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Turn down for watt: Community fit and thermal comfort habituation predict average household heating energy consumption

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Abstract

Lowering average household heating energy consumption plays a pivotal role in addressing climate change and has been central to policy initiatives. Strategies proposed so far have included commitments, incentives/ disincentives, feedback, and social norms. Yet, findings so far have been mixed and fail to explain the mechanism that drives energy conservation behavior. Using a sample of 2,128 participants across the United States, we collected survey data matched with archival temperature data to investigate the influence of past experiences on current energy conservation behaviors. Our findings indicate that childhood home temperatures significantly predict current home temperature settings. Importantly, community fit moderated this relationship. Individuals with high community fit were more likely to align their home temperature settings to those of their community. These insights not only shed light on the underlying mechanisms driving energy consumption behavior but also suggest that fostering a sense of community fit might be a more effective strategy for promoting sustainable energy practices.

1. Introduction

Climate change has become the largest environmental challenge of our time, with recent heat waves throughout the world highlighting the immediacy of this existential threat to life on Earth [1]. As noted by Adua [2], scientists have concluded that climate change is largely a consequence of human behavior (e.g., the burning of fossil fuels). In the United States [3], residential energy consumption accounts for 21% of the total energy consumption, which adds up to an annual cost of $219 billion for the nation or $1,856 per household. Given that over half of the annual electricity consumption per household goes to heating and cooling [4], it is important to understand the drivers of energy conservation in this sector. Surprisingly, only 42% of homeowners adjust their home thermostats to save energy and reduce utility bills, although half of all households are not occupied during the daytime [5]. Understanding what motivates consumer heating and cooling choices [6] is an important avenue for potentially reducing the burning of fossil fuels.

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Several behavioral science studies have attempted to determine which energy conservation promotion strategy will likely be the most effective [7]. Such strategies have included "commitments, financial appeals, incentives/disincentives, feedback, values-based messaging, and social norms" [8]. Unfortunately, findings so far have been mixed. Some research suggests that financial appeals or monetary incentives promote energy conservation efforts [9,10], while other studies failed to show such an effect or even found a negative effect between incentives and energy conservation efforts [11]. Given that individuals do not reliably react in the predicted direction to price changes [12,13], the departures from predicted behavior may be due to information processing biases that allow individuals to perceive their actual behaviors to be in line with their intentions [14].

Another approach has been based on social norms. Social norms are based on a social identity and social capital [15,16] perspective. These norms are calibrated according to beliefs about what other in-group members are doing or find acceptable [17]. Hence, individuals define themselves not only via a combination of personal traits (e.g., "I am a caring person") but also as members of a group (e.g., "I am an environmentalist"). The associated group membership, when made salient, directs individuals to identify themselves as a part of a group, and as such, social identity comprises the basis for self-definition and decision-making [8]. The group becomes an extension of the self, and group attitudes, emotions, and expected behaviors are viewed as one's own, even in the absence of other group members [18]. However, a recent large study by Brandon and colleagues [19] based on 16 million hourly electricity and daily natural gas observations over 18 months found little evidence that normative feedback, even when paired with smart thermostat technologies, had any statistically or economically significant effect on energy consumption changes. Indeed, the authors found that such technologies "actually increase electricity and gas consumption" and that "in the aggregate, users frequently override permanently scheduled temperature setpoints" (p. 4), which results in a less energy-efficient setting compared to the previous (automatic) setting. Therefore, focusing primarily on identifying the best feedback strategies without understanding the underlying psychological mechanisms and drivers of behavior seems to have failed to explain why rational consumers do not necessarily strive to optimize their energy consumption [20].

In this paper, we propose another mechanism, that may help explain under which circumstances individuals are more likely to adjust their home temperature settings to levels more aligned with the surrounding community. At the heart of our exploration are two key components, namely familial thermal comfort habituation and community fit. We operationalize familial thermal comfort habituation as individuals' recollections of their childhood home temperature. We posit that repeated exposure to certain stimuli (in this case, specific temperature settings) leads to decreased responsiveness to those stimuli over time, effectively setting a 'comfort norm' that individuals seek to maintain. Put differently, thermal environments experienced during formative years establish a baseline for thermal comfort preferences. In turn, these preferences influence adult individuals' subsequent thermal comfort choices, shaping their home temperature settings and, by extension, their household's heating energy consumption patterns.

Moreover, we argue that based on social adaptation theory, individuals' thermal comfort preferences are not only shaped by their early familial experiences but that individuals also adapt their behaviors—including those related to energy consumption and thermal comfort—to fit within the social and cultural fabric of their community, especially when they feel a strong sense of belonging or community fit. Community fit refers to the cognitive or emotional attachment to one's place of residence [21,22]. The affective aspect of community fit serves as the "glue that connects people to their community" [23]. We argue that the stronger the fit people have to their community, the more likely they will adapt their home temperature settings to those of other local community members. Put differently, community fit acts as a proxy for how well integrated (including thermally) individuals are in their local community. In turn, we expect that, on average, adaptation to local temperatures is likely to influence household energy consumption as well. Finally, we also consider average outdoor temperatures by state, as outside temperatures have a large effect on average home temperature settings [24]. Based on a large sample of 2,128 participants across the United States, we examine and find that childhood home temperature is strongly associated with current home temperature and that community fit moderates the relationship between childhood home temperature and current home temperature.

