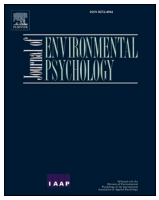
Journal of Environmental Psychology 102 (2025) 102545

Contents lists available at ScienceDirect

Journal of Environmental Psychology

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



The misperception of carbon footprints of the rich and the poor

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ARTICLE INFO

Keywords:
Inequality
Carbon footprint
Carbon tax
Misperception

ABSTRACT

Not everyone contributes to climate change to the same extent. While huge inequalities exist in consumption and associated greenhouse gas emissions, we show (using a large representative sample, $N = 1002$) that US residents are largely unaware of the substantial carbon inequality within their country. In fact, 95% of respondents underestimate the carbon footprint of the top 1% consumers. At the same time, people wish for a more equal distribution of carbon footprints. These results were replicated in two independent samples (total $N = 1455$) and emerged across a range of demographic variables and climate change beliefs. Finally, in two experimental studies (total $N = 2408$), we demonstrate that learning about carbon inequality increased support for carbon taxes. Overall, the present paper shows that people substantially misperceive the carbon footprint of top consumers. Educating people about carbon inequality leads to support for legislative measures that aim to address overconsumption.

1. Introduction

Current levels of resource consumption and associated greenhouse gas emissions are overall unsustainable crossing several planetary boundaries that define the safe operating space for humanity (Richardson et al., 2023). However, not everyone contributes to this problem equally. Greenhouse gas emissions that result from individual consumption decisions are distributed extremely unequally between the poor and the rich—both globally as well as within countries and regions. For instance, a recent study extrapolating wealth inequalities within and between countries estimated that in the year 2019 the average carbon footprint of one person from the bottom 50% of consumers in the US was 10 tonnes of CO2 equivalent (CO2e), whereas the carbon footprint of one person from the top 1% of consumers was 269 tonnes of CO2e (Chancel et al., 2022). In stark contrast, an average of 1.1 tonnes of CO2e per capita and year is estimated to be the remaining carbon budget to limit global warming to 1.5 °C (Chancel et al., 2022). In the present paper, we demonstrate that US residents are largely unaware of the substantial inequality in carbon footprints within their country. Notably, we show that people do not only misperceive inequality but also wish for a more equal distribution. Accordingly, educating people about carbon inequality increased support for legislative measures that put a price on greenhouse gas emissions, that is, carbon taxes.

Research on perceptions of *economic* inequality (i.e., income and wealth) has shown that people often misperceive inequality in the distribution of economic resources (Gimpelson & Treisman, 2017; Norton & Ariely, 2011). Building on this work, we hypothesize that US residents underestimate the inequality in the distribution of carbon footprints in the US (Hypothesis 1). Recent studies showed support for this idea (Nielsen et al., 2024). Our studies provide an independent replication of this first hypothesis. In addition, we assess whether people's idea about the *ideal* distribution of carbon footprints deviates from what it actually is. Past work in economics and psychology has shown that people's *ideal* distribution of economic resources is more equal than the current one (Norton & Ariely, 2011). It should be noted that this might not be based on a general preference for equal over unequal outcomes, but rather on the perception that inequality or the extent thereof is not justified (Starmans et al., 2017). Still, people indicate that the distribution of income or wealth should be more equal than it actually is and than they estimate it to be (Norton & Ariely, 2011). Consequently, we also hypothesized that US residents would indicate that the distribution of carbon footprints should be more equal than it is (Hypothesis 2) and than they estimate it to be (Hypothesis 3).

Moving past analysing people's perception of carbon inequality, we study the consequences of correcting people's beliefs about this form of inequality. Recent research on economic inequality has shown that it is the *perception* of inequality (rather than the actual distribution) that predicts support for redistributive measures (Choi, 2019; Gimpelson &

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https://doi.org/10.1016/j.jenvp.2025.102545
Received 10 April 2024; Received in revised form 7 December 2024; Accepted 2 February 2025
Available online 3 February 2025

Treisman, 2017). In the context of carbon inequality, larger underestimation of inequality might predict lower support for climate policy, at least in some countries (Nielsen et al., 2024). In line with this finding, we argue that learning about carbon inequality (i.e., correcting the perception) can motivate support for mitigation measures that limit overconsumption. If people misperceive the inequality in carbon footprints, being confronted with the actual (extremely unequal) distribution of carbon footprints should serve as a motivator to support change to the status quo. It has been shown that perceiving inequality (in economic terms) can motivate support for system change addressing climate change via legislation (Klebl & Jetten, 2023). We therefore expect that learning about inequality in consumption will increase support for carbon taxes that increase prices for emissions associated with goods and services (Hypothesis 4).

Besides increasing support for mitigation measures on the system level (i.e., carbon taxes), it seems possible that learning about the immense inequality in carbon footprints could also backfire and decrease motivation for *individual* efforts. Learning that some individuals emit much more than average might lead to resignation as individual efforts might feel like a drop in the ocean. Therefore, we also assessed the belief that one has the capabilities to execute behaviors in order to achieve a goal (i.e., self-efficacy) and perceived personal responsibility with regards to addressing climate change, as well as general motivation to act, and willingness to engage in individual behavior change.

