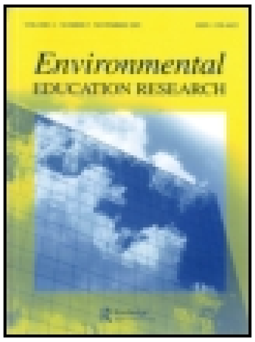

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The influence of personal beliefs, friends, and family in building climate change concern among adolescents

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ABSTRACT
Understanding adolescent climate change concern (CCC) may be a key strategy for building a citizenry that supports climate change action, as adolescents are likely less influenced by ideological polarization than adults. Prior research shows that climate education may build concern among adolescents, but other factors such as peer pressure may also be important. We investigated the relationships between CCC, acceptance of anthropogenic global warming (AGW), perceived level of acceptance among friends and family, and frequency of discussion of the issue among 426 middle school students in North Carolina, USA, and developed a novel instrument to measure each of these constructs. Acceptance of AGW had the strongest association with CCC. Frequency of discussion with friends and family was the second strongest predictor. Perceived level of acceptance among family and friends was the third strongest predictor. Model selection results suggest family had more influence than friends in this study. Girls perceived climate change as a higher risk than boys. In addition to building acceptance of AGW, leveraging discussions with peers and especially family may help build concern for climate change among future generations.

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Climate change; climate communication; climate literacy; climate change concern; climate education; climate conversations

Introduction

Tackling conservation challenges associated with climate change will require widespread engagement from a concerned citizenry. Considerable progress has been made in understanding the mechanisms of anthropogenic global climate change (Cook et al. 2013; IPCC 2013) and predicting likely impacts such as sea level rise (National Aeronautics and Space Administration 2014), increased flooding and droughts (Min et al. 2011), and global food insecurity (Turral et al. 2011). Creative solutions such as community smart grids (Stephens, Wilson, and Peterson 2015) and drought resistant crops (Godfray et al. 2010) offer promising paths to adapting to and mitigating climate change. However, the success of these solutions depends on concerned societal and business leaders and citizens who are willing to support, invest, and implement them. For instance, societal solutions such as carbon taxes (Avi-Yonah et al. 2009) will fail unless voters and political leaders are committed to their adoption. Similarly, individual actions such as driving less (Sperling and Cannon 2010), reducing household energy usage (Peterson, Peterson, and Liu 2013), and eating less meat (Hanjra and Qureshi 2010) have been presented as simple, potentially impactful solutions, but they require widespread adoption to be successful.

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One key finding from a growing body of research focused on climate change behaviors is that elevated climate change concern (CCC), is linked to both individual and collective climate change action (Bord, O'Connor, and Fischer 2000; O'Connor, Bord, and Fisher 1999; Spence et al. 2011; Tobler, Visschers, and Siegrist 2012). Authors in these studies use different terminology (i.e. perceived risk and concern), but all include some measure of how much respondents worry about climate change impacts to individuals or society, which we refer to as CCC in this paper. Understanding factors that build CCC may uncover pathways to a citizenry committed to tackling challenges related to climate change.

Adolescents represent an understudied but key audience to consider when building CCC. Though climate action is undoubtedly needed now, the brunt of climate change impacts are projected to arrive just as younger generations will reach adulthood (IPCC 2014). Accordingly, building concern among adolescents may ensure that leaders and citizens are prepared for action when impacts are the greatest. Further, unique characteristics of adolescents may make building CCC among adolescents easier than among adults. In the US, adult perceptions of climate change are polarized based on political ideology and worldview (Kahan 2012; McCright and Dunlap 2011a), factors that seem even more important than the influence of climate change knowledge (Hamilton 2011; Kahan et al. 2012). This may explain why climate change perceptions remain polarized along political lines in the United States (McCright and Dunlap 2011a, 2011b) and elsewhere (Capstick et al. 2015) despite mounting scientific evidence of negative impacts (Pew Research Center 2014). As among adults, adolescent climate change perceptions seem polarized by worldviews when climate change knowledge is low; however, adolescents reach similarly high levels of concern as climate change knowledge increases, regardless of worldview (Stevenson et al. 2014).