2. Main text

2.1. Incentives, norms and community fit

Scholars have argued that financial incentives and/or social norms (and normative feedback in particular) are important when promoting pro-environmental behavior and energy conservation [25,26]. Unfortunately, financial incentives have not proven reliably effective in attaining energy conservation goals [9,10]. Social norms were examined because it was hoped that they would motivate individual decision-making beyond simple hedonic or cost reasons [27]. Previous studies have manipulated the characteristics of the referent group to increase identification with a respective group but with limited results [28,29]. Energy companies frequently employ this approach by sending out quarterly reports to their consumers comparing their energy consumption to the consumption of their average neighbor and their most efficient neighbors. However, as stated earlier, a recent study by Brandon and colleagues [19] including 1,385 households found that normative feedback conditions had no statistical influence on individual household energy conservation efforts. Hence, while social norms might have the potential to drive energy consumption behavior, more research is needed to determine key predictors of household heating energy consumption patterns. In this paper, we propose two additional key predictors, namely family norms and community fit.

2.2. The role of familial thermal comfort habituation

While most available technologies today are more energy efficient than a decade ago, energy consumption has increased since the start of the industrial revolution and, if anything, has accelerated with each passing year [30,31]. It has become easier to adjust one's living environment to maximize comfort levels as more environment-altering technologies (e.g., air conditioning, central heating, or space heaters) become widely available. For example, 86% of all households in the U.S. had central air conditioning by 2015 [4]. Home temperatures can now easily surpass 70 F (21.1 C) or even 80 F degrees (26.6 C) even when outside temperatures are below freezing (i.e., < 32 F/ 0 C). Engaging in this behavior is not only in contradiction to the rising awareness and concern about energy-related environmental issues and associated climate change consequences [32] but also leads to increased utility costs. In turn, according to rational choice theory, increased utility costs should deter individuals from engaging in such behaviors and "nudge or outright force them to reduce energy consumption. However, many studies have found that individuals act in direct contradiction to this theory and are mostly unaware of their behavior in doing so [32]. Previous literature has argued that this phenomenon is likely due to habits.

Once formed, habits constitute a strong predictor of future behavior even "over and above intentions, suggesting that such behavior is initiated without much deliberation and thought" [33]: 246]. For example, Pierce, Schiano [30] found that participants were unwilling to alter their behavior and reduce energy consumption even when they were surprised to hear about the cost of running several devices in their homes. Pierce and colleagues [30] reported the following interaction between a participant (P8) and one of the researchers (Q): *"[P8] The dehumidifier, we have that on all day long! Two of them! That's a shocker! [Q:] Are those prices enough to make you change your behavior? [P8:] Well, no. No. Not enough to change"*. This example illustrates that "ordinary people in ordinary situations rely on a range of entirely irrational methods of dealing with cognitive demands of choice, including heuristics and rules of thumb" [30].

In short, behaviors are not necessarily a result of intention (e.g., reducing energy consumption). Rather, individuals infer intention post hoc to behavior to explain the respective behavior [30]. Habituation, therefore, plays an important role in understanding and explaining individual decision-making concerning energy conservation. More specifically, we postulate that family thermal comfort habituation (i.e., thermal comfort levels experienced during childhood) can predict individuals' home temperature settings and, in turn, energy consumption patterns.

We argue that familial thermal comfort habits, emerging from a confluence of family norms and the regional climate in which one grows up, influence and predict future thermal comfort levels due to their foundational role in establishing an individual's baseline for comfort. Family home temperature norms (i.e., parents or caregivers controlling the thermostat settings) instill a certain level of accustomed comfort from a young age. Children growing up in such environments rarely question or deviate from these established norms, leading to a deeply ingrained sense of what temperature is considered 'comfortable'.

Furthermore, it is likely that the regional climate plays a pivotal role in shaping these habits. For instance, individuals raised in colder regions may grow accustomed to colder indoor temperatures as well, while those from warmer regions likely grew accustomed to warmer indoor temperatures as a result of the warm climate. These early experiences with thermal comfort within the family setting create a benchmark that individuals carry into adulthood, influencing their preferences and behaviors related to energy consumption in their own homes. Excluding the variable of familial thermal comfort habits from the analysis of energy consumption behaviors may partly explain why some individuals appear resistant to adopting more energy-efficient practices, such as adhering to recommended thermostat settings. The deep-seated nature of these habits suggests that merely introducing technological solutions or financial incentives may not be sufficient to alter established patterns of behavior. To effectively encourage more sustainable energy usage, it is essential to consider and address these underlying habits formed through family norms and regional climate influences, recognizing their powerful impact on individual thermal comfort preferences and, consequently, on energy consumption patterns.