To examine our hypotheses, we gave participants the average carbon footprint of one person in the US in 2019, 21 tonnes of CO2e (Chancel et al., 2022), and let them estimate the average carbon footprint of one person from the bottom 50%, the middle 40%, the next 9%, and the top 1% of consumers. We also assessed what people think one person from each of these groups *should have* consumed. In addition, in two experimental studies, we examined how educating people about carbon inequality influences support for measures that aim at mitigating overconsumption.

2. Materials and methods

We conducted a series of studies to examine (a) to what extent US residents underestimate the inequality in carbon footprints in their country, and (b) whether learning about carbon inequality increases support for mitigation measures. After initial pilot testing of the study materials (see Supplementary Information), we recruited a large sample of US residents representative in age, gender, income, and location to match US census data (Study 1) and asked them to estimate the average carbon footprints of people from different parts of the distribution. We conducted a second study (Study 2) in which we incentivized the estimation of carbon footprints. Studies 3 and 4 were experimental studies aimed at testing the effect of learning about carbon inequality on support for mitigation measures. In both experimental studies, participants were randomly assigned to an Information treatment with information on the distribution of carbon footprints via a diagram or to a Control condition without this information before stating their support for carbon taxes. We also assessed different outcomes on the individual level (self-efficacy, perceived personal responsibility, general motivation to act, and behavior change intentions). In Study 3, participants first also completed the carbon footprint estimation task, while in Study 4, we omitted this element.

All studies were conducted in accordance with the Declaration of Helsinki. Participants gave informed consent before starting the study protocol. Preregistrations including hypotheses, measures used, sample size, and analysis plan can be found on our Open Science Framework repository (OSF; see https://osf.io/xq3sj/). Data and code are also available on the OSF.

2.1. Participants

2.1.1. Study 1

We planned to include 1000 US residents recruited via Prolific with English as their first language who fulfilled the inclusion criteria. 1226 opened the survey. In line with the preregistration, we excluded participants who (a) did not finish the survey ($n = 155$), (b) failed an attention check ("This is an attention check. Please answer with 'strongly agree'.", $n = 15$), (c) did not indicate lower or equal estimates for a lower vs. higher consuming group even after pointing out the necessity of this ($n = 35$), or indicated estimates that were higher than 100 times the average (2100 tonnes) for any of the groups ($n = 22$). The final sample therefore consisted of 1002 US residents with English as their first language, stratified by age, gender, income, and location to match US census data (for details on demographics see Supplementary Information). Participants reported living in households with between 1 and 9 members, most frequently in 2-person households (36.7%), followed by single households (21.2%), 3-person households (18.2%), and 4-person households (14.8%). The vast majority had no children in the house (74.1%), followed by one child (11.7%), 2 children (9.0%), three (3.9%) or more children (1.4%).

2.1.2. Study 2

We recruited a total of $N = 500$ US residents with English as their first language through Prolific. We excluded participants who (a) did not respond correctly to one of two attention check questions ($n = 12$), (b) did not report increasing estimates from lower to higher consuming groups even after having pointed out the necessity of this ($n = 35$), or (c) whose estimates exceeded 2100 for any of the groups ($n = 4$). The final sample consisted of $N = 454$ US residents (Mage $= 41.27$, $SD = 13.45$; 49.6% female, 2.0% Other/NA).

2.1.3. Study 3

We planned to include 1000 US residents with English as their first language who fulfill the inclusion criteria via Prolific. A total of $N = 1078$ started the survey. We excluded participants who failed to answer correctly to one of two attention check questions ($n = 19$), who reported lower values for higher vs. lower consuming groups ($n = 44$), or whose estimates exceeded 2100 for any of the groups ($n = 15$). The final sample was $N = 1001$ (Mage $= 36.88$, $SD = 12.86$; 49.1% female, 1.8% Other).

2.1.4. Study 4

We planned to include 1400 US residents with English as their first language who fulfilled the inclusion criteria to be able to detect effects as small as the ones shown in Study 3 (Cohen's $d > 0.15$) with 80% power and alpha $= 0.05$ (two-sided). A total of $N = 1447$ started the survey. We excluded participants who did not finish the survey ($n = 17$) or who failed to answer correctly to one of two attention check questions ($n = 23$). The final sample size was $N = 1407$ (M age $= 39.83$, $SD = 13.41$; 49.2% female, 2.1% Other/NA).

2.2. Measures

2.2.1. Estimation of carbon footprints (Study 1, Study 2, Study 3)

Participants were given the average carbon footprint of one person in the US in 2019 (21 tonnes, all numbers were taken from Chancel et al., 2022). Then, they were asked to estimate the carbon footprint of one person from (a) the bottom 50%, (b) the middle 40%, (c) the next 9%, and (d) the top 1% of consumers in 2019. In addition, we assessed what participants think the carbon footprint for one person from each group *should have* been (not in Study 3).

2.2.2. Climate change beliefs (all studies)

We assessed climate change beliefs including the belief that global warming is happening (on a scale from 1 = "extremely sure it is happening" to 5 = "extremely sure it is not happening"), the belief that

global warming is mostly human caused (with 1 = "cause mostly by human activities", 2 = "cause mostly by natural changes in the environment", 3 = "none of the above because global warming isn't happening"), perceptions of scientific consensus (with 1 = "most scientists think global warming is happening", 2 = "There is a lot of disagreement among scientists about whether or not global warming is happening", 3 = "most scientists think global warming is not happening"), and worry about global warming (on a scale from 1 = "not at all worried" to 5 = "very worried"). These items were adopted from the Yale Program on Climate Change Communication. Descriptive statistics can be found in Table 1.

