

Predictors of Willingness to Reduce Carbon Footprint and Effect of Survey Question Phrasing

Nikol Miojevic¹, Simone Robson² and Renata Ivanek Miojevic³

¹Ithaca High School, Ithaca, NY, USA

²Fountain Valley High School, Fountain Valley, CA, USA

³Cornell University, Ithaca, NY, USA

ABSTRACT

To minimize and prevent the many negative effects associated with climate change people must reduce their carbon footprints. Our objectives were to determine whether a person's likelihood to take political action against climate change, perceptions about fracking, and education level affect their willingness to reduce carbon footprint, and whether phrasing of a survey question affects how people respond. To this end, participants' responses were used from the publicly available nationally representative 2015 Cornell National Social Survey (CNSS) of 1,000 United States adults. Statistical analysis involved estimation and comparison of odds ratios (ORs) and the associated 95% confidence intervals (95% CIs). Findings indicated that willingness to reduce carbon footprint was positively associated with being likely to take political action against climate change (OR=6.53, 95% CI: 4.63-9.20) and with having gone to college (OR=1.43, 95% CI: 1.06-1.94). Conversely, support for fracking had a negative association with willingness to reduce carbon footprint (OR=0.42, 95% CI: 0.31-0.56). In CNSS, the question about carbon footprint was phrased in five different ways that either mentioned the danger from climate change or the benefit from reducing climate change, and linked the benefit or danger to humans or birds. It was discovered that how the question is asked matters. Participants appeared more affected by mention of humans than animals, though reactions to benefit and danger were not consistent. These findings will aid education efforts about climate change and carbon footprint and also help in the design of future surveys on the topic.

Introduction

Climate change presents a big issue for the present and an even bigger issue for the future. It is laden with many negative effects such as, sea-surface warming, sea level rises, and increased intensity and frequency of extreme weather events (Barnett and Adger, 2003). Many people do not believe that climate change exists, at least not as the consequence of significantly increased carbon dioxide and other greenhouse gas emissions due to human activities (Bain et al., 2012). Greenhouse gases cause global warming and in turn climate change by absorbing heat radiated by the Earth and reradiating some of it back to Earth, thereby trapping heat in the atmosphere. If people don't believe that greenhouse gas emissions are a problem, they won't be lowered, which would cause the continuation of anthropogenic climate change and possible further acceleration of it. However, there are people who want to reduce their carbon footprints to decrease climate change. A person's carbon footprint is the amount of greenhouse gases, usually specifically carbon dioxide, that are released into the environment due to their activities and lifestyle (Carbon Footprint, 2020). A person can reduce their carbon footprint through buying electric and fuel-efficient cars, using public transportation, investing in energy saving appliances, using electricity derived from renewable sources, and more. Simply knowing what type of people are willing and unwilling to reduce their carbon footprint in the United States would already be very valuable as it would deepen understanding of public perceptions. Additionally, it would provide the means to target specific groups of people for further research and education on climate change and carbon footprint.

The objective of this study was to use the publicly available nationally representative 2015 Cornell National Social Survey (CNSS) data (Survey Research Institute, 2015) to determine if a person's self-reported likelihood to take political action to prepare for and reduce the impacts of climate change, thoughts on fracking, and education level make the person more or less willing to reduce their carbon footprint. This question was motivated by three hypotheses (H). (H 1) Being likely to take political action against climate change is positively associated with willingness to reduce carbon footprint. (H 2) Support for fracking is negatively associated with willingness to reduce carbon footprint. (H 3) Having gone to college is positively associated with willingness to reduce carbon footprint. In the 2015 CNSS the carbon footprint question was phrased in five different ways as an experiment to evaluate whether phrasing affects participants' responses. Asking questions to survey participants is the main way that their characteristics are discovered, so the effect of question phrasing is a very important topic, as it may affect the results of studies using surveys. This motivated an additional hypothesis (H 4) that people will respond differently when asked differently phrased questions because their thoughts will be affected by information in the question. Another study (Dickinson et al., 2016) also used the 2015 CNSS with the outcome of interest also being willingness to reduce carbon footprint. However, the Dickinson et al. study did not evaluate any of the risk factors analyzed in our study. Thus, the current study presents a novel analysis of publicly available data.

Methods

About 2015 CNSS

As stated above, the source of data used was the publicly available 2015 CNSS, due to the fact that it was recent and included multiple questions relating to climate change. CNSS is a yearly cross-sectional telephone survey on 1,000 adults from the continental United States. Most of the survey questions change annually, besides some demographic questions. The participants are selected with a dual frame random digit dial (RDD) and cell phone sampling (Survey Research Institute, 2015). The 2015 CNSS was conducted with approval of Cornell University's Institutional Review Board (approval #1402004459).

