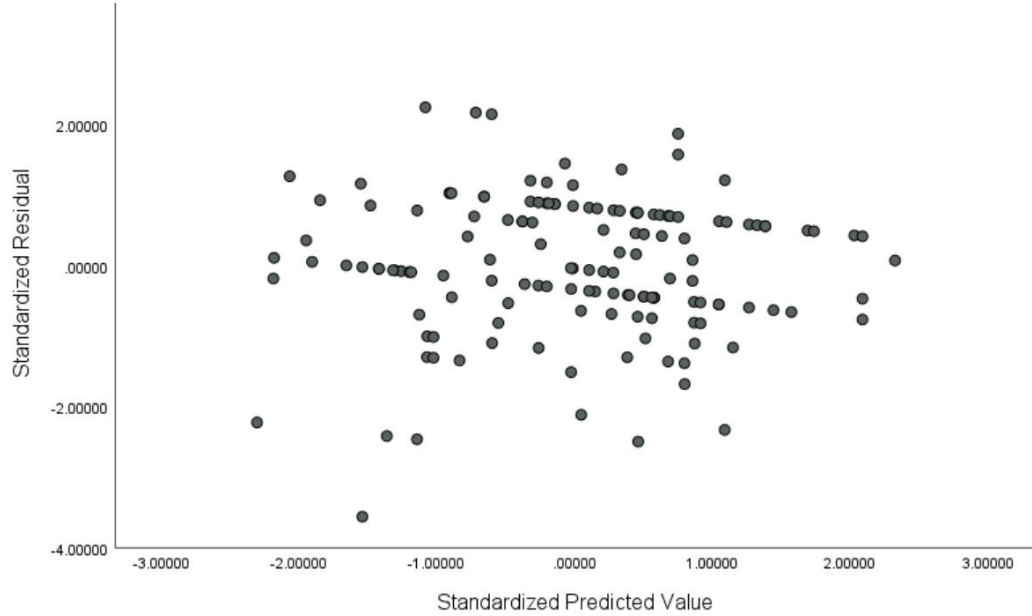


Figure 4

Test for Linearity and Homoscedasticity



Appendix A

Sample Questionnaire

Political Orientation and Values

We are interested in your political orientation and values concerning the environment.

Please read the statements below carefully and indicate to what extent you agree with the statements on a 6-point scale from strongly disagree (1) to strongly agree (6).

Political orientation. It is sometimes said that political opinions can be placed on a left-right scale. This is also known in some countries, like the US, as a liberal-conservative scale. Please indicate your general political opinions on the scale from Left-wing (1) to Right-wing (6).

	1	2	3	4	5	6
	Left wing					Right Wing
Where would you place yourself on such a left-right scale?	0	0	0	0	0	0

Political Wing (Left-Right) Identification.

	1	2	3	4	5	6
	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
I associate myself with my political wing	0	0	0	0	0	0
Being part of this political wing gives me a good feeling	0	0	0	0	0	0
Being part of this political wing is an important part of how I see myself	0	0	0	0	0	0

Environmental Values of Your Political Wing.

	1	2	3	4	5	6
		disagree	somewhat	somewhat	agree	

	strongly disagree		disagree	agree		strongly agree
I believe the political wing I associate myself with, prioritises nature and the environment	0	0	0	0	0	0
Someone from my political wing would want the government to invest in environmental technology	0	0	0	0	0	0
Someone from my political wing would want the government to take measures to reduce CO2 emissions	0	0	0	0	0	0

Acceptability of DACCS

We are interested in your opinion on how acceptable it is to implement DACCS.

Please read the statements below carefully and evaluate them on a 6-point scale from strongly disagree (1) to strongly agree (6).

	1 strongly disagree	2 disagree	3 somewhat disagree	4 somewhat agree	5 agree	6 strongly agree
I find the use of DACCS technology acceptable.	0	0	0	0	0	0
I find it acceptable to implement DACCS technology in my country.	0	0	0	0	0	0
I find it acceptable to use DACCS technology in order to reach global climate goals.	0	0	0	0	0	0
I find it acceptable to use more DACCS technology in my country than is used now.	0	0	0	0	0	0