Because worldview seems to wield less influence among adolescents, climate change education among younger generations may be more effective at building CCC and require less strategic framing (Nisbet and Mooney 2007; Wibeck 2013) to reach diverse groups. Greater receptivity to climate communication may help explain why age is negatively correlated with CCC in many studies worldwide (Corner et al. 2015; Hamilton 2011; Pew Research Center 2014). However, some studies document adolescents psychologically distancing themselves from the topic (Ojala 2015), suggesting that more research is needed to understand how to effectively build CCC among adolescents. Better understanding of how to build CCC among adolescents could strengthen efforts to unite future generations in commitment to overcoming climate change related challenges.

Though climate change knowledge does seem to foster CCC among adolescents (Stevenson et al. 2014), other factors such as the viewpoints of friends and family likely affect how adolescents perceive climate change. According to sociocultural learning theories (Vygotsky 1986), more capable peers support learning by providing feedback to ideas and assumptions through discussion and interaction and propose new ideas that a learner may not have thought of on his or her own. As informal learning often allows more interaction with peers than direct instruction by teachers, peers are especially critical within informal education contexts (Gerber, Cavallo, and Marek 2001; Gravemeijer 2009; Marsick and Watkins 2001). Because adolescents learn about climate change from informal sources like social media, television and the movies in addition to the classroom (Leiserowitz, Smith, and Marlon 2011), peers may be influential in shaping individual perceptions of climate change.

In addition to relying on peers to help construct knowledge, peers and parents may shape climate change perceptions by example. Sociologists understand social norms to include both injunctive (perceiving an action as right or wrong) and descriptive (observing or perceiving others to engage in an action) elements, which can influence behavior (Kollmuss and Agyeman 2002; Rivis and Sheeran 2003; White et al. 2009). In the context of conservation, descriptive norms (what individuals think others are doing) can be stronger motivators (Cialdini 2007) than the desire to save money, benefit the environment, or help society (Nolan et al. 2008). Further, diffusion theory supports the notion that individuals incorporate the perceived views of opinion leaders in forming perceptions and behaviors related to a host of topics, from smoking (Hafstad et al. 1997) to climate change (Nisbet and Kotcher 2009). Peers are integral to forming teenage attitudinal and behavioral norms in contexts ranging from political interest (Dostie-Goulet 2009) to sustainable behavior (De Vreede, Warner, and Pitter 2014). Parents pass on their environmental attitudes and behaviors to their children through socialization and modeling (Grønhøj and Thøgersen 2009, 2012; Meeusen 2014), and they help adolescents transcend their tendency toward impulsive behavior in order to consider long-term consequences (Stanton et al. 2004). Considering future impacts of current actions is a key step in understanding how current actions and policy may have long term environmental consequences (Weber 2006). These theories suggest perceptions of how friends and family view climate change may shape adolescents' own views on the topic.

Recent literature offers evidence supporting these theoretical relationships between friends and family and CCC (Mead et al. 2012; Öhman and Öhman 2013; Ojala 2013, 2015). These studies suggest parents may influence climate-related information-seeking behavior of teens, as those teens whose parents' perceived climate change as high risk were more likely to seek out information on climate change (Mead et al. 2012). Similarly, peers in classroom settings tended to help each other construct a shared understanding of climate change through discussion, and teachers facilitated this process by guiding students to understandings that were scientifically sound (Öhman and Öhman 2013). In addition, young people who talked about climate change with their friends and families were less likely to de-emphasize the seriousness of climate change than those who did not (Ojala 2013), and those who talked with skeptical parents and peers tended to be more skeptical themselves (Ojala 2015).

We build on these key studies by evaluating the relative importance of one's own beliefs, perceived beliefs of friends and family, and the frequency an individual discusses climate change with these groups on predicting CCC. Specifically, we investigate the role of personal beliefs, perceived beliefs of family and friends, and frequency of discussion of climate change in forming CCC among 436 middle school students in North Carolina, USA. Though CCC and risk perception are not identical (Leiserowitz 2006), they are related, and we drew on risk perception literature to generate hypotheses about CCC. Because personal acceptance of anthropogenic global warming (AGW) has been linked to CCC (Stevenson et al. 2014) and adolescents are forming personal opinions that exert influence over risk perceptions (Vollerberg, Iedema, and Raaijmakers 2001), we hypothesized that (1) personal acceptance of AGW would be positively associated with CCC. As friends and family likely influence general risk perception (Litt and Stock 2011; Meeusen 2014) and descriptive norms are particularly important in conservation contexts (Cialdini 2007; Nolan et al. 2008), we also predicted that (2) perceived level of acceptance of AGW among friends and family will be positively related to CCC. Finally, because increased interaction, including discussion, with friends and family can strengthen their influence over risk perception (Stanton et al. 2004) and interaction with others may be key to constructing understanding (Gravemeijer 2009) we hypothesized that (3) discussion of AGW with friends and family will be positively related to CCC and strengthen the relationships between perceived acceptance of AGW and CCC. Specifically, we predicted that adolescents who discuss AGW with friends and family who they think accept AGW will exhibit higher CCC, and those who discuss AGW with friends and family they think do not accept AGW will exhibit lower CCC.