2.3. The role of community fit

Building on the pivotal role of familial thermal comfort habits in shaping individual energy consumption behaviors, we posit that another key component determining current home thermal comfort is community fit. Community fit is the degree of cognitive and emotional alignment with one's local environment [21,22]. As individuals develop strong and high-quality ties to nearby family and friends, their fit to geographic places and "feelings of inclusion, compatibility, and belongingness" will increase [34]. This sense of attachment influences not only personal identity but also behaviors, including energy consumption patterns, which is in line with social identity theory. We know from the literature that social norms exert more influence on an individual's behavior as the salience of the suggested group membership (e.g., comparing your energy consumption to other "energy conserving heroes" in your neighborhood) increases [35]. Of course, simply living in any given community does not automatically result in the conscious adaptation of behaviors in line with other community members. We posit that individuals who experience a high degree of community fit are more inclined to adapt their home temperature settings to those of their local community.

This adaptation, particularly concerning thermal comfort levels among individuals with high community fit, is a subtle and largely unconscious phenomenon. This natural alignment with community standards does not stem from a deliberate attempt to be perceived as part of the group (in opposition of the social norms literature); rather, it occurs organically over time through continued exposure to the home environments of fellow community members. As individuals integrate more deeply into their local communities, they subconsciously absorb and emulate the prevailing thermal comfort practices, gradually aligning their own preferences with those of the community at large.

This unconscious adaptation is further influenced by the regional climate, which plays a significant role in shaping community norms and individual adaptations to temperatures. For instance, individuals residing in colder climates naturally acclimate to the lower temperatures, a process mirrored in their home thermal settings. This acclimatization is not a conscious decision to conform to community standards but an inherent response to prolonged exposure to the local climate. Similarly, those in warmer regions adapt to higher temperatures, reflecting this adjustment in their preference for warmer indoor environments. Recognizing the impact of geographic and climatic variations, we also consider the average outside temperatures, particularly the stark winter temperature differences across states [24]. This leads us to hypothesize that community fit acts as a moderating factor, influencing how individuals' childhood home temperatures and the prevailing outdoor temperatures of their current location intersect to determine their current home temperature settings. This line of argument also helps explain the discrepancy between studies that find that for some households responsiveness of energy consumption can be modified using social norm framing [36], while other households deliberately change the settings on their (smart) thermostats to undo the purported benefits [19], to meet their comfort needs. Specifically, we anticipate that a stronger community fit would lead to home temperatures that are more in line with local norms, resulting in lower temperatures in colder states and warmer temperatures in warmer states during the winter months. We hypothesize the following:

Hypothesis: *Community fit moderates the influence of the interaction between childhood home temperature and outside temperature on current home temperature*, *in that an increased community fit results in lower (warmer) home temperature in colder (warmer) winter states*.

3. Methods

Participants were recruited on Amazon Mechanical Turk (MTurk) via CloudResearch. CloudResearch, formerly known as TurkPrime, is a platform designed to improve online data collection on Amazon Mechanical Turk (MTurk), by providing features such as CloudResearch Approved Participants (CAP). By rigorously vetting and monitoring participants based on their historical performance and ongoing task quality, the CAP option ensures that researchers source data from respondents who consistently provide authentic and careful responses. To ensure we collect a broad and high-quality sample, we opted into this participant recruitment program for our survey. Inclusion criteria were that participants were at least 18 years of age, residents of the United States, and included as approved participants on CloudResearch. Ethics approval was granted by the Maynooth University Research Ethics Committee (SRESC-2022-2476604). Participants were recruited between 30th August 2022 and 27th October 2022. All participants provided informed consent, in writing.

In total, 2,259 CloudResearch-approved participants completed the survey. However, the final sample was smaller due to the following data cleaning protocol. Specifically, participants who either did not answer whether they control their home thermostat setting (10 participants) or who replied that they could not set the temperature for their home (e.g., indoor building temperature is centrally set; 37 participants) were not considered. We also dropped any participants who either failed to provide their current home temperature (1 participant) or the temperature of their childhood home (9 participants). We dropped participants who reported extremely low (< 60F, <15.55 C) or high (>85 F, >30 C) temperatures for their current or childhood home. Our final sample consisted of 2,128 (1,073 female and 1,055 male) participants.

Our participants reported an average age of 43.51 years old (*SD* = 12.63). Based on a total of 1502 participants who reported their race and ethnicity, our sample was 79.09% Caucasian, 8.85% Asian-American, and 6.79% African-American. The majority (84.02%) of our participants were either self-employed or paid employees, while a small portion was retired (6.11%) or looking for work (3.20%). Our sampling strategy was designed to capture a wide range of demographic characteristics, with a particular focus on age, sex, and ethnicity, to reflect the diversity of the U.S. population. These demographic variables are crucial for our analysis given their potential influence on energy conservation behaviors. Our comparison of these demographic characteristics with U.S. Census Bureau data, as presented in Table 1, demonstrates the representativeness of our sample in these key areas. The dataset is publicly available (https://osf.io/sk75a/).

As seen in Table 1, our sample is balanced in terms of male and female population, and aligned with Census data. In terms of age, our sample includes an overall somewhat younger demographic compared to U.S. Census data. However, all age groups are represented in our

Table 1. Sample comparison to U.S. census statistics.