Data Management

Four questions were selected from the 2015 CNSS (Table 1). The outcome of interest was how willing people are to change their current lifestyle to reduce their carbon footprint (question PMq1 in 2015 CNSS, corresponding to factor "CarbonFoot" in our study). The three other questions were all separately assessed with CarbonFoot to see if there was any association between the outcome of interest and the considered risk factors. One of these three risk factors was a person's likelihood to take political action to encourage governments or organizations to prepare for and reduce the impacts of climate change (question SBAq6 in 2015 CNSS, corresponding to factor "Action" in our study). Another of the considered risk factors was how people feel about fracking (question DBq1 in 2015 CNSS, corresponding to factor "Frack" in our study). Fracking, which is another name for hydraulic fracturing, is a method that is used to extract fossil fuels like natural gas and oil from shale rock located deep below the surface of the Earth (Survey Research Institute, 2015). The last of the risk factors assessed was a person's education level (question educ in 2015 CNSS, corresponding to factor "Educ" in our study). For each of the four questions there were several different responses in the 2015 CNSS based on the Likert scale that participants could choose from. In order to simplify the analysis, the responses were categorized into "yes" and "no". For CarbonFoot those who were unwilling to reduce their carbon footprint were categorized as "no" and those who were willing were categorized as "yes". Thus, the responses in 2015 CNSS for CarbonFoot, "very unwilling", "unwilling", "somewhat unwilling", and "neutral" were categorized as "no". "Neutral" was categorized as "no" because there were a large number of neutrals and it would

mean losing too much data if they were not included in our study, so in all questions where neutrals were present, they were just categorized as “no”.

The responses for CarbonFoot, “somewhat willing”, “willing”, and “very willing” were categorized as “yes”. The responses, “refused”, “do not know”, and “refused-don’t believe in/understand climate change” were not included in our study (Table 2). For Action, those who were unlikely to take political action against climate change were categorized as “no” and those who were likely were categorized as “yes”. Therefore, the responses in 2015 CNSS for Action, “very unlikely”, “somewhat unlikely”, and “neutral” were all categorized as “no”. The responses for Action, “somewhat likely”, and “very likely” were categorized as “yes”. The responses, “do not know” and “refused” were not included in our study (Table 2). For Frack those who opposed fracking were categorized as “no” and those who supported fracking were categorized as “yes”. Accordingly, the 2015 CNSS responses for Frack, “strongly oppose it”, “somewhat oppose it”, and “neither support or oppose it” were categorized as “no”. The responses, “somewhat support it” and “strongly support it” were categorized as “yes”. The responses, “do not know” and “prefer not to answer” were both not included in our study (Table 2).

For Educ, those who have not gone to college were categorized as “no” and those who have gone to college were categorized as “yes”. Hence, the responses in 2015 CNSS for Educ, “none or grades 1-8”, “high school incomplete”, “high school graduate”, and “technical, trade, or vocational school” were categorized as “no”. The responses, “some college, no 4-year degree”, “college graduate”, and “post-graduate or professional schooling” were all categorized as “yes”. The response, “refused” was not included in our study (Table 2). If a survey participant had a “not included” response for even one of the considered questions, they entirely could not be used, because their interview had missing data. This led to the number of survey participants used in the analysis dropping from 1,000 to 965.

Table 1. Questions and data from the 2015 CNSS (1,000 participants) used in this study and new factor names

Original Question	Responses	Number (%)	Factor name in our study
How willing are you to change your current lifestyle in order to reduce your carbon footprint? (PMq1)	very unwilling	77 (7.7%)	CarbonFoot
	unwilling	40 (4%)	
	somewhat unwilling	40 (4%)	
	neutral	136 (13.6%)	
	somewhat willing	235 (23.5%)	
	willing	188 (18.8%)	
	very willing	273 (27.3%)	
	refused	2 (0.2%)	
	do not know	4 (0.4%)	
	refused-don’t believe in/understand climate change	5 (0.5%)	
How likely would you be to take political action to encourage governments or organizations to prepare for and reduce the impacts of climate change? (SBAq6)	very unlikely	223 (22.3%)	Action
	somewhat unlikely	139 (13.9%)	
	neutral	185 (18.5%)	
	somewhat likely	252 (25.2%)	
	very likely	199 (19.9%)	
	do not know	1 (0.1%)	
	refused	1 (0.1%)	
Hydraulic fracturing, or "fracking", is a way to extract oil and natural gas from shale rock deep underground. Based on	strongly oppose it	214 (21.4%)	Frack
	somewhat oppose it	147 (14.7%)	
	neither support or oppose it	316 (31.6%)	
	somewhat support it	152 (15.2%)	

