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Is it up to them?

Individual leverages for sufficiency

Sufficiency is one important strategy for sustainable development. At an individual level, we need a better understanding of the relationship between sufficiency attitude and CO_2 footprint. In this paper, we analyze sufficiency as a psychological determinant of low-carbon lifestyles and introduce an empirical measurement scale for individual sufficiency attitudes.

Caroline Verfuerth, Laura Henn, Sophia Becker

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Abstract
Sufficiency aims at a total reduction of resource consumption, which is urgently needed to achieve our climate and sustainable development goals. This paper explores individual attitude towards a sufficiency-oriented lifestyle as a driver of a low carbon footprint. Survey data of 310 participants was analyzed to test whether individual sufficiency attitude manifests in people's carbon footprint. The results provide evidence for this relationship but its strength varies between behavioral domains – that is, heating, electricity, food consumption, everyday mobility, air travel. Potential structural and individual barriers to reducing CO_2 emissions are discussed as possible factors that could explain differences between the behavioral domains. We argue that intrapersonal factors matter for sustainable lifestyles but that policy-making and structural change should complement and facilitate voluntary endeavors to achieve low-carbon lifestyles.

Keywords
carbon footprint, individual behavior, low-carbon lifestyles, sufficiency, sufficiency attitude scale

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Analyzing individual sufficiency attitude as a driver of low-carbon lifestyle

"The term 'environmental problem' exposes a fundamental misconception: disruptions of Earth's ecosystems are at their root a human behavior problem" (Amel et al. 2017, p. 275). In Western societies such as Germany, billions of consumer choices are made by individuals every day. The aggregated impact of individual consumer behavior is both impressive and terrifying: 633 million tons of CO_2 emissions in 2015, which corresponds to a third (33.6 percent) of Germany's total (Destatis 2019, p. 9). While most experts agree that the current consumer behavior is highly problematic and change would have significant positive impact (Wynes and Nicholas 2017), there is less consensus on how to change behavior towards sustainable lifestyles. A central source of disagreement is the question about how lifestyle changes will come about: is it a matter of policies or individuals' efforts?

The distinction into three strategies for sustainable development – efficiency, consistency and sufficiency – presents a valuable guideline to reduce CO_2 emissions (Siebenhüner 2003). Technological innovation (i. e., efficiency) and the trend towards circular economies (i. e., consistency) are important steps to alleviate the pressure on natural resources but they often focus on *relative* consumption reductions and have limitations such as rebound effects (e. g., Buhl et al. 2017, Becker 2019). Sufficiency aims at a *total* reduction of resource consumption, which is urgently needed for sustainable development (Stengel 2011).

The sufficiency strategy builds on the idea that individuals voluntarily reduce their level of material consumption (Stengel 2011). The sufficiency concept meanders between a political strategy, a degrowth system-change (Kallis et al. 2012), and a nonmaterialistic individual attitude or lifestyle. While we acknowledge the importance of the first two perspectives, this paper focuses on individual sufficiency as an attitude. We explore opportunities to reduce CO_2 emissions at an individual level by analyzing attitude as a driver of low-carbon behaviors; however, we do not suggest that the responsibility for sustainable lifestyles merely lies on individuals.

Sufficiency behavior depends to a large degree on behavior opportunities defined by the context (e. g., infrastructure). For exam-

ple, public transport use depends on the availability and quality of a public transport system. While previous research has explored concepts associated with a sufficiency-oriented lifestyle such as voluntary simplicity (Hunecke 2005), empirical evidence of such lifestyles' influence on CO_2 emissions is scarce. However, to facilitate a transformation towards a more sustainable society a better understanding of the relationship between individual sufficiency and CO_2 emissions is crucial. In this paper we explore how a positive attitude towards a sufficiency-oriented lifestyle manifests in the individual carbon footprint and how this relationship differs between behavioral domains.