2.2.3. Mitigation measures (Studies 3 and 4)

In Studies 3 and 4, we assessed support for carbon taxes, intention to change individual behavior, general motivation to act, personal efficacy beliefs, and personal responsibility beliefs. Descriptive statistics can be found in Table 1. Support for carbon taxes as a means to reduce carbon footprints was measured with three items. Participants indicated how much they agreed with the following measures (on a scale from 1 = "strongly disagree" to 5 = "strongly agree"): (1) a carbon tax on all polluting purchases and (2) a carbon tax that primarily targets people with high personal carbon footprints. We then explained that a large part of the emissions from the top 1% (the ones with the largest carbon footprints) come from their investments in carbon intensive industries and asked how much participants agreed with the following statement: I support a tax on financial returns from investments in carbon intensive industries. As preregistered, we analyzed the three items separately and as an overall index of support for carbon taxes (Cronbach's alpha in both studies 0.83).

We also assessed to what extent participants would be willing to engage in the following behaviors: Limit flying, limit driving, limit meat consumption, limit heating or cooling in your home, limit the number of new things you buy. We aggregated responses into an index of intended behavior change. Next, we assessed general motivation to act against climate change with three items ("I feel energized to do more to respond to climate change"). We assessed personal efficacy with two items, ("I can personally help to reduce climate change by changing my behavior."). We assessed personal responsibility with one item ("I feel a personal responsibility to try to reduce climate change."). Participants responded on a scale from 1 = "strongly disagree" to 5 = "strongly agree".

2.2.4. Demographic characteristics (all studies)

We assessed gender, age, household income, location (state), home location (urban, suburban, or rural), education, number of household members, number of children in household, and political orientation (on a scale from 0 = "extremely liberal" to 10 = "extremely conservative"). Demographic characteristics of all samples are displayed in the Supplementary Information.

3. Results

3.1. People underestimate inequality in carbon footprints

In line with our first hypothesis, participants substantially underestimated the inequality in carbon footprints in the US (see Fig. 1). In particular, the estimated carbon footprint of a person from the bottom 50% of consumers lied significantly above the actual number both for the mean and for the median of estimates (see Table 2, Study 1). For the middle 40%, the next 9%, and the top 1% of consumers, the estimates were significantly and substantially below the actual numbers for both the mean and the median. Thus, many participants overestimated the carbon footprint of the bottom 50%, while the carbon footprint of all other groups was substantially underestimated by the vast majority (ranging from 79% for the middle 40% to 95% for the top 1%). Consequently, the Gini coefficient as a measure of inequality that can range between 0 = perfect equality and 1 = perfect inequality was substantially lower for the estimated compared to the actual carbon footprints. Likewise, participants underestimated the ratio of carbon footprints between the bottom 50% and the three other groups (see Table 2).

To rule out the possibility that the pattern is driven by participants' lack of effort in the study, we ran another study (Study 2) in which the estimation was incentivized—that is, the five participants with most accurate estimates (smallest sum of deviations from the actual numbers in any direction) received a bonus payment of 20£. In this study, we replicated the pattern that inequality in the distribution of consumption was substantially underestimated. Again, this resulted from an overestimation of consumption of the bottom 50%, whereas consumption of the other three groups was substantially underestimated (see Table 2, Study 2). The same pattern was replicated in an independent sample of participants who took part in the first experimental study (see Table 2, Study 3).

In Studies 1, 2, and 3, we also compared the ratios between the bottom 50% of consumers and the three other groups as well as the Gini coefficient as additional measures of inequality for the actual versus estimated numbers. All measures indicated less inequality in the estimated distribution compared to the actual distribution (see Table 3). For the analyses based on the mean of estimates, we excluded participants whose estimates resulted in a ratio larger than 1000 because otherwise very few observations distorted the results.

While estimates were overall far from the actual numbers, we found small but significant correlations between the accuracy of estimated carbon footprints and demographic variables as well as climate change beliefs (see Table 4). To explore associations between demographic variables and climate change beliefs with estimation accuracy, we ran an internal meta-analysis across our three studies (using fixed effects) in which the mean effect size (i.e., mean correlation) was weighted by sample size (Goh et al., 2016). All correlations were Fisher's z transformed for analyses and converted back to Pearson correlations for presentation. Table 4 reports the meta-analytical correlation estimates; the zero-order correlations in each study can be found in the Supplementary Information. Results show that male gender, higher education,

Table 1
Mean and standard deviation of climate change related beliefs and mitigation measures.

	Study 1		Study 2		Study 3		Study 4	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Belief in climate change	1.60	0.93	1.70	0.94	1.56	0.87	1.76	1.04
Human caused climate change	1.21	0.46	1.22	0.44	1.14	0.38	1.25	0.51
Scientific consensus	1.16	0.38	1.16	0.38	1.12	0.34	1.22	0.46
Worry about climate change	3.74	1.28	3.76	1.15	3.80	1.19	3.70	1.27
Carbon tax support	–	–	–	–	3.74	1.09	3.62	1.12
Behavior change intentions	–	–	–	–	3.39	1.09	3.03	1.15
General motivation	–	–	–	–	3.45	1.12	3.40	1.16
Personal efficacy	–	–	–	–	3.24	1.19	3.27	1.25
Personal responsibility	–	–	–	–	3.43	1.29	3.42	1.31

Table 2
Deviation of mean and median estimates from the actual carbon footprints of the bottom 50%, the middle 40%, the next 9%, and the top 1% of consumers.