Methods

Instrument development

We measured CCC using four questions, asking how much respondents were worried about climate change and the degree to which they thought it would impact themselves, people in the United States, and future generations (Table S4). We measured personal acceptance of AGW with two questions – one asking whether students believed global warming (GW) was happening, and another asking whether they thought it was caused by humans. We measure perceived acceptance of AGW among friends and family as a measure of descriptive social norms (Cialdini 2007; Nolan et al. 2008). Each of these items were adapted from one of the only published instruments used with both adults and adolescents (Leiserowitz, Smith, and Marlon 2011). To measure perceived acceptance of AGW among friends and family, we asked participants how many of their friends and family they estimated agreed with their views on AGW. We also asked participants how often they discussed AGW with each of these groups. In addition, we included demographic questions for age, gender and ethnicity.

The final instrument was based on several rounds of pretesting. We administered a draft instrument to 48 middle school students, collected written and verbal feedback, conducted cognitive interviews (Desimone and Le Floch 2004), and repeated this process with a revised survey and another group of middle school students ($n = 44$). For wording of the final questionnaire, please see the online Supplemental information.

Sampling

We randomly selected 150 middle school teachers in the 20 coastal North Carolina counties to recruit for the study. Two school districts would not allow teachers to participate, eliminating 27 of the 150 from consideration. Of the remaining teachers, 36 responded and 24 consented to participate. No students declined to participate. Thus self-selection bias may exist among teachers, but any impact on the unit of analysis, students, from participating teachers being slightly more engaged in some way should occur evenly across the entire sample. The resulting schools were representative of the state in terms of locale and Title I status, a measure of school-level socio-economic status (107th Congress, 2002). Between March and May of 2013, we visited all 24 classrooms and surveyed students in person. Our sample included 110 sixth graders, 108 seventh graders, and 207 eighth graders, with the majority spanning ages 11–14 (14 students were 15 years old). The majority of the 426 students in this sample were female (55.6%), and white (57.9%) with fewer African American (17.0%), Hispanic (7.1%), American Indian (1.4%) and Asian (1.4%) students. Some also identified as multi-racial (11.6%) or other (3.6%).

Data analysis

We collapsed ethnicity categories into white and non-white because sample size did not allow more fine grained divisions in our models. We compared ethnicity and gender in our sample to population data through the North Carolina Department of Public Instruction, and found the sample representative on both measures ($z = 0.492$, $p = 0.622$ for ethnicity; $z = 1.69$, $p = 0.091$ for gender).

The only variable that was associated with a scale was CCC, and we completed a post hoc confirmatory factor analysis (CFA) to measure construct validity for our CCC scale using structural equation modeling. This method compares the covariance matrix of a hypothesized model of a construct to an observed matrix (Schreiber et al. 2006). Similarity between hypothesized and observed models supports the notion that the underlying construct(s), or factor(s) of interest are related to the observed scales in hypothesized ways. Our hypothesized model includes four observed variables (individual survey items) that are associated with one construct (CCC) (Figure 1).

For each other variable, we first centered responses around zero. We used a single question to measure acceptance of global warming (GW), human causes (HC) (Table S1), discussion with friends and discussion with family (Table S3). For the perceived acceptance of AGW among friends and family, we combined several questions (Figure 2, Table S2). To measure perceived acceptance among friends, we multiplied responses to student acceptance that (1) GW is happening and (2) caused by humans with responses to the questions asking how many friends shared their views on each of these points. Because responses were centered around zero, multiplying these responses created scales such that low scores meant students perceived that none of their friends accept AGW and high scores meant they perceived that all of their friends accept AGW. For instance, if a student scored high on acceptance that GW is happening and low on how many of their friends share their viewpoints, the product would be a negative score, indicating they perceive that few of their friends think GW is happening. We summed these two products to create one variable for perceived acceptance among friends. We formed the perceived acceptance of AGW among family variable in the same way (Figure 2).