Sufficiency as a psychological determinant of individual CO_2 impact

The sufficiency strategy at the individual level aims at reducing resource consumption through a lower demand for consumer goods and services (Siebenhüner 2003). In this paper, we conceptualize sufficiency as a person's evaluation of a sufficiency-oriented lifestyle. The extent of a person's sufficiency attitude determines the extent to which he or she acts upon the attitudinal goal (Kaiser et al. 2010). Accordingly, the extent of sufficiency attitude determines the probability for a person to overcome obstacles of sufficiency behaviors, which can be expected to result in a more sufficiency-oriented lifestyle (Kaiser et al. 2010). Following Kaiser et al. (2010), individual behavior depends on two factors: 1. individual attitude – the extent to which a person favors a behavioral goal (e.g., having a low-carbon lifestyle) – and 2. difficulty of the behavior – a composite of behavioral costs (e.g., financial costs, effort). On this basis, we assume that a person with a high level of sufficiency attitude will engage in a wide range of sufficiency behaviors, which, we argue, cumulate to a lower individual carbon footprint (Henn et al. 2019).

Carbon footprint of individual lifestyles

The carbon footprint (hereafter CO_2 footprint) measure estimates emissions of CO_2 equivalents based on individual lifestyle choices (e.g., size of living space, mobility behavior, diet). Overall, the environmental impact differs between behaviors; for example, taking the train instead of an airplane saves more resources than switching off lights when leaving a room. In this case the higher-impact behavior change is more difficult and, as we argue, requires a higher level of sufficiency attitude in order for people to engage with. Thus, we assume that a high level of sufficiency attitude may result in a lower CO_2 footprint. We further hypothesize that the strength of the correlation between sufficiency attitude and CO_2 footprint may vary between lifestyle domains, depending on the individual sphere of influence.

Sphere of influence of individual behavior choices

The CO_2 footprint reflects the relationship between individual behaviors and the structural context. CO_2 emissions caused by public infrastructure are beyond the individual sphere of influence and a constant in the footprint calculation. Other behaviors are within the sphere of influence. However, to reach very low CO_2 emissions, challenging behaviors (e.g., reducing meat consumption) need to be adopted. We argue that sufficiency attitude influences the behavior within the individual sphere of influence.

Where infrastructure and policies support low-carbon behavior, people's sphere of influence is relatively large and sufficiency attitude should have greater impact on people's CO_2 emissions. For example, Whitmarsh (2009) showed that people who have a concern for climate change would engage in recycling behavior for which infrastructures are in place; however, energy saving behaviors were mostly influenced by demographic variables like income or external factors such as renting a house. Not owning a house or having a lower income may result in people having fewer opportunities to perform energy saving investments (see, e.g., review by Kastner and Stern 2017) whereas recycling behaviors are unaffected by these sociodemographic factors. Similarly, affordability of and access to sustainable food influence diet choices, although a reduction in dietary CO_2 emissions can also be achieved through adopting a plant-based diet. This option is affordable and widely available for people and therefore within their sphere of influence. Hence, it could be argued that, while energy-related CO_2 emissions partially depend on external factors, dietary CO_2 emissions would likely be influenced by personal choice. On this basis we argue that sufficiency attitude has a greater effect on CO_2 domains where a person has greater sphere of influence (e.g., diet) than on those with a smaller sphere of influence (e.g., heating). To our knowledge, there has been no research that assessed the relationship between sufficiency at an individual level and CO_2 footprint.

Research goals

The aim of our study is threefold. First, we present an empirical approach to operationalizing individual sufficiency attitude with a self-report-based scale. Second, we test whether a higher level of sufficiency attitude correlates with a lower individual CO_2 footprint, and explore potential differences between the CO_2 footprint domains. Third, we discuss detected differences between CO_2 footprint domains. Our findings can inform policy-makers and practitioners by providing domain-specific evidence that supports policies which promote voluntary goals or structural change.

Method: procedure, sample, measures

To empirically investigate the relationship between sufficiency attitude and low-carbon behaviors, we conducted an online survey in Germany. A convenience sample was recruited via e-mail and *Facebook*. E-mails were sent out to e-mail lists within the university (i.e., students and staff), to other universities and to personal contacts. Further, participants were recruited through public *Facebook* groups in which a short description and a link to the survey were published. Participants completed the anonymous survey between May and June 2015. The survey took approximately 20 minutes to complete and participants could enter a prize draw for one of three Amazon vouchers each worth 20 euros.