Actual footprint			Estimated footprint (in tonnes)			Deviation (Δ in tonnes)				
			M	*SD*	*Median*	*Δ*	*t*	*df*	*p*	*Cohen's d*
Bottom 50%	10	Study 1	12.64	20.54		2.64	4.07	1001	<0.001	0.13
					11	1.00	9.07		<0.001	
		Study 2	11.85	7.12		1.85	5.53	453	<0.001	0.26
					12	2.00	5.47		<0.001	
		Study 3	11.96	11.52		1.96	5.38	1000	<0.001	0.17
					11	1.00	6.44		<0.001	
Middle 40%	22	Study 1	20.04	27.25		−1.96	−2.28	1001	0.029	−0.07
					20	−2.00	−16.60		<0.001	
		Study 2	19.02	10.68		−2.98	−5.95	453	<0.001	−0.28
					20	−2.00	−10.07		<0.001	
		Study 3	19.49	15.19		−2.51	−5.23	1000	<0.001	−0.17
					20	−2.00	−14.53		<0.001	
Next 9%	53	Study 1	34.05	51.21		−18.95	−11.72	1001	<0.001	−0.37
					27	−26.00	−22.89		<0.001	
		Study 2	31.98	26.72		−21.02	−16.76	453	<0.001	−0.79
					27	−26.00	−16.48		<0.001	
		Study 3	31.86	27.78		−21.14	−19.42	1000	<0.001	−0.76
					26	−27.00	−23.10		<0.001	
Top 1%	269	Study 1	95.10	221.74		−173.90	−24.83	1001	<0.001	−0.78
					40	−229.00	−23.64		<0.001	
		Study 2	67.49	113.70		−201.51	−37.76	453	<0.001	−1.77
					42	−227.00	−17.57		<0.001	
		Study 3	90.36	191.02		−178.64	−29.59	1000	<0.001	−0.93
					40	−229.00	−23.63		<0.001	

Table 3
Comparison of Gini-coefficient and ratios between bottom 50% and the other groups for estimated vs. actual distribution.

Actual			Estimated			Deviation				
			M	*SD*	*Median*	*Δ*	*t*	*df*	*p*	*d*
Ratio	2.20	Study 1	1.86	1.18		−0.34	−9.11	994	<0.001	0.29
Bottom 50%-Middle 40%					1.50	−0.70	−17.85		<0.001	
		Study 2	1.98	1.60		−0.22	−2.92	451	0.004	0.14
					1.50	−0.70	−10.69		<0.001	
		Study 3	1.97	1.37		−0.23	−5.21	991	<0.001	0.17
					1.56	−0.64	−14.71		<0.001	
Ratio	5.30	Study 1	3.50	4.82		−1.80	−11.76	994	<0.001	0.37
Bottom 50%-Next 9%					2.45	−2.85	−20.79		<0.001	
		Study 2	3.76	4.61		−1.54	−7.10	451	<0.001	0.33
					2.40	−2.90	−12.75		<0.001	
		Study 3	3.88	7.88		−1.42	−5.67	991	<0.001	0.18
					2.50	−2.80	−19.51		<0.001	
Ratio	26.90	Study 1	12.20	36.76		−14.70	−12.61	994	<0.001	0.40
Bottom 50%-Top 1%					4.00	−22.90	−21.91		<0.001	
		Study 2	11.07	49.24		−15.83	−6.83	451	<0.001	0.32
					3.81	−23.09	−15.55		<0.001	
		Study 3	12.88	40.36		−14.02	−10.94	991	<0.001	0.35
					4.00	−22.90	−21.23		<0.001	
Gini-coefficient	0.38	Study 1	0.21	0.14		−0.17	−37.51	1001	<0.001	1.18
					0.18	−0.20	−23.59		<0.001	
		Study 2	0.21	0.14		−0.17	−10.98	452	<0.001	1.19
					0.17	−0.21	−16.06		<0.001	
		Study 3	0.21	0.15		−0.17	−34.81	999	<0.001	1.10
					0.18	−0.20	−23.20		<0.001	

and household income predicted smaller deviations from the actual carbon footprints which resulted mostly from more accurate estimations for the top 1%. More conservative political views were associated with larger deviations, in particular for the top 1%. The belief that climate change is happening, the belief that climate change is human caused, the perception of scientific consensus on climate change, and worry about climate change were all associated with smaller deviations from the actual carbon footprints overall and in particular for the top 1% and next 9% of consumers.