	Survey Sample	U.S. Census
Average Age	43.51	47.76
Age brackets		
18–24	2.21%	6.48%
25–34	25.85%	13.76%
35–44	31.77%	12.88%
45–54	19.03%	9.41%
55–64	13.39%	8.55%
65–74	6.72%	9.58%
75+	1.03%	6.46%
Sex		
Male	49.58%	49.60%
Female	50.42%	50.40%
Ethnicity		
Asian	8.85%	6.30%
Black	6.79%	13.60%
Hispanic or Latino	4.26%	19.1%*
Native (and Other)	1.00%	1.60%
White	79.09%	75.50%

Note

* estimated based on US Census data

** Hispanics may be of any race, so also are included in applicable race categories.

https://doi.org/10.1371/journal.pclm.0000407.t001 sample. In terms of race and ethnicity, we are largely in line with Census data, except for the proportion of the population of Hispanic or Latino descent in which case our sample is less representative. However, according to the U.S. Census, Hispanics may be of any race so are therefore included in all applicable race categories, which might help to explain the discrepancy in this case. Nevertheless, overall, our sample seems largely representative of the U.S. population.

3.1. Measures

3.1.1. Current home temperature in winter. We asked participants to indicate their average home thermostat setting during the winter months. Participants indicated this measure in Fahrenheit (F), and values were subsequently converted to Celsius (C) for comparison purposes.

3.1.2. Childhood home temperature in winter. We requested participants to recall and report the average thermostat setting in their childhood homes during winter, understanding that precise recollection might not be possible for everyone. We posit that it is the perceived, rather than the actual, thermostat setting from one's childhood that influences current thermostat behaviors. For instance, individuals who remember their childhood homes being kept at 20˚C might base their current settings on this memory, accurate or not. Furthermore, we intentionally did not define a specific age range for 'childhood' to allow participants to reflect on the time they personally associate most strongly with their formative years. We believe this approach captures the period most impactful and memorable to an individual, making it a reliable indicator of their habitual home temperature preferences. This method, despite its reliance on subjective memory, serves as an effective proxy for understanding the ingrained thermal comfort habits that guide current behaviors.

3.1.3. Community fit. Community fit primarily was measured using the three-item Likert scale ($\alpha = 0.84$; 1 = Strongly disagree, 5 = strongly agree), which is a subscale of the job embeddedness scale. Items included "The community I live in is a good match for me", "The area where I live offers the leisure activities that I like", and, "I think of the community I live in as home". We also measured state satisfaction as an additional proxy variable for community fit. This scale was a 4-item five-point Likert scale ($\alpha = 0.81$) which asked participants how satisfied they were with their state (instead of the local community). Participants were asked to indicate their satisfaction (1 = extremely dissatisfied, 5 = extremely satisfied) with the following: "living in the state in general", "your job, employment, career in the state you live in", "the culture of the state you live in", and finally "your family life in the state you live in". The purpose of measuring community fit via the state satisfaction scale was to assess whether community fit when extended to the state (compared to the local community) level, would also be able to act as a proxy of community fit to the degree that it can predict local adaptations of home temperatures.

3.1.4. Average (outside) winter temperature by state. Many governments and smart thermostat companies promote that lowering one's home temperature can lead to significant savings. For example, Nest's website promotes up to 12% savings on heating and 15% on cooling costs. However, as Brandon and colleagues [19] correctly stated, these claims are largely local climate agnostic. For example, heating a home to 22 C is going to cost more if the outside temperature is sub-freezing (e.g., -5 C) compared to a milder outside temperature (e.g., 10 C). Therefore, accounting for average outside temperature is important when predicting home temperature. For this reason, we accounted for average outside temperatures during the winter months (Dec–Feb 2021) for each state (and the District of Colombia). Average winter temperatures ($M = 7.89$, $SD = 4.46$) were provided by NOAA National Centers for Environmental

Table 2. Pairwise correlations of main variables.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Current home thermostat setting	-						
(2)	Community fit	0.00	(.84)					
(3)	State Satisfaction	0.02	0.76***	(.81)				
(4)	Average Winter Temperature	0.23***	-0.07**	-0.04	-			
(5)	Childhood home thermostat setting	0.52***	-0.03	-0.00	0.23***	-		
(6)	Household income	-0.03	0.20***	0.24***	-0.02	-0.07**	-	
(7)	Age	-0.05*	0.16***	0.12***	0.04*	-0.02	-0.02	-
(8)	Sex	0.00	0.02	-0.02	0.02	-0.02	-0.01	0.11***

Note
*** $p < .001$
** $p < .01$
* $p < .05$; n = 2,127.

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National Centers for Environmental Information (24) for all states, except for Hawaii and Washington D.C. For these missing regions, average temperature values for January 2021 were considered instead as provided by World Weather [37].

3.1.5. Demographics. Research has established that there is a link between age [38], gender [39] and ideal home temperature. We hence control for age and gender. We also accounted for race and education. We control for household income as lower household income is likely to be associated with efforts to lower utility costs, which subsequently means decreasing (increasing) thermostat temperature settings during the winter months in cold (warm) states. Finally, we controlled for the state of upbringing vs. current state of residence to account for geographical mobility (see Table 2, Model 4). This approach allows us to partially isolate the effect of early thermal environments from the effects of current climate conditions.