We used multiple linear regression to model how personal acceptance of AGW, perceived acceptance of AGW among friends and family, and frequency of discussion with friends and family predicted CCC

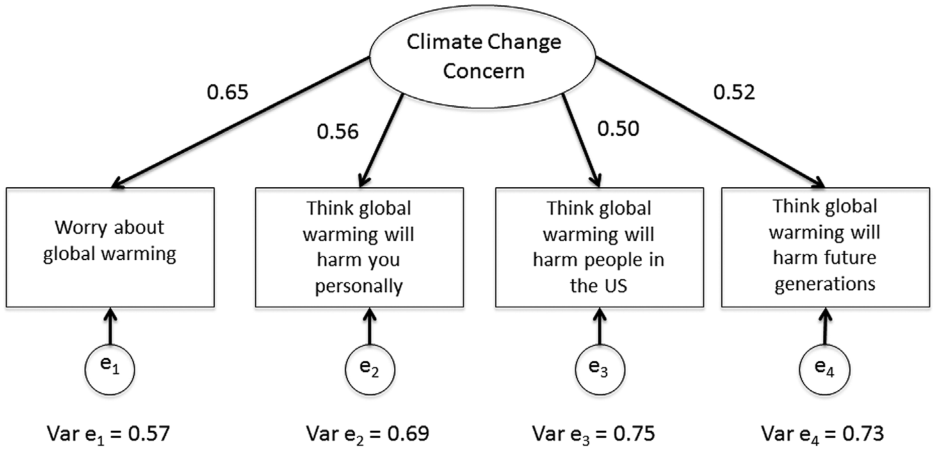

Figure 1. CFA of the risk perception scale.

Notes: All coefficients are standardized and significant ($p < 0.001$), e = error. Root mean squared error of approximation = 0.021, comparative fit index = 0.998, standardized root mean squared residual = 0.021.

using STATA software version 12.1. We also tested for an interaction between perceived acceptance of AGW and discussion, but none of these interaction terms were significant in any of the models so we excluded them. We also controlled for gender, ethnicity, and age, but only gender was significant in any of the models, so we excluded ethnicity and age.

We also used Akaike's information criterion corrected for small sample size (AIC_c) to compare several competing models. Each of our variables of interest (personal acceptance of AGW, perceived acceptance

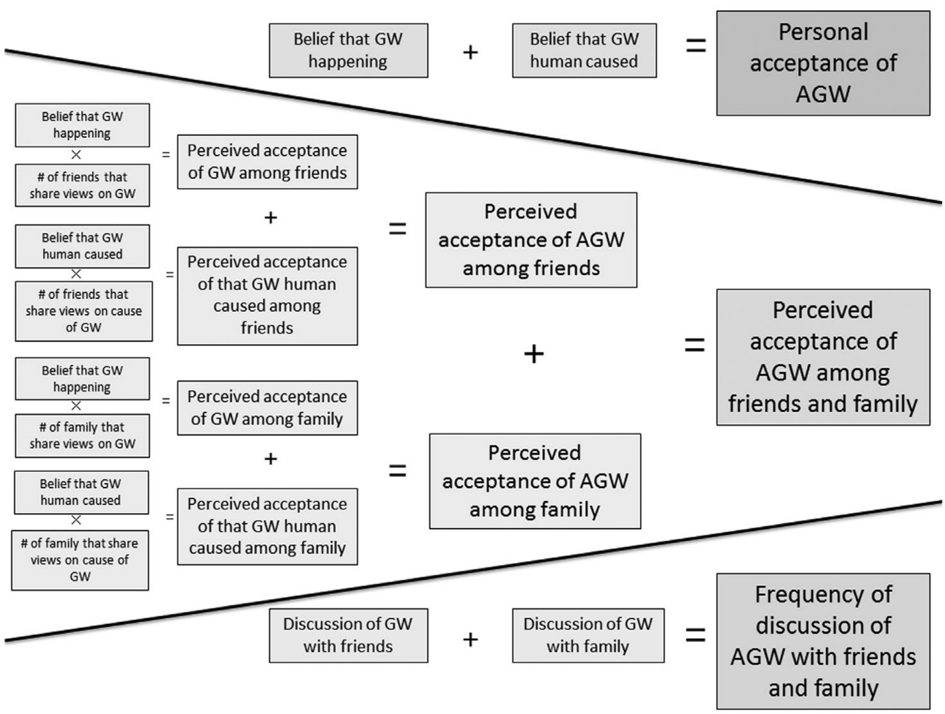

Figure 2. Derivation of personal acceptance of AGW, perceived acceptance of AGW among friends and family, and frequency of discussion of AGW with friends and family.