3.2. People wish for less inequality in carbon footprints

Participants indicated that the distribution of carbon footprints should have been more equal. The large representative sample in Study 1 indicated that the carbon footprint of the bottom 50% should have been larger than it actually is ($M_{Ideal} = 10.94$, $SD = 6.28$, $b = 0.94$ [0.55; 1.33], $t(997) = 4.72$, $p < .001$, Cohen's $d = 0.15$). In contrast, according to participants, the carbon footprints of all other groups should have been substantially lower than they actually are. The effect was largest for the top 1% ($M_{Ideal} = 28.23$, $SD = 28.46$, $b = -240.77$ [−242,54;

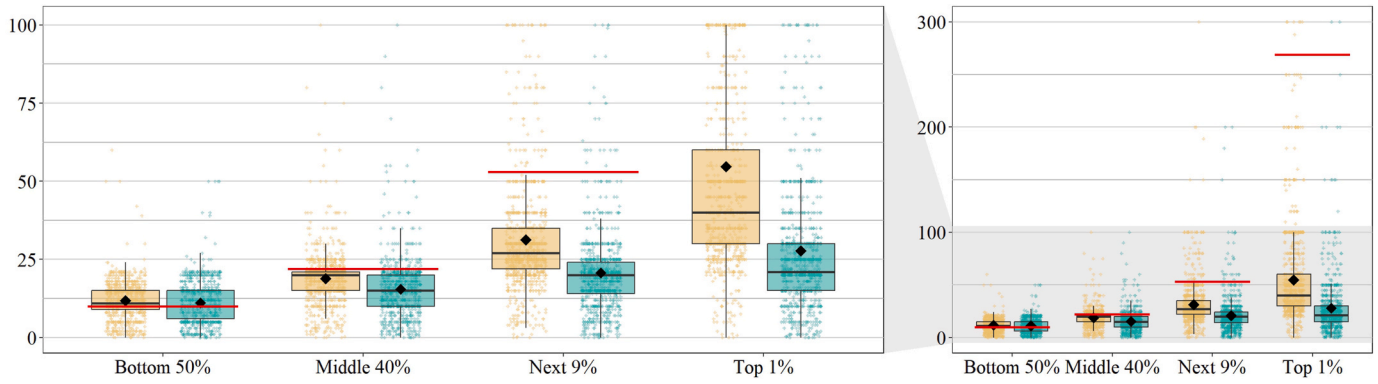

Fig. 1. Estimated (yellow) and ideal (green) carbon footprint for one person from the bottom 50%, the middle 40%, the next 9%, and the top 1% of consumers in Study 1. Diamonds depict the mean values, black horizontal lines indicate the median, the box contains the middle 50% of estimates, whiskers extend from the hinge to the largest value no further than 1.5 times the inter-quartile range. Red horizontal lines display the actual carbon footprint according to the World Inequality Report (Chancel et al., 2022). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 4
Meta-analytical correlations between demographic variables and climate change beliefs with the deviation of estimates from the actual carbon footprints ($k = 3$, $N = 2457$).

Deviation	Bottom 50%	Middle 40%	Next 9%	Top 1%	Overall
Age	−0.04*	0.02	−0.04	0.02	0.003
Gender (male)	0.006	−0.03	−0.04*	−0.09*	−0.06**
Education	−0.08***	−0.02	−0.03	−0.10***	−0.10***
Household income	−0.03	−0.04*	−0.03	−0.04*	−0.05*
Political views (conservative)	0.03	0.02	0.04	0.10***	0.09***
Belief in climate change	−0.04	−0.05*	−0.09***	−0.13***	−0.12***
Human caused climate change	−0.02	−0.02	−0.05*	−0.10***	−0.08***
Scientific consensus	−0.01	−0.01	−0.06**	−0.10***	−0.08***
Worry about climate change	−0.03	−0.01	−0.07***	−0.09***	−0.07***

Note. Deviation depicts the absolute difference between the estimated and actual numbers. The overall deviation was calculated as the sum of the absolute differences between estimated and actual numbers across the four groups. Climate change beliefs are scaled so that higher numbers represent higher endorsement of the constructs (e.g., more worry about climate change). Thus, a negative value indicates that higher endorsement of the construct is associated with a lower deviation from the actual numbers. *$p < .05$, **$p < .01$, ***$p < .001$.

−239.00], $t(997) = -267.30$, $p < .001$, Cohen's $d = 8.46$), followed by the next 9% ($M_{Ideal} = 20.48$, $SD = 15.18$, $b = -32.52$ [−33.46; −31.58], $t(997) = -67.67$, $p < .001$, Cohen's $d = 2.14$), and still large for the middle 40% ($M_{Ideal} = 15.35$, $SD = 8.83$, $b = -6.65$ [−7.20; −6.10], $t(997) = -23.81$, $p < .001$, Cohen's $d = 0.75$).

We also compared participants ideal distribution of carbon footprints to their estimated distribution. Participants indicated that the carbon footprint of all groups should have been smaller in comparison to what they estimated it to be. This effect was smallest for the bottom 50% of the consumption distribution ($b = -1.71$ [−2.98; −0.44], $t(997) = -2.63$, $p = .009$, Cohen's $d = 0.08$), larger for the middle 40% ($b = -4.67$ [−6.36; −2.98], $t(997) = -5.42$, $p < .001$, Cohen's $d = 0.17$) and next 9% ($b = -13.34$ [−16.47; −10.22], $t(997) = -8.37$, $p < .001$, Cohen's $d = 0.27$), and largest for the top 1% ($b = -63.94$ [−76.87; −51.01], $t(999) = -9.71$, $p < .001$, Cohen's $d = 0.31$).