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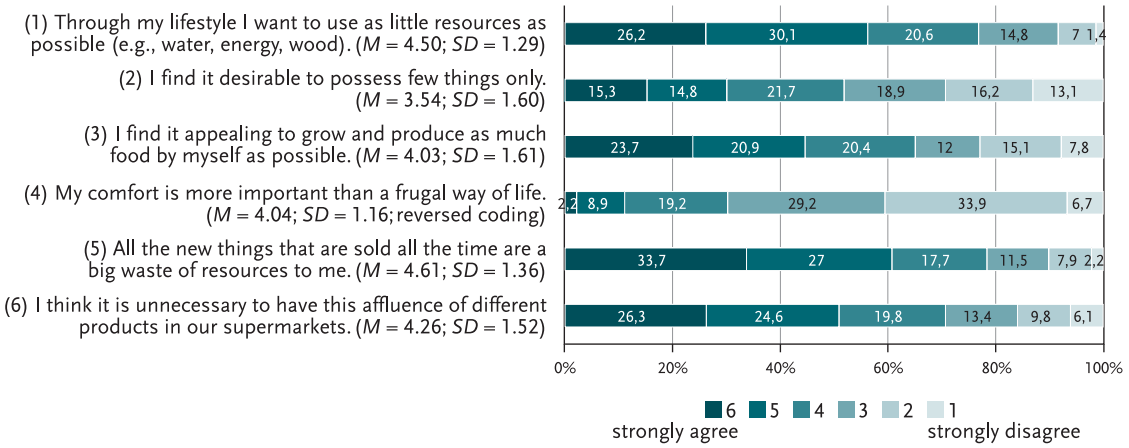

FIGURE 1: Relative response frequencies to the items of the sufficiency attitude scale. Item 4 was reverse-coded for the analysis. *M* = mean, *SD* = standard deviation.

The survey was completed by a total of 310 participants (N = 310; 69.5 percent female). Age ranged from 17 to 65 years (mean M = 27.0) with a relatively high education level (88.5 percent held A-levels and/or university degrees). The income was relatively low with the most frequent bracket of 500 euros to 1000 euros per month (37.5 percent) and below 500 euros or no income as the second most frequent group (27 percent). A further 15.2 percent had 1000 to 1500 euros, 7.3 percent 1500 to 2000 euros and 9 percent had more than 2000 euros (3.9 percent did not indicate their income). The majority of participants (86.1 percent) was renting an accommodation and 13.9 percent were homeowners. Most participants stated to live in apartment buildings (81.2 percent), while 7.5 percent of participants lived in a townhouse and 11.1 percent in a detached house. 43.2 percent of households reported to own at least one car (31.0 percent one, 12.2 percent two or more).

Attitude towards a sufficiency-oriented lifestyle was measured with a 6-item scale based on a master thesis (Henn 2013). The data presented in this paper is based on a master thesis by Verfuerth (2015). The six items of the sufficiency attitude scale cover a variety of statements about waste of resources, a frugal lifestyle and oversupply of consumer goods (figure 1). Participants were asked to state to what extent they agreed with the presented statements on a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree). The scale showed a good reliability with standardized Cronbach's α (alpha) is 0.83 (M = 4.18, standard deviation SD = 1.08) and sufficient variance (figure 1).

To test the incremental validity of sufficiency attitude in relation to conventional measures of pro-environmental orientation, we also assessed the New Ecological Paradigm (NEP) scale (Dunlap et al. 2000). The 8-items scale asked participants about their agreement (1 = strongly disagree to 7 = strongly agree) to statements on nature and humans' rights to deploy natural resources. The scale showed an acceptable reliability with alpha is 0.654 (M = 4.89, SD = 0.67, N = 337).

The CO_2 footprint was assessed using the questions of the *KlimAktiv* CO_2 footprint calculator.[1] The *KlimAktiv* CO_2 footprint calculator was co-developed by the German Environmental Agency (Öko-Institut 2015) and, at the time of the survey, among the most commonly used measures for individual CO_2 footprints in Germany and considered particularly user-friendly. Hence, the *KlimAktiv* CO_2 footprint calculator was considered suitable for our purpose. Responses were entered manually to the *KlimAktiv* calculator to calculate each individual CO_2 footprint.