of AGW among friends and family, and frequency of discussion with friends and family) could be represented as composite variables or individually (e.g. personal acceptance of AGW = personal acceptance of climate change [CC] and human causes [HC]; Figure 2). Each pair of individual variables were correlated: personal acceptance of HC and personal acceptance of GW ($r = 0.44$, $p < 0.001$), perceived acceptance of AGW among family and perceived acceptance of AGW among friends ($r = 0.51$, $p < 0.001$), and discussion of GW with family and discussion of GW with friends ($r = 0.40$, $p < 0.001$). Because each of these pairs of variables were potentially collinear in the regression model and we were interested in the most parsimonious model for predicting CCC, we tested a series of eight models that included each possible combination of the combined vs. separate variables (Table 1). We compared these models using AIC_c to select among this set of models to predict CCC (Burnham and Anderson 2004). In selecting our final models, we relied on the recommendation that models with delta AIC_c of less than 2 should all be considered (Burnham and Anderson 2002).

Results

Personal acceptance of GW ranged from −4 to +4 and personal acceptance of HC ranged from −2 to +2. Histograms revealed distributions skewed left with average scores of 1.98 (SD = 1.92) and 0.85 (SD = 1.20), respectively. Perceived acceptance of AGW among friends and family scores ranged from −22 to +24. A histogram revealed a symmetric distribution with an average score of −0.70 (SD = 8.15). Frequency of discussion among friends and family scores ranged from −4 to +2, and the histograms were skewed right with averages of −1.48 (SD = 0.74) and −1.20 (SD = 0.88), respectively. Concern scores ranged from 1 to 17, and were symmetrically distributed (mean = 9.33; SD = 3.66). For results for individual items, see the online Supplemental information.

Reliability of the CCC scale ($\alpha = 0.61$) was consistent with accepted level of 0.60 for exploratory analysis (Hair et al. 2010) and similar to that found in other studies on risk perception (Betz and Weber 2002). CFA results associated with the CCC scale indicated acceptable levels of goodness of fit tests (root mean squared error approximation = 0.021, comparative fit index = 0.99, and standardized root mean squared residual = 0.021; Figure 1). Guidelines for measures we used below are as follows: root mean squared error of approximation: <0.06–0.08, comparative fit index: ≥0.95, standardized root mean squared residual ≤0.08. Significant relationships between observed variables and the latent variable paired with acceptable goodness of fit measure supports acceptable construct validity (Schreiber et al. 2006).

Table 1. Model comparison using AIC ($n = 426$).

Candidate model	df	$-2nL$	AIC_c	Delta AIC_c
1. Acceptance of AGW + perceived belief among friends and family + discussion with friends and family + gender	5	2122.50	2132.64	0.00
2. Acceptance of GW + acceptance of HC + perceived belief among friends and family + discussion with friends and family + gender	6	2121.68	2133.88	1.24
3. Acceptance of AGW + perceived belief among friends and family + discussion with family + discussion with friends + gender	6	2122.03	2134.23	1.58
4. Acceptance of AGW + perceived belief among family + perceived belief among friends + discussion with friends and family + gender	6	2122.50	2134.70	2.05
5. Acceptance of GW + acceptance of HC + perceived belief among friends and family + discussion with friends + discussion with family + gender	7	2121.19	2135.46	2.82
6. Acceptance of GW + acceptance of HC + perceived belief among family + perceived belief among friends + discussion with friends and family + gender	7	2121.68	2135.95	3.31
7. Acceptance of AGW + perceived belief among friends + perceived belief among friends + discussion with family + discussion with friends + gender	7	2122.03	2136.30	3.65
8. Acceptance of GW + acceptance of HC + perceived belief among friends + perceived belief among friends + discussion with family + discussion with friends + gender	8	2121.19	2137.54	4.89

Model selection through AIC_c supported three models (Table 1). Model 1 included all three combined variables (personal acceptance of AGW, perceived acceptance among friends and family, and discussion with friends and family; df = 7, AIC_c = 2132.6, Akaike weight = 0.33). Model 2 considered personal acceptance separately (acceptance of GW and acceptance of HC; df = 6, AIC_c = 2133.9, Akaike weight = 0.19), and Model 3 considered discussion with friends and family separately (k = 7, AIC_c = 2134.2, Akaike weight = 0.15).