In Study 2, we replicated the pattern that participants wished for a more equal distribution of consumption. In particular, participants indicated that the carbon footprint of the bottom 50% should have been larger than it actually was ($M_{Ideal} = 10.80$, $SD = 6.31$, $b = 0.80$ [0.21; 1.38], $t(452) = 2.69$, $p = .007$, Cohen's $d = 0.13$). In contrast, according to participants, the carbon footprints of all other groups should have been substantially lower than they actually are. The effect was largest for the top 1% ($M_{Ideal} = 31.53$, $SD = 43.87$, $b = -237.47$ [−241.52; −233.42], $t(452) = -115.20$, $p < .001$, $d = 5.41$), followed by the next 9% ($M_{Ideal} = 21.14$, $SD = 14.08$, $b = -31.86$ [−33.16; −30.56], $t(452) = -48.17$, $p < .001$, Cohen's $d = 2.26$), and still large for the middle 40% ($M_{Ideal} = 15.31$, $SD = 8.43$, $b = -6.69$ [−7.47; −5.92], $t(452) = -16.90$, $p < .001$, Cohen's $d = -0.79$). Participants also indicated that the carbon footprint of all groups should have been smaller than they estimated it to be. The effect was smallest for the bottom 50% ($b = -1.04$ [−1.54; −0.53], $t(452) = 4.06$, $p < .001$, Cohen's $d = 0.19$), larger for the middle 40% ($b = -3.71$ [−4.49; −2.92], $t(452) = 9.29$, $p < .001$, Cohen's $d = 0.44$), next 9 % ($b = -10.86$ [−13.14; −8.58], t(452) = 9.36, $p < .001$, Cohen's $d = 0.44$), and top 1% ($b = -36.04$ [−46.17; −25.92], $t(452) =$, $p < .001$, Cohen's $d = 0.33$).

In Studies 1 and 2 we compared the Gini-coefficient as well as the ratios between the bottom 50% of consumers and the three other groups as additional measures of inequality for the actual versus ideal numbers. All measures indicated less inequality in the ideal distribution compared to the actual distribution (see Table 5). We did not preregister a cutoff for the questions about ideal consumption, but for analyses involving the mean, we excluded participants who indicated ideal carbon footprints of 1000 or more for any of the groups or a ratio larger than 1000 because otherwise very few observations distorted the results.

Exploratory analyses did not reveal any substantial or consistent correlations between what people consider an ideal distribution of carbon footprints and demographic variables or climate change beliefs.

3.3. Learning about carbon inequality and climate action

We conducted two experimental studies in which participants were randomly assigned to one of two conditions: In the Information condition, they learned about carbon inequality by seeing an animated graph with the carbon footprints of one person from the bottom 50%, the middle 40%, the next 9%, and the top 1% of consumers (see

Table 5
Comparison of Gini-coefficient and ratios between bottom 50% and the other groups for ideal vs. actual distribution.

Actual			Ideal			Deviation				
			M	*SD*	*Median*	*Δ*	*t*	*df*	*p*	*d*
Ratio	2.20	Study 1	1.57	0.75		−0.63	−26.44	990	<0.001	0.84
Bottom 50%-Middle 40%					1.40	−0.80	−22.15		<0.001	
		Study 2	1.67	1.41		−0.53	−7.99	448	<0.001	0.38
					1.38	−0.82	−14.64		<0.001	
Ratio	5.30	Study 1	2.26	1.89		−3.04	−50.58	990	<0.001	1.61
Bottom 50%-Next 9%					1.72	−3.58	−25.10		<0.001	
		Study 2	2.55	2.90		−2.74	−20.07	448	<0.001	0.95
					1.80	−3.50	−16.28		<0.001	
Ratio	26.90	Study 1	3.43	5.44		−23.47	−135.77	990	<0.001	4.31
Bottom 50%-Top 1%					2.08	−24.82	−26.77		<0.001	
		Study 2	4.21	9.51		−22.69	−50.53	448	<0.001	2.39
					2.33	24.57	−17.88		<0.001	
Gini-coefficient	0.38	Study 1	0.13	0.12		−0.25	−68.13	1001	<0.001	2.15
					0.11	−0.27	−26.87		<0.001	
		Study 2	0.14	0.12		−0.24	−40.89	452	<0.001	1.92
					0.12	−0.26	−17.82		<0.001	

Supplementary Information). In the Control condition, they did not receive this information.

In line with our hypothesis, participants in Study 3 who had been exposed to the distribution of carbon footprints reported higher support for carbon taxes (analyzing the average of three items; $M = 3.84$, $SD = 1.07$) compared to participants in the control condition who had no information on the distribution of carbon footprints ($M = 3.64$, $SD = 1.11$; $b = 0.20$ [0.07; 0.34], $t(999) = 2.99$, $p = .003$, Cohen's $d = 0.19$; see Fig. 2, Study 3).

Specifically, receiving information on carbon inequality increased support for a tax on all polluting purchases ($b = 0.20$ [0.04; 0.36], $t(999) = 2.48$, $p = .013$, Cohen's $d = 0.16$) and a carbon tax that targets individuals with high carbon footprints ($b = 0.30$ [0.15; 0.46], $t(994.58) = -3.81$, Cohen's $d = 0.24$). Support for a tax on returns from investments in fossil fuel intensive industries did not differ significantly between experimental conditions ($b = 0.11$ [0.04; 0.26], $t(999) = -1.44$, $p = .151$, Cohen's $d = 0.09$). There were no significant differences between Information condition and Control condition on intentions to change their individual behavior (e.g., limit driving, limit meat consumption), general motivation to act, personal efficacy, or personal responsibility beliefs (all $ps \geq .125$). Further, we did not find evidence that the effects of experimental condition on any outcome were moderated by household income, education, political orientation, or climate change beliefs (all $ps \geq .130$).