4. Results

As individuals (Level 1) were nested within geographical regions (i.e., states, Level 2), we fitted multilevel mixed-effects regression models with heteroscedastic robust standard errors. The inclusion of variables at each step was guided by both theoretical considerations and preliminary analyses. Variables such as community fit, outside temperature, and childhood home temperature were included based on their theoretical relevance to energy conservation behaviors, as outlined in our literature review. Model 1 displays main effects, while M2-M3 show main effects plus interaction effects. M4 includes additional control variables. All analyses were conducted using Stata 17.0 (Stata, 2021). Pairwise correlations are provided in Table 2 below and the main regression results can be found in Table 3.

We find that childhood home temperature positively predicts current home temperature (Table 3, Model 1: $b = 0.45$, $SE = 0.03$, $z = 13.43$, $p < 0.001$). Specifically, individuals who grew up in warmer homes tend to maintain higher thermostat settings in their current homes, suggesting a lasting influence of early thermal environments on current temperature preferences.

The three-way interaction between community fit, average outside winter temperature, and childhood home temperature was significant and positively predicted current home temperature (Table 3, Model 3: $b = 0.01$, $SE = 0.00$, $z = 4.40$, $p < 0.001$). To better interpret this interaction, we plotted this interaction (1st percentile, mean, 99th percentile) accordingly, and plotted results split by average outside winter temperature (cold winter = 0.77 C, mild winter = 7.72 C,

Table 3. Step-wise mixed-effects regression model.

	Model 1	Model 2	Model 3	Model 4
	b/SE	b/SE	b/SE	b/SE
Community Fit	0.07	0.07	2.26***	2.48*
	(0.04)	(0.04)	(0.67)	(1.05)
Outside Temperature	0.07***	-0.06	1.03***	0.94
	(0.01)	(0.12)	(0.30)	(0.53)
CHT	0.45***	0.41***	0.79***	0.83***
	(0.03)	(0.06)	(0.15)	(0.21)
Household Income	0.00	0.00	0.00	0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Age	-0.01**	-0.01**	-0.01**	-0.09***
	(0.00)	(0.00)	(0.00)	(0.03)
Sex	0.07	0.07	0.07	0.13
	(0.08)	(0.08)	(0.08)	(0.11)
Outside Temperature X CHT		0.01	-0.04***	-0.04
		(0.01)	(0.01)	(0.02)
Community Fit X Outside Temperature			-0.30***	-0.27*
			(0.07)	(0.13)
Community Fit X CHT			-0.10***	-0.11*
			(0.03)	(0.05)
Community Fit X Outside Temperature X CHT			0.01***	0.01*
			(0.00)	(0.01)
Grew up in same state				-0.17*
				(0.09)
Employment status				0.17
				(0.22)
Age^2				0.00**
				(0.00)
Ethnicity				
Asian-American				(baseline)
African-American				0.73**
				(0.24)
Hispanic/Latino				0.02
				(0.28)
Native American				0.24
				(0.43)
Other (Pacific)				-0.41
				(0.72)
Caucasian				-0.14
				(0.21)
Education				0.02
				(0.04)
Constant	11.17***	12.18***	4.03	4.43
	(0.67)	(1.30)	(3.28)	(4.71)
χ^2	762.83***	803.22***	870.12***	1869.22***
AIC	9033.85	9033.73	9023.23	6356.59

(*Continued*)

Table 3. (Continued)

	Model 1	Model 2	Model 3	Model 4
	b/SE	b/SE	b/SE	b/SE
BIC	9084.81	9090.36	9096.84	6473.50

Note: Model 1 displays main effects, while Model 2 –Model 3 show main effects plus interaction effects. Model 4 includes additional control variables; CHT = Childhood Home Temperature; Employment status = working (1), not actively working (0); Sex =

*** $p < .001$

** $p < .01$

* $p < .05$; n = 2127.

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warm winter = 16.77 C). Fig 1 shows the main regression interaction on current home temperature settings.

Results indicate that in the case of a cold winter, as childhood home temperature increases, individuals who indicated a high community fit seem to keep a lower home temperature on average (slope = 0.29, $SE = 0.06$, z = 5.31, $p < 0.001$) than individuals who indicated a low community fit (slope = 0.66, $SE = 0.12$, z = 5.67, $p < 0.001$). Put differently, low community fit