anything you may have heard or read about hydraulic fracturing, do you: (DBq1)	strongly support it	148 (14.8%)	
	do not know	22 (2.2%)	
	prefer not to answer	1 (0.1%)	
What is the last grade or class that you completed in school? (educ)	None or grades 1-8	6 (0.6%)	Educ
	High school incomplete (grades 9-11)	40 (4%)	
	High school graduate (grade 12 or GED certificate)	196 (19.6%)	
	Technical, trade, or vocational school after high school	38 (3.8%)	
	Some college, no 4-year degree (including 2 year Associate Degree)	260 (26%)	
	College graduate (BS, BA, or other 4-year degree)	278 (27.8%)	
	Post-graduate training or professional schooling after college	181 (18.1%)	
	Refused	1 (0.1%)	

Table 2. 2015 CNSS data grouping for willingness to reduce carbon footprint (CarbonFoot), likelihood to take political action against climate change (Action), thoughts on fracking (Frack), and education level (Educ), with participants with “not included” responses removed (sample size 965)

Factor	Response grouping		Number (%)	
CarbonFoot	no	very unwilling	286 (29.6%)	
		unwilling		
		somewhat unwilling		
		neutral		
	yes	somewhat willing		679 (70.4%)
		willing		
Action	no	very unlikely	526 (54.5%)	
		somewhat unlikely		
		neutral		
	yes	somewhat likely	439 (45.5%)	
		very likely		
	Frack	no	strongly oppose it	668 (69.2%)
somewhat oppose it				
neither support or oppose				
yes		somewhat support it	297 (30.8%)	
		strongly support it		
Educ		no	None or grades 1-8	
	High school incomplete (grades 9-11)			
	High school graduate (grade 12 or GED certificate)			

		Technical, trade, or vocational school after high school	698 (72.3%)
	yes	Some college, no 4-year degree (including 2 year Associate Degree)	
		College graduate (BS, BA, or other 4-year degree)	
		Post-graduate training or professional schooling after college	

Statistical Analysis

Each of the factors, Action, Frack, and Educ were put in a two-by-two table with CarbonFoot (Table 3). The number of people was counted who said “yes” to CarbonFoot and “yes” to the factor (yes/yes), then “no” to CarbonFoot and “yes” to the factor (no/yes), and so on with “yes/no” and “no/no”. The numbers in this table were used to calculate the odds of “yes” to the factor in those who said “yes” to CarbonFoot. This was done by dividing the number of those who said “yes” to CarbonFoot and said “yes” to the factor by the number of those who said “yes” to CarbonFoot and “no” to the factor. Then the odds of “yes” to the factor in those who said “no” to CarbonFoot was found. This was done by dividing the number of those who said “no” to CarbonFoot and “yes” to the factor by the number of those who said “no” to CarbonFoot and “no” to the factor. From these two odds the odds ratio (OR) was calculated for each factor by dividing the odds of “yes” to the factor in those who said “yes” to CarbonFoot by the odds of “yes” to the factor in those who said “no” to CarbonFoot. The OR was used as a measure of association between the outcome of interest and each factor. An OR is bounded by zero and infinity. If the OR is greater than 1 it indicates a positive association and if it is less than 1 it indicates a negative association, and the farther the OR is from 1 the stronger the association. To determine whether the estimated OR for each factor is statistically significantly ($p < 0.05$) different from the null value of 1 (meaning no association because the two odds from which the OR is derived are equal) we estimated the corresponding 95% confidence interval (95% CI) using the large sample normal approximation method with variance based on a Taylor series expansion (Giesecke, 2002). In order to estimate the 95% CI, first the error factor needed to be calculated. To do this for each factor separately the formula in Equation 1 was used where yes/yes, no/yes, yes/no, and no/no were defined above.

$$\text{Equation 1: } \text{Error factor} = e^{1.96 \sqrt{\frac{1}{\text{yes/yes}} + \frac{1}{\text{no/yes}} + \frac{1}{\text{yes/no}} + \frac{1}{\text{no/no}}}}$$

To calculate the lower limit of the 95% CI for each factor the OR for that factor was divided by its error factor. To calculate the upper limit of the 95% CI the OR was multiplied by the error factor. For each factor the lower and upper limit calculated gave the 95% CI.