We found support for hypotheses one and two, and partial support for hypothesis three. Personal acceptance of GW and HC were positively related to CCC whether considered together or separately (hypotheses one, Table 2, Figure 3(A)). Personal acceptance of AGW was the strongest predictor of CCC (Figure 3(A)) and when acceptance of GW and HC were considered separately, acceptance of GW was a better predictor of CCC than acceptance of HC (Model 2 of Table 2). Perceived acceptance of AGW among friends and family was also a positively related to CCC (hypothesis two; Table 2, Figure 3(B)). We found that increased discussion of GW among both friends and family were positive predictors of CCC (hypothesis three), but that when considered separately, discussion among family had a stronger association with CCC than discussion among friends (Model 3 of Table 2, Figure 3(C)). The interaction between perceived acceptance of AGW among friends and family and frequency of discussion of AGW

Table 2. Predictors of CCC among middle school students (n = 426).

	Model 1				Model 2				Model 3			
Variable	Std. beta	Beta	SE	p	Std. beta	Beta	SE	p	Std. beta	Beta	SE	p
Personal acceptance of global warming					0.359	0.683	0.084	<0.001				
Perceived acceptance of human causes					0.168	0.515	0.134	0.001				
Personal acceptance of AGW	0.457	0.625	0.054	<0.001					0.457	0.625	0.054	<0.001
Perceived acceptance of AGW among friends/ family	0.116	0.052	0.018	0.004	0.114	0.051	0.018	0.005	0.116	0.052	0.018	0.004
Frequency of discussion with friends									0.117	0.579	0.212	0.006
Frequency of discussion with family									0.193	0.801	0.180	<0.001
Frequency of discussion of GW with friends and family	0.261	0.704	0.108	<0.001	0.260	0.699	0.108	<0.001				
Student gender*	0.182	1.342	0.287	<0.001	0.178	1.310	0.289	<0.001	0.180	1.326	0.288	<0.001
Constant	8.740	0.400			8.667	0.389			8.684	0.408	8.740	0.400
	$R_a^2 = 0.354$				$R_a^2 = 0.356$				$R_a^2 = 0.356$			

Notes: Here we report three competing models that AIC supports as candidates for predicting climate change concern. Model 1 considers personal acceptance as a combination of acceptance of global warming and acceptance of human causes (anthropogenic global warming [AGW]). Model 2 considers these personal acceptance variables separately. Model 3 considers personal acceptance of AGW and discussion of GW among friends and family separately.
*0 = male, 1 = female.