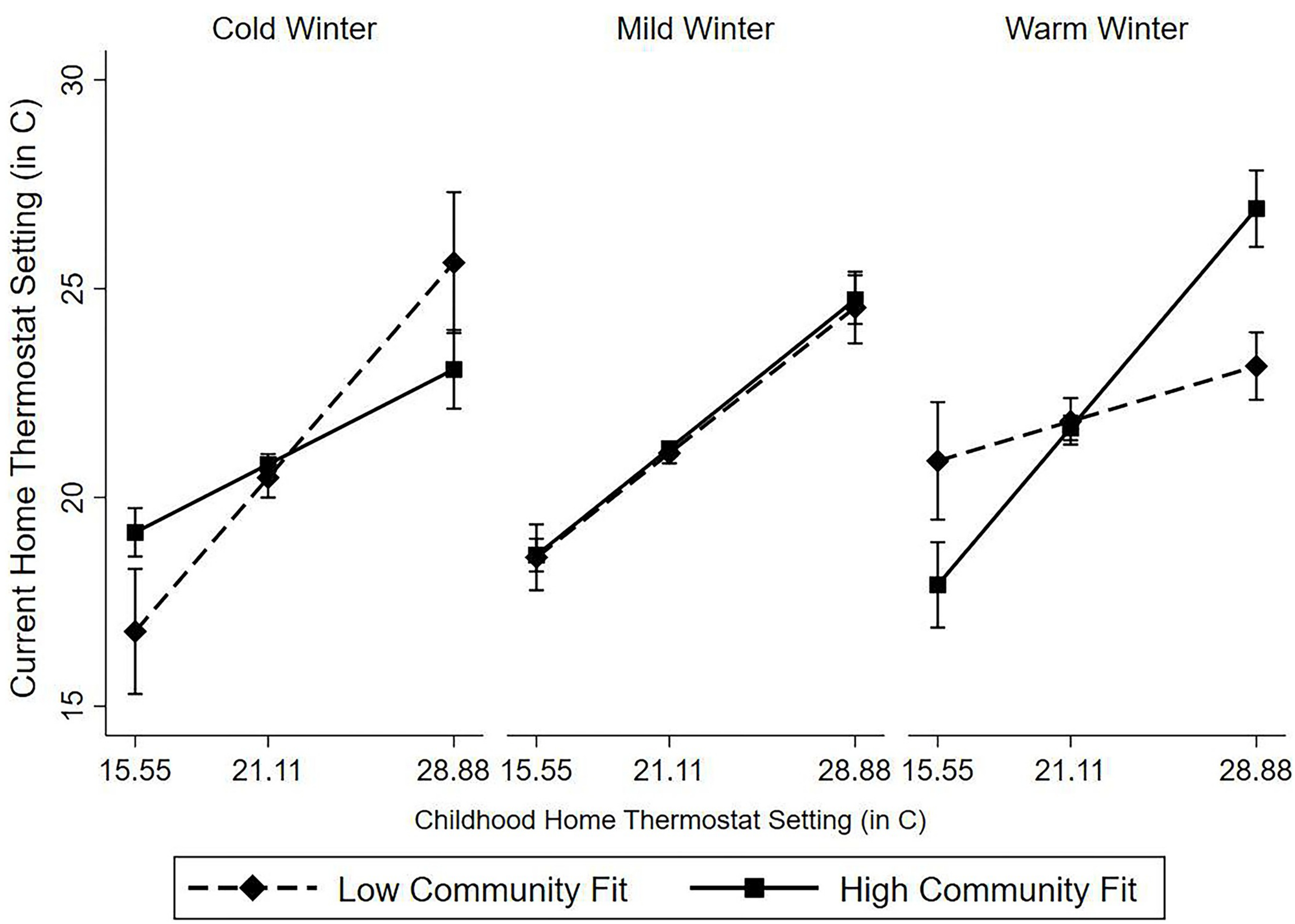

Fig 1. Main regression interaction on current home temperature settings.

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moderates the relationship between childhood home temperature and current home temperature, in that low community fit individuals in cold winter regions seem to keep a higher home temperature.

In mild winter regions, plots indicate little difference between low (slope = 0.45, *SE* = 0.06, $z = 7.40$, $p < 0.001$) and high community fit (slope = 0.46, *SE* = 0.04, $z = 12.99$, $p < 0.001$). However, in warm winter regions, individuals who indicated a high community fit seem to keep a higher home temperature on average (slope = 0.68, *SE* = 0.07, $z = 9.33$, $p < 0.001$) compared to individuals who indicated a low community fit (slope = 0.17, *SE* = .08, $z = 2.08$, $p = 0.04$). Put differently, community fit moderates the relationship between childhood home temperature and current home temperature, in that low community fit individuals in warm winter regions (e.g., Florida) are more likely to keep a lower home temperature compared to high community fit individuals. We discuss these results in the discussion section below.

4.1. Robustness check

To test whether the reported results hold when considering additional factors, we ran an additional model (Table 3, Model 4) including a series of control variables, including race, education, state while growing up, and age^2. Results were robust and remained largely unchanged (Model 4: $b = 0.01$, *SE* = 0.01, $z = 1.97$, $p = 0.05$), even though this sample was smaller (1,502 participants) due to some missing ethnicity data.

We also examined whether state satisfaction (i.e., the degree to which participants are satisfied with their current home state) could serve as an alternative measure of community fit and yield similar results. We reran the main three-way interaction using this variable instead of community fit (i.e., replicating Table 3, Model 3) and found similar results ($b = 0.01$, *SE* = 0.00, $z = 4.18$, $p < 0.001$). Controlling for all additional controls (except for ethnicity due to incomplete data) left the three-way interaction coefficient largely unchanged as well ($b = 0.01$, *SE* = 0.00, $z = 3.98$, $p < 0.001$). When restraining the sample to include only participants who also provided information regarding their ethnicity, the interaction coefficient was no longer significant ($b = 0.01$, *SE* = 0.00, $z = 1.88$, $p = 0.06$). While this might be due to the more limited sample size, it is impossible for us to declare so definitively. Hence, it seems that community fit is a more robust predictor of current home temperature.