Table 3. Cross-tabulation, odds ratios (ORs) and 95% confidence intervals (95% CIs) for likelihood to take political action against climate change (Action), thoughts on fracking (Frack), and education level (Educ) with willingness to reduce carbon footprint (CarbonFoot)

Sample Size=965		CarbonFoot		Association	
		yes	no	OR	95% CI
Action	yes	390	49	6.53	4.63-9.20
	no	289	237	ref ¹	
Frack	yes	170	127	0.42	0.31-0.56

	no	509	159	ref	
Educ	yes	506	192	1.43	1.06-1.94
	no	173	94	ref	

¹ref: reference level in calculation of odds ratio

The CarbonFoot question consisted of five different phrasings of which each person was randomly asked only one (Figure 1). The introductory part of the question differed (or was missing) and the main part of the question was the same in all phrasings (i.e., the question was stated as “[*variable introductory phrasing*], how willing are you to change your current lifestyle in order to reduce your carbon footprint?”). Phrasing one was named “no text”, phrasing two “dangerous for birds”, phrasing three “dangerous for people”, phrasing four “beneficial for birds”, and phrasing five “beneficial for people” (Figure 1). The people who answered each question phrasing were separated and the same analysis as previously described was run on each of the five groups with the three risk factors to get an OR and the corresponding 95% CI for each CarbonFoot phrasing with each of the factors. The ORs for the different phrasings were first compared graphically. Next, we used a one-tailed z-test for comparison of 2 independent samples to compare phrasings with the most different ORs based on graphical comparison. The z-test results in a test statistic called the z-score, which is the distance between two means (in our case the two natural log transformed ORs we want to compare) in units of the standard error. The estimated z-score is compared to the critical value of 1.645, corresponding to the significance level of 5%, to determine the associated p-value. A p-value above 0.05 indicates no significant difference between the two phrasings analyzed and a p-value below 0.05 indicates a significant difference. Statistical analyses were conducted in Excel.

CarbonFoot Phrasings		Action		Frack		Educ	
		yes	no	yes	no	yes	no
1. How willing are you to change your current lifestyle in order to reduce your carbon footprint? (no text)	yes	81	60	39	102	101	40
	no	12	51	28	35	41	22
2. <i>Given that climate change is dangerous for birds</i> , how willing are you to change your current lifestyle in order to reduce your carbon footprint? (dangerous for birds)	yes	72	48	33	87	94	26
	no	7	41	24	24	35	13
3. <i>Given that climate change is dangerous for people</i> , how willing are you to change your current lifestyle in order to reduce your carbon footprint? (dangerous for people)	yes	86	76	37	125	120	42
	no	11	49	31	29	32	28
4. <i>Given that reducing climate change is beneficial for birds</i> , how willing are you to change your current lifestyle in order to reduce your carbon footprint? (beneficial for birds)	yes	85	51	29	107	102	34
	no	11	52	27	36	50	13
5. <i>Given that reducing climate change is beneficial for people</i> , how willing are you to change your current lifestyle in order to reduce your carbon footprint? (beneficial for people)	yes	66	54	32	88	89	31
	no	8	44	17	35	34	18

Figure 1. Cross-tabulation with heat map (colors darken as numbers increase) between five willingness to reduce carbon footprint (CarbonFoot) phrasings from the 2015 CNSS (text in bold italic font indicates the variable)

introductory phrasings) and risk factors: likelihood to take political action against climate change (Action), thoughts on Fracking (Frack), and education level (Educ)

Results

As mentioned before, of the 1,000 telephone interviews that were conducted in the 2015 CNSS, only the responses from 965 interviews were used due to the deletion of the people with “not included” responses. In the survey 679 people (70.4%) said “yes” to CarbonFoot and 286 people (29.6%) said “no” to CarbonFoot. This demonstrates that of the people asked, more are willing to reduce their carbon footprint. For Action 439 people (45.5%) said “yes” and 526 people (54.5%) said “no”. This is around half of the people considered being likely to take political action against climate change and half unlikely. For Frack 297 people (30.8 %) said “yes” and 668 people (69.2%) said “no”, showing that a higher portion of the people surveyed do not support fracking. Concerning Educ, 698 people (72.3%) said “yes” and 267 people (27.7%) said “no”. This shows that of the people asked a greater amount have attended college. All this information is shown in Table 2.