Results

Next, we present the descriptive results for the sufficiency attitude scale and the CO_2 footprint, followed by an assessment of the relationship between both measures by using regression analysis while controlling for the NEP (Dunlap et al. 2000). This approach allowed us to test whether sufficiency attitude explains incremental variance of the CO_2 footprint better than a conventional measure of pro-environmental orientation (i.e., NEP).

Descriptive results for sufficiency and CO_2 footprint

Overall, most participants agreed to a certain extent with the sufficiency statements (figure 1). However, item 2 "I find it desirable to possess few things only" received the highest aggregated disagreement (combined responses "strongly disagree" and "disagree") of respondents (48 percent) compared with the other items, while item 5 "All the new things that are sold all the time are a big waste of resources to me" received the highest agreement by respondents (34 percent).

The average CO_2 footprints of our sample for the areas air travel, mobility, and household energy consumption differ slightly from the German average (figure 2; for comparability reasons, the *KlimAktiv* reference data is from 2015, same year as the survey). These differences are probably due to the overrepresentation of students in our sample; however, we can only speculate which sociodemographic factors (e.g., age, education, income) account for the differences. Importantly, given that the variance within each variable is sufficient, the validity of our results is not threatened by this sample bias as long as we focus on the relationship between

1 *KlimAktiv* CO_2-Rechner: *www.klimaktiv.de* (accessed September 5, 2015). All values based on data from 2015.

variables and refrain from generalizing our findings to the German population. Note that data for heating and electricity were only available as a combined measure in the *KlimAktiv* CO_2 footprint calculator; therefore, we aggregated our sample's footprints for heating ($M = 1.93$, $SD = 1.79$) and electricity ($M = 0.33$, $SD = 0.34$). In both our sample and the German average, household energy consumption makes up the largest share of the individual footprint. In our sample this area is followed by air travel, everyday mobility and diet, whereas, in the German average, air travel contributes the least.

Considerable differences between the CO_2 footprint domains and between participants can be observed (figure 2), indicated by large standard deviations in the domains air travel ($SD = 2.94$), everyday mobility ($SD = 2.71$), and household energy ($SD = 1.88$), as well as a small standard deviation in food ($SD = 0.39$).

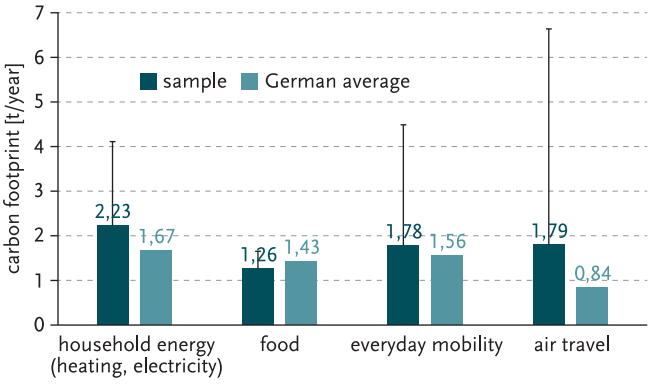

FIGURE 2: Average CO_2 footprint in tons per year (t/year) for the study sample (dark green) compared to the German average (light green; data retrieved from *Klimaktiv* CO_2 footprint calculator in 2015[1]).

Influence of sufficiency attitude on CO_2 footprint

To test our hypothesis that high levels of sufficiency attitude are reflected in lower individual CO_2 footprints, we first conducted correlation analyses for each of the CO_2 footprint domains (i.e., heating, electricity, everyday mobility, air travel, food) and the overall CO_2 footprint. We then conducted a regression analysis that included the NEP and sufficiency attitude as predictors of the CO_2 footprint. This allowed us to compare the predictive power of sufficiency attitude for each CO_2 footprint domain.