In Study 4, unlike Study 3, participants were not asked to estimate the distribution of carbon footprints before being assigned to an experimental condition. This approach was implemented to prevent any potential bias that might result from participants forming initial assumptions about the distribution upon being prompted to estimate it. This also mirrors a real-life scenario where individuals encounter information about carbon inequality, for example through a newspaper article. Typically, a reader would not have speculated on carbon footprints prior to encountering the actual figures in the article. In this study, we replicated the effect that support for carbon taxes averaged across the three items was higher in the Information condition ($M = 3.79$, $SD = 1.06$) compared to the Control condition ($M = 3.45$, $SD = 1.15$; $b = 0.34$ [0.23; 0.46], $t(1392.76) = 5.79$, $p < .001$, Cohen's $d = 0.31$; see Fig. 2, Study 4) with larger effects sizes compared to Study 3. Receiving information on carbon inequality increased support for a tax on all polluting purchases ($b = 0.23$ [0.10; 0.37], $t(1401) = 3.35$, $p < .001$,

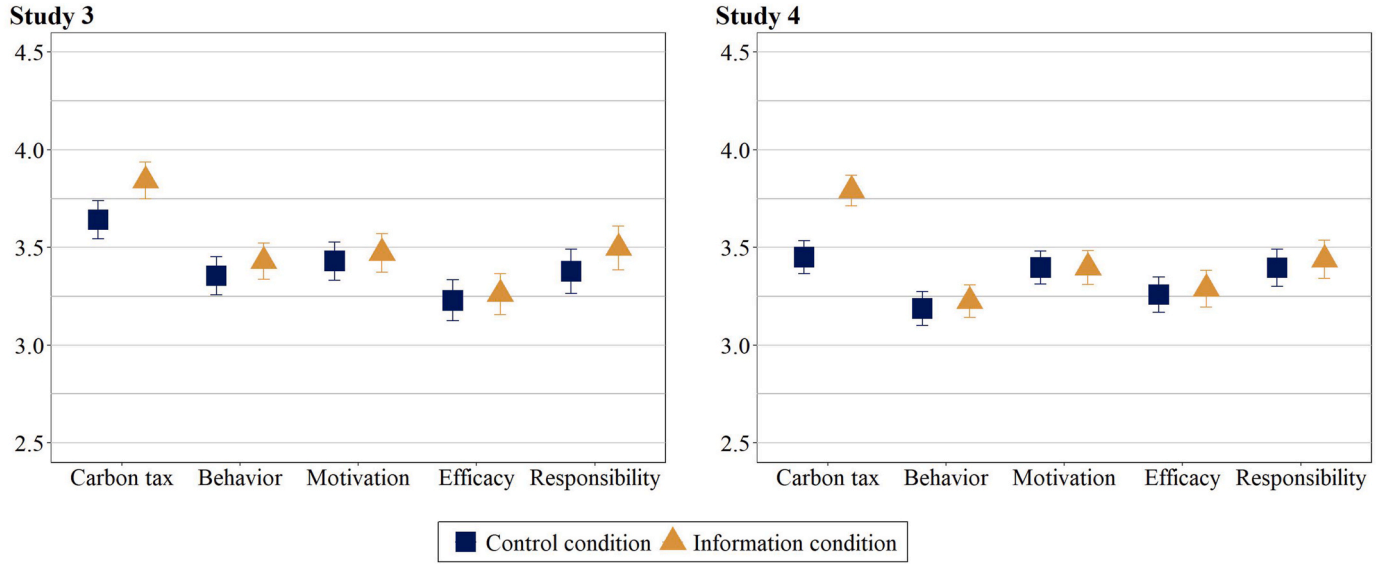

Fig. 2. Average support for carbon taxes, intentions to change individual behaviors, general motivation to act, personal efficacy beliefs, and personal responsibility beliefs depending on whether participants learned about the actual distribution of consumption ("Information condition") or not ("Control condition"). Bars represent 95% confidence intervals.

Cohen's $d = 0.18$), for a carbon tax that targets individuals with high carbon footprints ($b = 0.55$ [0.42; 0.69], $t(1387.86) = 7.89$, Cohen's $d = 0.42$), and for a tax on returns from investments in fossil fuel intensive industries ($b = 0.24$ [0.11; 0.37], $t(1394.39) = 3.62$, $p < .001$, Cohen's $d = 0.19$). As in Study 3, there were no significant differences between the experimental conditions on intentions to change individual behavior, general motivation to act, personal efficacy, or personal responsibility beliefs (all $ps > .122$). Further, we again found no evidence that the effect of the experimental condition on any outcome was moderated by household income, education, political orientation, or climate change beliefs (all $ps \geq .100$).

4. Discussion and conclusion

Across several studies we found robust evidence that US residents are largely unaware of the substantial carbon inequality within their country. In particular, the carbon footprint of the poorest 50% is slightly overestimated, while the carbon footprint of all other consumers is substantially underestimated. Our results mirror those found in another series of studies across different economically diverse countries that was recently published (Nielsen et al., 2024), providing evidence for the robustness of this effect.