Statistical analysis of the data revealed a strong positive association between being likely to take political action against climate change and willingness to reduce carbon footprint. The OR of 6.53 (Table 3) is greater than 1 so it is a positive association and it is quite far from 1 so it is a strong association. The 95% CI of 4.63-9.20 (Table 3) proves the strong positive association as it is quite far above 1. This means that people who are likely to take political action against climate change are much more likely to be willing to reduce their carbon footprint than people who are unlikely to take political action against climate change. Through statistical analysis it was also found that there is a moderate negative association between supporting fracking and being willing to reduce carbon footprint. The OR of 0.42 (Table 3) demonstrates this. It is below 1 which is a negative association and is a moderate distance from 1 indicating a moderate association. The 95% CI is 0.31-0.56 (Table 3) which confirms the moderate negative association as it is moderately below 1. This moderate negative association means that people who support fracking are more likely to be unwilling to reduce their carbon footprint than people who oppose fracking. Statistical analysis of the data divulged a weak positive association between having gone to college and being willing to reduce carbon footprint. The OR of 1.43 (Table 3) is above 1 only slightly so there is a weak positive association. The 95% CI of 1.06-1.94 (Table 3) supports this. This means that people who have attended college are somewhat more likely to be willing to reduce their carbon footprint than people who have not attended college.

For the five phrasings that were used for CarbonFoot, data was statistically analyzed to reveal any associations between the CarbonFoot phrasing and the factors and to see if the associations changed based on what phrasing was used in asking the question. A strong positive association was discovered between being likely to take political action against climate change and each of the phrasings of CarbonFoot. The ORs and the 95% CIs are all above 1 (Table 5), indicating a positive association. The ORs are quite far from 1 (Figure 2 and Table 5) so it could be said there is a strong association, however, the 95% CIs are very wide (Table 5) so there is a lot of uncertainty for where the true odds ratios are and whether they indicate a strong, moderate or weak association. Statistical analysis revealed a moderate negative association between supporting fracking and four of the CarbonFoot phrasings. These four phrasings were “no text”, “dangerous for birds”, “dangerous for people”, and “beneficial for birds”, which all had ORs and 95% CIs below 1 (Table 5). All the ORs for these phrasings were a moderate distance below 1 (Figure 2 and Table 5) so it could be said there is a moderate association, however the 95% CIs are fairly wide (Table 5) so it is hard to know the true strength of association. There was no association between Frack and the phrasing “beneficial for people”, because the 95% CI contained 1 (Table 5). Statistical analysis of the data revealed no association between having attended college and four of the CarbonFoot phrasings. These four phrasings were “no text”, “dangerous for birds”, “beneficial for birds” and “beneficial for people”, because their 95% CIs contained 1 (Table 5). The one phrasing where there was an association with Educ was “dangerous for people”, where there was a weak positive association because the OR and 95% CI were only slightly above 1 (Table 5). As expected, the ORs between the three factors and CarbonFoot overall (where all the data from the phrasings was combined) sit somewhere around the middle of the

ORs of the separate phrasings with the factors (Figure 2). As clearly depicted in Figure 2, the phrasings with the most different ORs were “dangerous for birds” and “dangerous for people” for Action, “dangerous for people” and “beneficial for people” for Frack, and “dangerous for people” and “beneficial for birds” for Educ. These phrasings were the ones that were put through the z-test to see if there was a statistically significant difference between the ORs. For Action the z-test revealed no significant difference between ORs for “dangerous for birds” and “dangerous for people” because the p-value was 0.17, which is above 0.05, indicating no significant difference. For Frack the z-test divulged a significant difference between the ORs for “dangerous for people” and “beneficial for people” because the p-value was 0.02, which indicates a significant difference because it is below 0.05. Finally, for Educ the z-test revealed a significant difference between the ORs for “dangerous for people” and “beneficial for birds” because the p-value was 0.01, which is below 0.05.

Table 5. Odds ratios (ORs) and 95% confidence intervals (95% CIs) between willingness to reduce carbon footprint (CarbonFoot) phrasings and factors: likelihood to take political action against climate change (Action), thoughts on Fracking (Frack), and education level (Educ) (OR and corresponding 95% CI not containing the value of 1, meaning presence of statistically significant association, are indicated with bold font)

CarbonFoot Phrasings	Action		Frack		Educ	
	OR	95% CI	OR	95% CI	OR	95% CI
no text	5.74	2.82-11.69	0.48	0.26-0.89	1.35	0.72-2.56
dangerous for birds	8.79	3.64-21.20	0.38	0.19-0.76	1.34	0.62-2.90
dangerous for people	5.04	2.45-10.39	0.28	0.15-0.52	2.50	1.35-4.63
beneficial for birds	7.88	3.77-16.47	0.36	0.19-0.69	0.78	0.38-1.61
beneficial for people	6.72	2.92-15.49	0.75	0.37-1.52	1.52	0.75-3.07