5. Discussion

This paper adds to the discussion on energy conservation by arguing for the role of community fit as a mechanism to explain energy conservation behaviors. We argue that by accounting for habitual temperature settings in childhood homes and the degree of community fit, we can predict current home thermostat settings, which impact energy consumption.

Overall, we find that participants who live in colder winter regions and who grew up in a warmer home (e.g., 80 F / 26.67 C) maintained a higher home temperature compared to participants who grew up in a colder home (e.g., 70 F / 21.11 C). However, the degree to which individuals identify and can relate to their community (i.e., community fit) strongly moderated this relationship. For example, participants living in colder winter regions (e.g., New York) who strongly identified with their current local community maintained a lower thermostat setting than participants who indicated a poor community fit. Put differently, it is likely that high community fit participants seemed to adjust their home temperature settings compared to low community fit participants, even when accounting for familial thermal comfort habits (i.e., childhood home temperature). Individuals in warm winter regions (e.g., Florida), on average, seemed to be less likely to use central heating and rather are more likely to cool their home temperature via air-conditioning, resulting in colder current home temperatures.

However, we find that this assumption only seems to apply to low community fit individuals. Individuals who indicated high community fit reported higher home temperatures, due to likely more limited air conditioning.

These results speak to the importance of the combination of familial thermal comfort habituation and community fit-based behaviors in predicting home temperature settings, and in turn household heating energy consumption. In fact, results indicated a several-degree difference (up to 4.77 F / 2.65 C) between low and high community fit participants in similar climates (i.e., same winter region and habitual temperatures).

These differences likely translate to energy consumption differences and higher (or lower) utility costs as well. In terms of savings, the U.S. Department of Energy states that by lowering home temperatures by 7–10 degrees Fahrenheit (e.g., from 77 F/ 25 C to 70 F/21.11 C), households could save up to 10% on annual utility costs. With the average monthly consumption of 893 kWh at 13.15 cents/kWh (in 2020), this amounts to an annual utility bill of 1,409.52 USD [40]. Implementing this suggestion would result in savings of up to 140.95 USD annually per household and total savings of approximately 19.27 billion USD. And because the presented findings are based on actual human behavior, we argue our results are more indicative of actual savings than smart thermometer advertising which can indicate an average saving of 10–12% [41]. However, these claims are largely unsubstantiated as they do not account for a) inconsistent human behavior regarding thermostat settings (especially when the home is vacant) and b) local climate conditions. In addition, with the current ongoing war between Russia and Ukraine, energy prices have increased dramatically (July 2021: 13.87 cents/kWh; July 2022: 15.46 cents/kWh for residential buildings). Holding energy consumption constant at 2020 levels (i.e., 893 kWh/household/month) this price increase would result in 1,656.69 USD in utility costs per household, an 11% increase. In terms of CO_2 emissions, with an average of 0.85 pounds of CO_2 emissions per kWh, savings of 10% (i.e., 89.3 kWh per household) would result in total savings of approx. 56.5 million metric tons of CO_2 per year nationally. For comparison, Oregon's annual human-caused greenhouse gas emissions in 2018 were 52.75 Mt. [42].

Finally, we accounted for childhood home thermostat settings during the winter months as our proxy for familial thermal comfort habits. Here, it is important to keep in mind that while such comfort levels, especially those acquired during childhood, can be "deeply entrenched and difficult to change [. . .], this does not mean that habits are immune to deliberative processes" [20]. Nevertheless, new habit acquisition is not uniform, and individuals can take anywhere from 18 to 254 days to acquire a new habit according to Lally, Van Jaarsveld [43]. Therefore, while we would encourage future studies to be conducted on testing the efficacy of new energy conservation habituation, researchers should be mindful of this wide range when defining the timespan of their studies. Behaviors can be changed, albeit some are more difficult to change than others.

6. Limitations and future research

This study is not without limitations, including self-report data. In addition, we equated home thermostat settings to home temperature. We acknowledge that the thermostat setting might not equal the actual home temperature. This is due to a series of construction factors. For example, if wall isolation is poor, the thermostat setting might be set at a higher temperature (e.g., 86 F / 30 C) than the actual home temperature (e.g., 73.4 F / 23 C). Likewise, if there is another heating source available, for example, a functioning fireplace, central heating might not be required compared to a home without a functioning fireplace. Hence, in some cases, the thermostat setting might not equal the actual home temperature. However, we are confident in our choice of this proxy due to two reasons. Firstly, although home thermostat settings might be set higher than the actual home temperature, the association between thermostat settings and energy consumption is still valid as it takes more energy to heat a poorly insulated home to a comfortable temperature. Secondly, the number of cases in which thermostat setting does not equal home temperature is likely quite low in our sample. For example, in total, only two participants indicated that they make use of another heating source (e.g., a fireplace) to heat their home.

Related to the point above, we also acknowledge the potential influence of a home's physical characteristics on energy consumption patterns. Older homes may require residents to adjust their thermostats to higher settings to achieve desired comfort levels leading to increased energy consumption. Our study did not delve into a direct evaluation of homes' insulation standards either. Instead, we factored in household income as a potential indicator, stipulating that household income could serve as a surrogate marker for various facets of home quality, insulation being a prime aspect. There is a conceivable link suggesting that households with a lower income bracket might predominantly occupy homes that are either older or not optimally insulated. Such living conditions could inherently influence their choices regarding thermostat settings. This indirect approach to gauging insulation quality is a limitation we recognize, and future research would benefit from a more direct assessment of insulation conditions in homes.