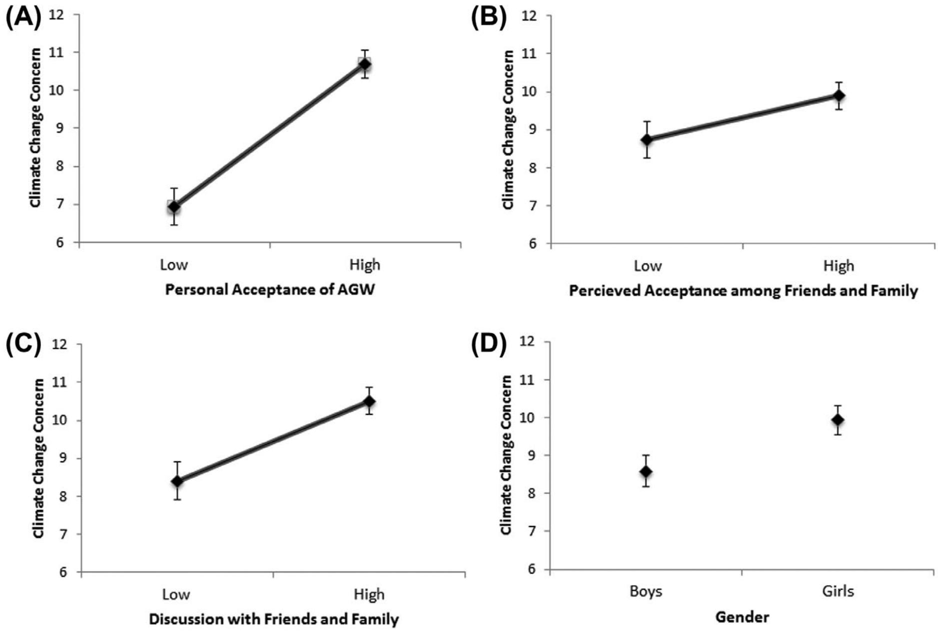

Figure 3. Predicted change in CCC associated with personal acceptance of AGW (A), perceived acceptance of AGW among friends and family (B), frequency of discussion with friends and family (C), and gender (D).

Notes: Low and high values for A–C reflect predictions for the 10th percentile and 90th percentile values of independent variables. Gender was coded male = 0 and female = 1, and values represent average concerns among boys and girls, respectively. All variables except for the one highlighted in a given chart were held at their average values. Higher slopes represent higher effects sizes.

was not significant, indicating that the frequency of discussion did not affect the relationship between perceived acceptance among friends and family and CCC. We also found that girls exhibited higher CCC than boys (Table 2, Figure 3(D)). The relative effect sizes of each independent variable are represented in Figure 3.

Discussion

Personal beliefs may be most important

Our results suggest that perceptions of how friends and family view climate change predicted CCC among adolescents, but building individual acceptance of AGW may be the best path to fostering concern for climate change among future generations. The positive relationship between perceived views of friends and family and concern are consistent with previous research suggesting that descriptive norms can influence conservation attitudes and behaviors (Cialdini 2007; De Vreede, Warner, and Pitter 2014; Peterson et al. 2012). In a context specific to adolescents and climate change, Ojala (Ojala 2015) found that students who thought their friends and family were skeptical of climate change were more likely to be skeptical themselves. Our results suggest that this relationship may extend to CCC, with those students who perceive that their friends and family are accepting of AGW being more concerned themselves. However, our results also suggest that personal acceptance was more strongly related to CCC than descriptive norms. This may be explained by research suggesting that during adolescence an individual's attitudes and norms solidify and become more resistant to the influence of family and friends (Vollerberg, Iedema, and Raaijmakers 2001). Encouragingly, this suggests informing adolescents of the real risks posted by AGW may be more straightforward than among adults both because adolescents are not unduly influenced by peer pressure in regard to AGW subject matter (this study) and climate change knowledge seems to overcome the polarizing influence of worldviews among adolescents (Flora et al. 2014; Stevenson et al. 2014). Climate literacy efforts targeting adolescents such as the growing repository of lesson plans available through the CLEAN network (Cleanet.org 2013) or presentations by the Alliance for Climate Education (Acespace.org 2015) may be better investments than those targeting adults. Future research should continue to explore the role of climate education in building CCC as well as how concern levels change as adolescents reach adulthood. Further, personal acceptance of GW may be even more important than acceptance of HC in predicting CCC among adolescents. Among adults, acceptance of GW and HC are linked to support for adaptation vs. mitigation efforts, respectively (Arbuckle, Morton, and Hobbs 2013; Bord, O'Connor, and Fischer 2000). Future research should address if this dynamic is present among adolescents.

Friends, and especially family, influence beliefs

Despite the critical role of individual acceptance of AGW, communicators and educators may be able to capitalize on the influence of peers to strengthen climate literacy efforts. Adolescent risk literature suggests that when family and friends influence concern and behavior, increasing social interaction amplifies that influence (Maxwell 2002; Stanton et al. 2004). For instance, because teens tend to mirror the behavior of peers in risk environments, researchers suggest encouraging interaction with peers who are a positive influence will solidify favorable behavioral norms (Maxwell 2002). As adolescents spend a considerable amount of time at school with peers, educators could encourage such positive peer influence through group discussions and projects. Because increased climate change knowledge seems to build acceptance of AGW among adolescents (Stevenson et al. 2014), teaching climate literacy topics through group discussions or projects or providing informal learning activities that allow for peer interaction may build individual concern for climate change as well as form group attitudinal norms through peer interactions.