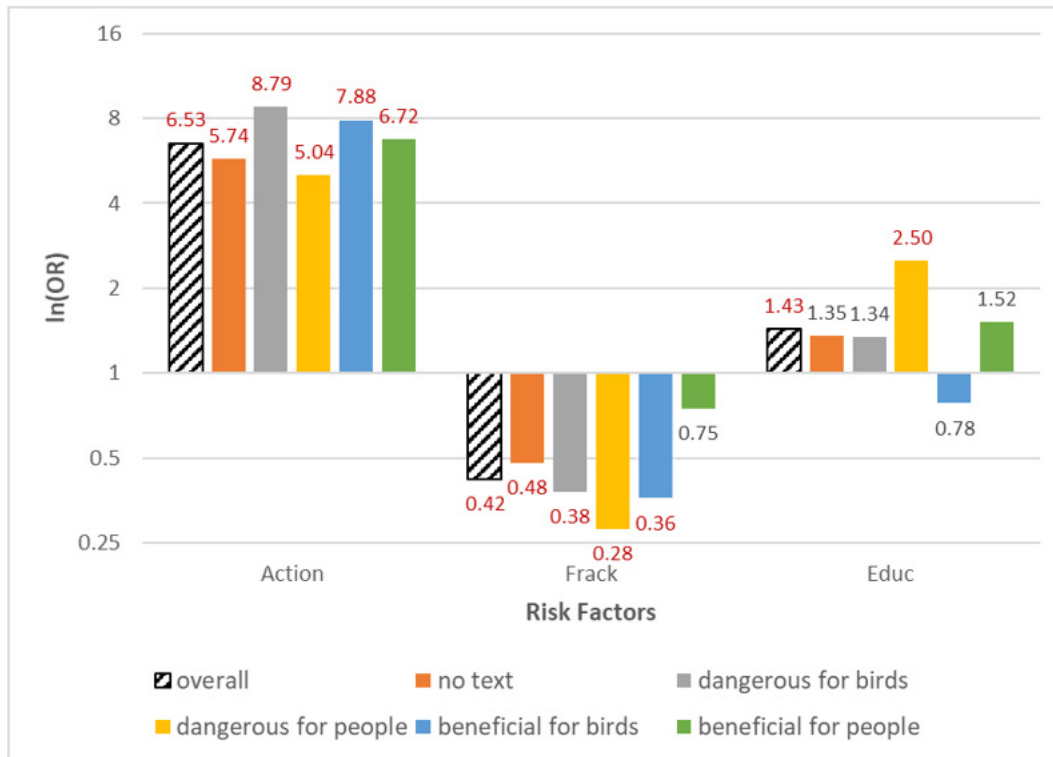


Figure 2. Bar graph with natural log scale showing the odds ratios (ORs) of each of the three risk factors, likelihood to take political action against climate change (Action), thoughts on Fracking (Frack), and education level (Educ), with the willingness to reduce carbon footprint (CarbonFoot) question overall (the diagonally striped bar) and with each of the five CarbonFoot phrasings (bars marked with a red OR reading have a statistically significant association)

Discussion

This study used publicly available survey data to determine whether a person’s perceived likelihood to take political action against climate change, thoughts on fracking and education level affect their willingness to reduce carbon footprint and whether phrasing of a survey question affects how people respond. Our findings are discussed in the following paragraphs.

Our findings confirmed our hypothesis (H 1) that being likely to take political action against climate change is positively associated with willingness to reduce carbon footprint. The reason for this association could be that people who are likely to take political action against climate change are also willing to take another type of action against climate change. A recent study about climate change looked at the relationship between public opinion and taking political action and found that changes in public opinion are not usually sufficient to create political action (Levine and Kline, 2017). This study is different from our study in that it looks at the connection between opinion and action while ours looks at the connection between two types of action, so the results from the Levine and Kline study do not fully apply to our study. To our knowledge there have been no studies that have looked at the relationship between willingness to reduce carbon footprint and likelihood to take political action against climate change, making this aspect of our study novel. Our findings also confirmed the hypothesis (H 2) that support for fracking is negatively associated with willingness to reduce carbon footprint. This could be because people who support fracking might support the use of fossil fuels, which releases greenhouse gases (Bessou et al., 2011); so, those people are unlikely to be willing to reduce their carbon footprint. We had expected that there would be a stronger negative association between Frack and CarbonFoot. The reason for the moderate association could be that some people support fracking because it is a source

of income and is a source of jobs but still want to reduce their carbon footprint. Another possible reason is that some people who oppose fracking are unwilling to reduce their carbon footprints maybe because they oppose fracking due to the pollution, health problems and harm to the environment which they believe it causes, but they don't believe in climate change, and do not see a purpose in reducing their carbon footprint.