The correlation *(r)* between sufficiency attitude and CO_2 footprint describes the strength of the relationship between the attitude and the footprint (table 1, p. 378). A higher correlation value indicates a stronger relationship while a negative correlation value indicates a negative relationship (i.e., higher attitude means lower CO_2 footprint). Squared *r* (R^2) is the explained variance: if R^2 is X/100 the sufficiency attitude explains X percent of the CO_2 footprint's variation. As shown in table 1, the food-related CO_2 footprint had the strongest correlation: almost 30 percent of the food CO_2 footprint's variance is explained by sufficiency attitude. For the domains everyday mobility and electricity, sufficiency attitude accounted for about seven percent of the variance in CO_2 footprint, while air travel could not be explained with the individual sufficiency attitude, indicated by the nonsignificant correlation. For the heating CO_2 footprint, sufficiency attitude only explained 1.7 percent of the variance. Overall, 8.8 percent of the combined CO_2 footprint's variance was explained by individual sufficiency attitude, which supports our hypothesis that higher levels of sufficiency attitudes are related to lower individual CO_2 footprints.

Controlling influence of income and New Ecological Paradigm

To validate our measure of sufficiency, determine its incremental variance, and control for sociodemographic factors, we used multiple regression analysis to calculate the influence of the variable "income" and of NEP on the CO_2 footprint (table 2, p. 379). We first evaluated the model fit (a *p*-value < .05 indicates a high probability for a true result; Field 2013), which indicates that the used predictors significantly explain the variance of the footprint measure.

Second, we assessed the beta values to better understand which predictors explain the footprint variance better. Betas (β) indicate the weights of each predictor variable (income, NEP, sufficiency attitude) in explaining the CO_2 footprint, with positive betas indicating a positive relationship and negative ones indicating a negative relationship between the predictor variable and the CO_2 footprint. A significant beta value (i.e., with a *p*-value < .05) means that the variable explains a unique variance in the CO_2 footprint. Our results show positive beta values for income which means that a higher income is related to a higher CO_2 footprint, while the betas for sufficiency attitude are negative indicating that high sufficiency attitude are related to a lower CO_2 footprint. The NEP measure showed no significant betas for the domains which means that the NEP does not contribute to explaining the domain-specific CO_2 footprint when income and sufficiency attitude are included. For the total CO_2 footprint, all three predictors' betas become significant and thus they all contribute to the variance explanation.

Sufficiency attitude has the largest betas – and is therefore the strongest predictor[2] – for the domains electricity, food, everyday mobility, and the overall CO_2 footprint. The domains heating and air travel are significantly influenced by income, while sufficiency attitude and the NEP are not significant predictors.

When including the predictors income and NEP, the explained variance of the CO_2 footprint increased. More specifically, the explained variance of the domains air travel and everyday mobility increased from 0.8 percent to 3.5 percent and 7.5 percent to 8.3 percent respectively, with income being a significant predictor (table 2, p. 379). Income became the sole significant predictor of the heating-related footprint while sufficiency attitude was no longer significant. For the domains food and electricity use sufficiency remained the only significant predictor. Sufficiency attitude and income can be identified as the strongest predictors for the >

2 Beta values are standardized coefficients and are directly comparable (Field 2013).

TABLE 1: Average CO_2 footprint for behavioral domains and variance explained by sufficiency attitude. *M* (t CO_2e) is the mean CO_2 footprint in tons CO_2 equivalents. *SD* = standard deviation. *Variance explained by sufficiency attitude* is calculated as $r^2 * 100$. *r* = correlation. Public emissions are based on *KlimAktiv* reference data from 2015[1] and are a constant, therefore, no correlation is reported. a significance level $p < .05$; b significance level $p < .001$.

FOOTPRINT DOMAIN	*M* (t CO_2e)	*SD*	VARIANCE EXPLAINED BY SUFFICIENCY ATTITUDE [%]	*r*
heating	1.90	1.79	1.7	–.131[a]
electricity	0.33	0.34	7.2	–.268[b]
food	1.26	0.39	29.8	–.545[b]
everyday mobility	1.78	2.71	7.5	–.276[b]
air travel	1.79	2.94	0.8	–.087
public emissions	0.73	0.00	0	–
combined	9.79	8.09	8.8	–.296[b]

overall CO_2 footprint, while the NEP scale still accounts for a significant part of the variance. Overall, 13.4 percent of the CO_2 footprint's variance can be explained by the variables income, sufficiency attitude, and NEP (table 2) in comparison to 8.8 percent with sufficiency attitude alone (table 1).