Our results suggest that efforts to encourage interactions with family may be more important in shaping CCC than similar efforts focused on peers. In related research, communication with friends and family was associated with lower instances of de-emphasizing the seriousness of climate change (Ojala 2013) and descriptive norms of friends and family predicted climate skepticism (Ojala 2015). In both of these studies, the influence of family was more important than that of friends, and our study suggests this also may extend to CCC as discussion with family was slightly more important than with friends. This is not surprising as parents are likely the most important social influences on young people (Bandura 1977), even in the context of forming worldviews (Vollerberg, Iedema, and Raaijmakers 2001). As worldviews predict CCC among adolescents, particularly at low levels of climate change knowledge (Stevenson et al. 2014), the stronger association between discussion with parents over peers with CCC may be linked to how parents contribute to the worldviews of their children. Future research should address whether worldviews of parents and their children predict CCC and whether descriptive norms are reflective of the actual views of friends and family.

Discussion matters

We expected that increased discussion with perceived skeptics would be associated with climate change skepticism among adolescents. However, our findings related to frequency of discussion and CCC suggest that discussion even with perceived skeptics may build concern for climate change. Somewhat surprisingly, discussion of climate change with both friends and family was positively associated with CCC regardless of the perceived level of acceptance of the other party. As adolescents tend to mirror the climate change perceptions of their parents (Mead et al. 2012; Ojala 2013) and imitate peers in a host of risk behaviors (Gardner and Steinberg 2005; Maxwell 2002), we would expect that discussion with friends and family who adolescents perceive as skeptical of AGW would build skepticism and thus lower CCC. Despite our finding being somewhat counterintuitive, Mead et al. (2012) found adolescents' climate change perceptions mirror those of their parents', but adolescents families who discuss climate change are more likely to seek information about the topic, regardless of level of concern (Mead et al. 2012). Engagement stemming from discussion may result in heightened concern somewhat independently from personal beliefs held by discussants. This may be explained by research suggesting high levels of discussion support persistent salience of most issues (Wyatt, Katz, and Kim 2000). Future research could address whether adolescents are influenced by discussions or initiate them as they become more concerned. As discussion may build issue saliency and CCC, encouraging adolescents to talk about the issue may be a key step in ensuring that future voters and decision makers are united in purpose in addressing climate change.

Demographic factors

Although not part of our initial hypotheses, our finding that females were more concerned about climate change than males highlights avenues for further research. Among adults, women tend to be more concerned than men about climate change and a host of other environmental threats (Finucane et al. 2000; McCright 2010; Smith and Leiserowitz 2012; Zia and Todd 2010). This may be related to findings that women have more pro-environmental attitudes than men, which some researchers attribute to a more emotive or relational view of the environment (Carrier 2009), more future-oriented thinking (Joireman and Liu 2014), or higher likelihood to apply their values to environmental problems (Stern, Dietz, and Kalof 1993). Another explanation may be that women and men are socialized differently, which can result in differing levels of environmental concern and trust in science (McCright 2010). Further, women may experience lower positions of power and be socialized to perceive their positions as less powerful, making women more likely to assign higher risk in a variety of contexts (Finucane et al. 2000). Several studies have found that women perceived climate change as higher risk than men (McCright 2010; Zia and Todd 2010). Studies have considered gender as a predictor of CCC among adolescents and found no relationship among US students (Mead et al. 2012) and that Swedish boys had higher levels of climate skepticism than girls (Ojala 2015).However, our study suggests that CCC associated with gender are parallel between adults and teenagers. Future research should address if gender socialization activities that influence concern among adult women also operate as a causal factor among girls.

Conclusions

Current adolescents will become voters, policy makers, and leaders during the years in which climate change conservation challenges are most fully realized (IPCC 2014), so ensuring they are united in their commitment to respond is critical. Promisingly, climate literacy efforts may be more effective among adolescents than adults in building CCC (Stevenson et al. 2014), suggesting that current efforts to bring climate literacy into K-12 settings may build personal acceptance of AGW among adolescents. Personal acceptance seems to be a key predictor of CCC, but this concern may be further developed through encouraging discussions among friends and family. As climate change is projected to effect everything from biodiversity to personal health (Mills, Gage, and Khan 2010; Pacala and Socolow 2004), parents, communicators, and educators, and conservationists should add climate change to the list of talking points essential to ensuring adolescents are prepared to be healthy adults, engaged citizens, and sustainers of the planet.

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Notes on contributors

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