A study found that beliefs about other impacts of fracking have a greater effect in determining support for fracking than beliefs about fracking's connection with climate change (Evensen and Brown-Steiner, 2018). This finding may support the two possible explanations for the moderate association, as it suggests that impacts such as jobs and health concerns can very much determine whether or not a person supports fracking. However, to our knowledge no studies have been conducted that looked at the relationship between thoughts on fracking and willingness to reduce carbon footprint. The findings of this study confirmed our hypothesis (H 3) that having gone to college is positively associated with willingness to reduce carbon footprint. This could be because longer education provides more opportunities to learn about climate change and understand its causes and effects, leading people to understand why reducing their carbon footprint is important. It is possible that people who are more educated also have higher incomes which allows them to have enough money to be able to make carbon footprint reducing changes in their lifestyles, such as buying electric cars and more efficient appliances. Interestingly, another study found that more years of education is positively associated with increased household carbon footprint (Kennedy et al., 2015).

The study discusses how a possible reason for this association could be that longer education is connected with greater income, which allows for larger houses, more waste, more travel, etc., leading to a greater carbon footprint. A reason for the difference between the results of the studies could be the fact that our study asked people if they were willing to reduce their carbon footprint and did not look at what the people's carbon footprints actually were, as the other study did. People who are less educated might not be willing to reduce their carbon footprint because they do not have the means and maybe understanding of the problem, but their carbon footprints may be smaller than those who are more educated because they have smaller houses, less waste, and less travel. What this shows is that those who should be educated about climate change and methods of reducing carbon footprint and incentivized into making changes are not necessarily those who have not gone to college, but those who have enough income to have large carbon footprints and the means to make lifestyle changes. In identifying those people, greater education could serve as a possible indicator of greater income.

We tested the hypothesis (H 4) that the way a question is phrased affects people's responses. Our findings indicated this to hold in some cases but not all. No matter which question phrasing was asked there was always a strong positive association between being likely to take political action against climate change and willingness to reduce carbon footprint (Table 5 and Figure 2). A reason why there was no effect when the question was phrased in different ways for this factor could be that people who are unlikely to take political action against climate change already have their minds made up about taking any sort of action against climate change, so they are not swayed by the extra information in some of the question phrasings, emphasizing the dangers of climate change and the benefits from reducing it. The people who are likely to take political action against climate change would have their beliefs about climate change confirmed and they would remain willing to reduce their carbon footprint, so a strong positive association would always result. The z-test confirmed that it does not matter which question phrasing is asked for likelihood to take political action against climate change, as even the phrasings with the most different ORs were found not to be significantly different. Saying that reducing climate change is beneficial for people led there to be no association between support for fracking and willingness to reduce carbon footprint, whereas there was a moderate negative association between the two for all the other CarbonFoot phrasings (Table 5 and Figure 2). This could be because people who supported fracking, who were originally unwilling to reduce their carbon footprint, became willing when they heard that reducing climate change is beneficial for people. Interestingly, participants had this reaction to "beneficial for people" and not to "dangerous for people".

Presumably, some people are more affected by hearing something is dangerous and others are more affected by hearing something is beneficial. This could for example be affected by aversion to risk, but with the information available it is impossible to investigate. Therefore, we cannot explain why people were more affected by "beneficial

for people” than by “dangerous for people”. The z-test confirmed that question phrasing does matter for thoughts on fracking, specifically it matters whether the “dangerous for people” or “beneficial for people” phrasing is asked, as the ORs for those were significantly different. Those who support fracking might have become more willing to reduce their carbon footprint when they heard that reducing climate change is beneficial for people, not for birds, because people generally give more importance to humans than to animals, so the effect is greater when people are mentioned. Saying that climate change is dangerous for people led there to be a weak positive association between having gone to college and willingness to reduce carbon footprint, while there was no association between the two when asked the other versions of CarbonFoot (Table 5 and Figure 2).