Discussion

Overall, the results indicate that higher levels of sufficiency attitude are associated with a lower-carbon lifestyle; however, the influence of sufficiency attitude varies between domains. Notably, sufficiency attitude had explanatory power that outperformed a conventional measure of pro-environmental orientation (NEP; Dunlap et al. 2000). Income was identified as another important predictor that significantly contributed to explaining the CO_2 footprint in domains where sufficiency attitude was less dominant. groups occupy higher living space which may explain their higher heating CO_2 footprints. This constitutes an opportunity for sustainability policies to focus on changing these structural factors (e. g., via financial incentives or regulation) instead of targeting merely motivation or capability of people (Michie et al. 2011, Verfuerth et al. 2019).

Conversely, our results indicate that a policy approach that fosters individuals' sufficiency-orientation could be fruitful in reducing dietary CO_2 emissions. Here it seems that individuals have a greater sphere of influence and motivational factors such as sufficiency attitude translate into significantly lower CO_2 footprints. As such, by applying sufficiency principles to meat consumption a person can significantly reduce his or her dietary CO_2 footprint (Scarborough et al. 2014). Policies that use the "choice architecture" approach, such as nudging, offer easy and effective ways to support low-carbon diets. For example, changing the default in canteens by placing plant-based foods more prominently could effectively reduce people's dietary CO_2 emissions (Thaler and Sunstein 2009), and tailored campaigns that focus on people's motivation (Michie et al. 2011) could promote sufficiency-oriented food choices.

Applying sufficiency principles to the individual lifestyle can significantly reduce a person's carbon emissions – especially in the food domain where sufficiency attitude explained almost one third of the food CO_2 footprint.

Food and heating

The results show that sufficiency attitude has the strongest explanatory power in the food domain explaining almost one third of the food CO_2 footprint while the explanatory power of sufficiency attitude for the heating domain is rather weak. These results correspond with our argument that structural constraints can reduce people's sphere of influence and, therefore, reduce the influence of sufficiency attitude on CO_2 emissions such as those caused by heating. Moreover, while income significantly influences the heating CO_2 footprint, the influence of income on food-related emissions is negligible. To expand on this, we argue that, for instance, tenants who have limited power over the conditions of their house or apartment (e. g., building insulation) experience structural constraints. However, is has to be added that in average higher income

Everyday mobility and electricity

In the domains everyday mobility and electricity our results show only moderate influence of sufficiency attitude on the individual CO_2 footprint. Sufficiency attitude explained 7.5 percent of the individual mobility footprint and 7.2 percent of the electricity footprint. Everyday mobility behaviors and CO_2 emissions are subject to both internal factors including individuals' motivation and capabilities (e. g., sufficiency attitude), and external factors (e. g., infrastructure, carsharing options). These external factors lie out-

TABLE 2: Regression models including income, New Ecological Paradigm (NEP, Dunlap et al. 2000), and sufficiency attitude as predictors for the CO_2 footprint. *Variance explained* is calculated from the conventional regression model fit index R^2 by multiplying it by 100; it represents the percentage of variance of the footprint explained by all predictors (i.e., income, NEP, and sufficiency attitude). Regression weights that reach statistical significance are bold. *F*-values indicate the variability between group means, *p*-values indicate the significance of the results (significance level: $p \leq .05$). a Total footprint comprises heating, electricity, food, everyday mobility, air travel, and a constant of emissions for public infrastructure (in Germany: 0.73 tons per person year).

PREDICTORS	CO_2 FOOTPRINT HEATING		ELECTRICITY		FOOD		EVERYDAY MOBILITY		AIR TRAVEL		TOTAL[a]	
	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*
income	**.20**	.001	.07	.18	.09	.08	**.11**	.04	**.18**	.002	**.21**	<.001
NEP	–.10	.09	–.09	.10	–.06	.25	–.07	.25	–.09	.14	**–.11**	.05
sufficiency attitude	–.09	.13	**–.24**	<.001	**–.52**	<.001	**–.25**	<.001	–.05	.41	**–.25**	<.001
variance explained [%]	5.4		7.6		30.1		8.3		3.5		13.4	
model fit	$F(3, 304) = 6.74$, $p < .001$		$F(3, 304) = 9.32$, $p < .001$		$F(3, 304) = 44.57$, $p < .001$		$F(3, 304) = 10.12$, $p < .001$		$F(3, 304) = 4.72$, $p < .003$		$F(3, 304) = 16.67$, $p < .001$	

side the individual sphere of influence and are instead subject to policy-making. Nonetheless, capability constraints can include the lack of knowledge of how to successfully integrate alternative modes of transport into daily life. These challenges can be addressed through knowledge policies (Santos et al. 2010).