At the same time, people wish for a more equal distribution of consumption both in comparison to what the distribution actually is and to what people estimate it to be, although only a minority suggested equal levels of consumption for all. This has important implications also for the debate around climate justice: US residents mostly agree with a distribution that allows some individuals to emit more than others, but they clearly disagree with the extent of inequality in carbon footprints that is reality at the moment.

Learning about the substantial carbon inequality increased support for carbon taxes. Here, we found small-to-medium effect sizes (Funder & Ozer, 2019)—occurring across a range of demographic variables and climate change beliefs. Thus, educating people about the existence of substantial carbon inequality should increase support for mitigation measures in large parts of the population. Importantly, we did not find evidence that learning about carbon inequality decreased intentions to change individual behaviors, general motivation to act, personal efficacy, or personal responsibility beliefs.

Our results thus complement findings showing that perceiving economic inequality can increase support for structural (vs. individual level) mitigation measures (Klebl & Jetten, 2023). In the present studies, we assess system-level change (i.e., carbon taxes) and individual-level change separately and find that system-level change increases while individual-level outcomes remain unchanged. Thus, educating people about inequality in consumption seems to be an effective tool to increase support for restrictive climate policies.

Some limitations of the present studies should be acknowledged. Technically, we used the average within each group as a comparison while the instructions referred to "one person" to reduce complexity. Providing specific estimates of carbon footprints for different segments of the population is arguably a challenging task, which is also reflected in the huge variability of absolute numbers provided. Possibly, a longer explanation and a comprehension check could have heightened people's understanding of the footprint concept and the method used to assess it in the World Inequality Report (Chancel et al., 2022). Importantly, however, beyond deviating from the actual numbers, it is the inequality in the distribution and the relations between top and bottom consumers that are misperceived in a very consistent pattern.

We want to acknowledge that our studies remain silent on the specific psychological processes leading to the substantial misperception of the distribution of carbon footprints. It has been shown that people often misperceive the role of economic wealth on carbon emissions and associated consequences like global warming (Andretti et al., 2024). Associating poverty with pollution and wealth with green technologies might explain the overestimation at the bottom and the underestimation at the top. On a different note, recent research points at basic cognitive processes at work: People overestimate small numbers, and underestimate large numbers (Landy et al., 2018). In this respect, it has been shown that people overestimate the small proportions of their fellow citizens who are immigrants, Muslim, LGBTQ, and Latino, but underestimate the large proportion of those who are White or Christian—above and beyond xenophobia or media bias (Landy et al., 2018). Applied to carbon inequality, the results of the present work might reflect this very general pattern of human psychology: People overestimate the carbon footprints of the bottom 50% of consumers and underestimate the carbon footprints of the top 1%. However, even if the estimations are based on such a general cognitive pattern of human psychology, our results still capture people's (mis)perception and preferences surrounding carbon inequality. Likewise, irrespective of the cognitive origins of people's misperceptions of carbon inequality, our results show that correcting these wrongly held beliefs leads to increased support for restrictive climate policies.

In a similar vein, our studies remain silent on the specific psychological processes leading to increased support for carbon taxes after having learnt about the substantial carbon inequality. It might well be that injustice concerns play a role. Perceiving inequality might not automatically lead to support for redistribution, as people might justify existing inequalities (Hing et al., 2019). However, learning that the actual distribution far exceeds what people consider "ideal" might motivate support for measures against overconsumption. Future studies need to explore this idea in more detail.

Importantly, if justice concerns do play a role, the implemented measures (i.e., carbon taxes) should be designed in a way that addresses inequalities. Although consumers with larger carbon footprints pay a larger absolute amount of carbon taxes, these taxes are often unsuccessful in reducing inequalities (Andersson & Atkinson, 2020). Another way to look at this is by noticing that the misperception of carbon footprints was largest for the top 1% of consumers. Thus, learning about carbon inequality might direct attention towards top consumers and might particularly increase support for policies that target this group, for instance, by increasing taxes on private jets or frequent flyers (Chancel, 2022). In line with this, our research revealed that educating people about consumption inequality leads to greater support for a carbon tax specifically aimed at individuals with high carbon footprints, compared to a general carbon tax applied to all polluting purchases. On the other hand, we only found small effects for a carbon tax on returns from investments in fossil-fuel intensive industries even when this was described as one of the drivers of the high carbon footprint by the top 1%. Future research could benefit from more systematically varying the outcome measures (e.g., in terms of who is targeted, which behavior is targeted, through which channel) and to assess the consequences people attribute to these measures. This approach would be useful in determining which carbon mitigation strategies could gain more public support when people learn about carbon inequality.

Overall, the current set of studies *quantified* the substantial extent to which US residents underestimate the inequality in the distribution of carbon footprints, while showing that educating about carbon inequality increased support for restrictive climate policies like carbon taxes. In this regard, the present research opens a new avenue in research studying the perception of the carbon footprint of the poor and the rich and its relations to climate policy support.

CRediT authorship contribution statement

Laila Nockur: Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Sergio Pirla:** Writing – review & editing, Formal analysis, Conceptualization. **Stefan Pfattheicher:** Writing – review & editing, Methodology, Conceptualization.

Competing interests statement

The authors declare no competing interests.

Acknowledgements

This research was funded by a Starting Grant from Aarhus University's Research Foundation awarded to the first author.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2025.102545.

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