The reason for this could be that when people who have gone to college hear that climate change is dangerous for people, they become more willing to reduce their carbon footprint because they want to protect themselves and other people. It is possible that those who have not gone to college also want to protect themselves and other people when they hear that climate change is dangerous for humans but if they have a small income, they may not have the means to change their lifestyle, causing them to remain unwilling. It could also be that people who have not gone to college do not believe that climate change exists or do not understand how it could be threatening since they have not been taught about it, so the information in the question does not have an effect on them and they remain unwilling to reduce their carbon footprint. For the same reason previously mentioned, saying that climate change is dangerous for people has a greater effect than saying it is dangerous for birds. The z-test proved that for education level it matters which phrasing is asked, specifically it matters whether “dangerous for people” or “beneficial for birds” is asked, as the ORs for those were significantly different. Of course, there may be other reasons for the changes that are seen in people’s responses when asked different question phrasings. Another study also found that how a question is asked can affect people’s responses (Hiscox, 2006). In the study some survey participants were given an introduction that linked increased trade to job loss before being asked if they favored increasing trade with other countries, while other participants were only asked the question without the introduction. It was found that those with the introduction were less likely to favor increasing trade, demonstrating that how a question is asked matters.

Conclusion

This study has provided a better understanding of the characteristics of people who are willing and unwilling to reduce their carbon footprint in the continental United States. Knowing the characteristics of those who are unwilling to reduce their carbon footprint can aid targeting them for education or further research to better understand the reasons for their reluctance to reduce their carbon footprint. Additionally, people who are willing and have the means to reduce their carbon footprint can be incentivized into doing so. The findings concerning the effect of question phrasing can be considered by researchers when creating surveys and by the general public when reading about the results of studies that used surveys to understand if the findings are valid. Being likely to take political action against climate change was found to have a strong positive association with willingness to reduce carbon footprint for the possible reason that they are both actions against climate change so if a person is likely to do one, they are probably willing to do the other. Support for fracking was found to have a moderate negative association with willingness to reduce carbon footprint, which was a lower strength association than expected but suggests the possibility that fracking’s effect on things besides climate change like jobs and health has an impact on support. Having gone to college was found to have a weak positive associated with willingness to reduce carbon footprint, however, this finding may have been affected by the not evaluated factor of income, presenting a major limitation of this study. How a question is phrased can affect people’s responses. Mention of benefit or danger to people in a question is more powerful than mention of benefit or danger to animals and it is unknown why for thoughts on fracking the most powerful reaction was to a “beneficial” option and for education level it was to a “dangerous” option. Future studies could be designed to address this identified knowledge gap.

Limitations

Given that the survey data used in our study is from the continental United States the results do not apply to other regions, which is a serious limitation because the findings of our study would also be valuable to other places across the world that are interested in reduction of carbon footprints and research involving surveys. There is of course the possibility of bias in our study considering its observational, cross-sectional nature. It is possible that the questions were not understood by the survey participants leading them to answer incorrectly.

The participants could have lied because they wanted to ruin the study or because they felt pressure to answer in a certain way. It is also possible, though highly unlikely, that the responses of the survey participants were recorded incorrectly. Due to the fact that this was a telephone survey only people with phones, enough time, and who were willing to share information about themselves participated. If there were more or less of these people in a particular group that would cause a divergence from the true OR (e.g., if people who support fracking and are unwilling to reduce their carbon footprint could not participate in the study because they did not have phones, there would have been very few of them in the study even if they are a large portion of the United States population, causing the OR for Frack to be incorrect). These possibilities could lead to the results of our study not being representative of people's true opinions and characteristics across the United States, undermining the validity of our findings. If there are associations between a risk factor not looked at in our study, a risk factor observed, and the outcome of interest it could lead to the strength of association being incorrect between the factor observed and outcome of interest because the factor not looked at is affecting it. It could also lead to incorrect possible explanations for what is found in the results. For example, say Educ is associated with income (people with higher education earn more money and people with more money can pay for higher education) and income also is associated with CarbonFoot (people with more money have the means to make changes to their lifestyle to reduce their carbon footprint). Just looking at Educ and CarbonFoot, without suspecting income's effect, it seems that there is a weak positive association between them, so people who have gone to college are more willing to reduce their carbon footprint. What seems to be a possible explanation for this is that people with more education have a better understanding of climate change. Whereas, really the association may be strong or moderate or there may be a negative association and the reason for the association could also have something to do with income. This incomplete understanding of the reason for what is seen in the results could lead to extensive efforts to educate those who have not gone to college about climate change when this might not even be necessary or is not the only thing efforts should be focused on. For this reason, future studies must take into account income when looking at education level and willingness to reduce carbon footprint to see if it has an effect.

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