Air travel

Our results show that sufficiency attitude is not related to the individual CO_2 footprint of air travel. This is in line with previous studies showing that personal pro-environmental norms and attitudes cannot predict long-distance travel behavior (Barr and Prillwitz 2012). However, people could reduce their air travel intensity in three ways: they can 1. decide not to travel, 2. choose a (holiday) destination closer to their home that does not require air travel, or 3. choose more eco-friendly means of transport (e.g., train, boat) (Davison et al. 2014). Waiving air travel altogether requires a strong dedication to sufficiency and often conflicts with other life goals (e.g., gaining experience from travelling). Further constraints for alternatives to air travel may include perceived unfeasibility of a multiday journey or a limited availability of overnight trains. The decision to use an airplane is generally under individual control, but individuals' choices to travel by plane are catalyzed by factors including time and costs benefits compared with other travel modes and social narratives where (long-distance) travelling is a pleasant activity itself (Sheller and Urry 2006). Strategies to reduce aviation emissions could include demand reduction through consumers opting for trains instead of planes and a change in policy which could include a ban of airport extensions or higher kerosene taxation (Creutzig 2016).

Limitations and future research

While the empirical results of this study contribute to a better understanding of the influence of sufficiency attitude on individual CO_2 emissions, a number of limitations should be acknowledged:

First, the sample is biased towards higher average education and environmental concern due to an overrepresentation of students and environmentally interested people (i.e., self-selection bias in survey). The results are therefore not representative of the German population and thus not generalizable. Nonetheless, our findings shed light on the meaning of individual sufficiency attitude for low-carbon lifestyles. Future research should further explore the potential of sufficiency attitude for fostering low-carbon lifestyles and further validate the sufficiency attitude scale.

Second, the results from our study are correlational and allow no causal assumptions. Longitudinal studies or experiments are needed to better understand the direction of influence between sufficiency attitude and low-carbon lifestyles.

Third, with variance explanations below ten percent in all but one domain and with two domains (i.e., air travel and heating) being negligibly influenced by sufficiency attitude, we are far from arguing that our measure for sufficiency attitude will be the one crucial factor for a sustainable society. Nonetheless, the findings present a novel approach to link sufficiency attitude with the CO_2 footprint.

Future research should further investigate factors that affect people's sphere of influence such as a shift in social norms (e.g., flight shaming). Moreover, future research should account for individual rebound effects of emissions-reducing interventions, particularly with regards to differences between the CO_2 footprint domains and socioeconomic factors (e.g., income, homeowners vs. tenants). Buhl et al. (2017) suggest that behavioral triggers to rebound effects should be considered, which may include sufficiency attitude. Hence, future research could assess whether sufficiency attitude has the potential to reduce rebound effects.

Conclusion and implications

Our study demonstrated a relationship between individual sufficiency and behavioral consequences (i.e., CO_2 emissions) in different lifestyle domains. Furthermore, we showed that sufficien- >

cy attitude has more explanatory power on actual resource consumption than general pro-environmental orientation (as measured by the NEP). We further demonstrated that the influence of individual sufficiency attitude on resource-saving behaviors varies between different lifestyle domains. As such, our contribution can serve to design and evaluate well-tailored sufficiency policies to reduce behavioral barriers for a transition to a low-carbon future.

The implementation of a sufficiency strategy for sustainable development is required to complement technology-focused efficiency strategies (Stengel 2011) to change unsustainable lifestyles and achieve an overall reduction of resource consumption (Wynes and Nicholas 2017). With this paper we hope to contribute to a better understanding of low-carbon lifestyle by offering a psychological perspective for the definition of sufficiency and introducing an empirical measurement of sufficiency attitude at an individual level.

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