In addition, while, on average, it is likely that adjusting one's home temperature settings (lower in cold winter regions/ higher in warm winter regions) as conceptualized via community fit is likely to result in energy conservation, we do not expect this to always be the case. For example, indicating high community fit for a highly affluent area in which individual households feature a private pool or spa and whose household members own several cars will not automatically translate into energy savings and could even result in con-environmental behaviors. Nonetheless, the percentage of pools (8%) or hot tubs (5%) per household is quite low [44]. With regard to car ownership statistics per household, based on the 2021 American Community Survey, the average American household owns 1.80 cars, or approx. 0.90 cars per driving-age household member. Given these statistics, we would expect familial thermal comfort habits and degree of community fit to be indicative of household energy consumption for the average household.

Related to the point above, as we do not measure community norms directly (incl. with regard to community energy conservation), we cannot definitively state that individuals are likely to adjust their home temperature settings as a result of adhering to community norms. Hence, results should be interpreted accordingly and with caution.

Furthermore, while we did ask participants to report whether they are in direct control of setting their home temperate settings, our research methodology did not encompass specific queries about renter vs. ownership, nor the presence of young children in the homes of our respondents. In the presence of younger children in the household, comfort temperature levels might be higher than preferred by adults. However, it is worth noting data from the US Census Bureau, which indicates that households with young children (0–5 years of age) constitute a relatively minor proportion, approximately 5.6% in 2020. Hence, while young children's presence might shape energy consumption behaviors in certain households, its influence on the broader trends identified in our study is likely to be limited.

Finally, we do not claim for the found associations to be causal. The conducted study is cross-sectional and observational and does not constitute nor replace a (quasi-natural) experiment, nor did we study the association between childhood home temperature, community fit, and current home temperature longitudinally. Likewise, there might be other factors or combinations of factors (e.g., financial incentives + familial thermal comfort habituation

+ community fit) that were not considered in this paper but which might predict household heating energy consumption more accurately. We do encourage future research to explore these (combinations of) factors further.

7. Conclusion and policy implications

In the pursuit of effective energy conservation, our study highlights the critical role of community fit for energy conservation efforts. Various interventions in the past have been tried to increase the frequency, strength, and quality of connections among individuals in a neighborhood. For example, James W. Rouse (1914 to 1996) believed that he could build a city that would be a "garden for the growing of people" [45]. This new city should enhance inhabitants' sense of responsibility to the city and each other. To prove that such a city could exist, he and his team designed, built, and developed the city of Columbia, Maryland, USA in the 1960s [45]. Instead of a central governing body found in most large cities, Columbia was composed of nine distinct villages. Rouse believed the small villages would cultivate a sense of social responsibility among their residents and promote a sense of community fit [45]. Columbia was the first successful planned community in the USA and it consistently ranks on "best places to live in America" lists [45]. In other words, community fit can be influenced and enhanced by the very structure of the cities that we live in.

A second implication of our work would be to change the focus of campaigns designed to affect energy consumption behavior. Perhaps more effective interventions emphasize localized strategies over generic national campaigns. Policymakers may need to pivot towards campaigns that deeply resonate with the unique identity and values of individual communities. By tailoring messages that align with local culture, traditions, and aspirations, there's an opportunity to enhance the sense of community fit, which in turn can catalyze more robust conservation efforts.

Further amplifying this community-centric approach, incentive programs can be reframed to emphasize collective achievements. While offering individual-oriented incentives inconsistently worked in the previous literature, perhaps framing discounts or rebates for energy-efficient choices as a community-wide reward might work. It might instill a shared sense of responsibility and accomplishment. This sense of collective achievement can be further bolstered through strategic urban planning. By designing neighborhoods with communal spaces, parks, and community centers, interactions among residents can be facilitated, nurturing stronger feelings of community fit.

The foundation for these community-driven conservation efforts can be laid early on through educational initiatives. Schools can introduce energy conservation curricula that emphasize community values and collective action. Moreover, engaging students in hands-on, community-based conservation projects can provide practical insights while fostering a sense of community from a young age.

However, implementing these community-focused strategies is not without challenges. Communities are diverse, each with its unique set of values and priorities. Policymakers must ensure that energy conservation policies are adaptable, catering to the distinct ethos of each community. Another challenge lies in sustaining community engagement. While the initial enthusiasm might be high, maintaining this momentum requires consistent effort. Regular feedback sessions and community updates can serve as touchpoints, ensuring continued community involvement. Additionally, a shift towards community-centric initiatives might necessitate a reallocation of resources from broader campaigns, requiring policymakers to judiciously balance the benefits against the implications of such shifts.

In conclusion, enhancing community fit presents a promising avenue for driving energy conservation behaviors. By crafting policies that foster a sense of belonging and collective responsibility, we can tap into the intrinsic motivation of communities to conserve energy, leading to more sustainable outcomes.

Author Contributions

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