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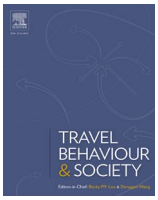

Emotions as antecedents of sustainable travel behaviour

Christian Bretter [a,b,*], Kate Pangbourne [a]

[a] Institute for Transport Studies, University of Leeds, LS2 9JT Leeds, UK
[b] UQ Business School, University of Queensland, Brisbane 4059, Australia

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ABSTRACT

Promoting the use of sustainable transport alternatives is critical for reducing carbon emissions. In this paper, we propose a cognitive mechanism that explains the extent to which individuals use different sustainable travel modes (e.g., the bus, train, bicycle, and car-sharing). Specifically, we hypothesise negative emotions related to cars as an antecedent of sustainable travel mode use where emotions such as shame, sadness, and upset are positively associated with the extent to which individuals use sustainable transport modes. These negative emotions are further hypothesised to mediate the effect of car attitudes on sustainable travel mode use. Using a broadly representative sample of the UK population (N = 1294), we test these hypotheses and find, firstly, that car attitudes are negatively associated with the use of all sustainable travel modes. Secondly, we demonstrate that negative emotions related to cars mediate this effect. In other words, negative emotions – and not car attitudes – are (positively) associated with the extent to which individuals use all sustainable travel modes. The more individuals perceive the car as something 'good', the less they experience emotions such as shame, sadness, and upset when thinking about cars; and it is these negative emotions that then drive sustainable travel mode use. Our study reveals that emotions can and should also be understood as antecedents of sustainable travel modes. We then discuss implications for practitioners and further research.

1. Introduction

The transportation sector is one of the major contributors to global greenhouse gas emissions and thus represents one significant challenge to tackling climate change (Lamb et al., 2021). Higher adoption rates of sustainable travel modes are crucial to promote a transition towards a more sustainable society. The (fossil-fuelled) car represents an obstacle for this transition: Consequently, individuals need to drastically increase the use of public transport and active transport modes to travel. Perhaps unsurprisingly, the Intergovernmental Panel on Climate Change (IPCC) has been advocating strongly for the reduction of using privately owned (fossil-fuelled) vehicles while demonstrating that riding buses, trains, or bicycles (and other alternatives) would lead to significant reductions in carbon emissions (IPCC, 2022; Jaramillo et al., 2022).

A lot of scholarly inquiries have thus focused on how to foster a transition towards such sustainable travel modes. Some rather focused on infrastructure (Cui et al., 2020; Friman et al., 2020; Javaid et al., 2020) while others focused on individual-level psychological determinants such as attitudes (Anable, 2005; De Vos et al., 2020, 2022; García et al., 2019). While we acknowledge the existence of engineering-based approaches, our aim here is to draw out a cognitive mechanism that helps to explain why individuals use sustainable travel modes, thus focusing our elaborations on psychological research. Grounded in the Theory of Planned Behaviour (TPB; Ajzen, 1991), attitudes have mostly been researched from an attitude-behaviour-alignment perspective, that is, attitudes towards certain travel modes have been shown to be able to explain the use of such travel modes. For example, Namgung and Akar (2014) showed that pro-bus attitudes are associated with the use of buses. However, given the predominance of the car in society (Sheller and Urry, 2006; Urry, 2004), one could also argue that car attitudes may be associated with the adoption of sustainable travel modes. In other words, an attitude-behaviour-misalignment may exist where attitudes do not need to be aligned with the behaviour of interest to have an effect. The first aim of this paper is to test this hypothesis via a large, broadly representative sample.

More recently, scholars have started to include emotions in their examinations of sustainable travel modes (Barría et al., 2023; Friman et al., 2017; Mouratidis et al., 2023). In such inquiries, emotions have been treated as outcomes of (sometimes anticipated) mode choices (Manca and Fornara, 2019). For example, Mouratidis et al. (2023) found

* Corresponding author at: Institute for Transport Studies, University of Leeds, LS2 9JT Leeds, UK.
E-mail address: c.bretter@uq.edu.au (C. Bretter).

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that emotions that arise *after* the mode choice has been made are associated with travel satisfaction. Although these findings are valuable, a significant body of knowledge exists in the environmental psychological literature that shows emotions can indeed be seen as an *antecedent* of environmental behaviour, that is, they *precede* mode choice (Harth et al., 2013; Schneider et al., 2021; Taufik and Venhoeven, 2019). The second aim of this paper is to build on this knowledge and test whether emotions can be understood as precursors to sustainable travel mode usage. Finally, the third aim of this paper is to test whether emotions mediate the relationship between car attitudes and sustainable travel mode choices, thus testing whether they are more important than attitudes in predicting sustainable mode choice. A mediator refers to a variable that explains the process through which two variables are related (Gonzalez and MacKinnon, 2021). Via testing this mediation, this paper's overarching aim is to draw out a cognitive mechanism that helps to explain people's use of sustainable travel modes.

We make three main contributions. First, although a lot of research on attitudes on travel mode choice exists, we show that car attitudes are systematically and negatively related to the frequency (and intentions) of using sustainable travel modes, thereby demonstrating that the dominance of the automobile in today's society results in indirect cognitive effects that relate to the adoption of sustainable travel modes. Second, using evidence from environmental psychology, we establish negative emotions related to cars as antecedents of sustainable travel mode choices. We therefore contribute to the literature by (a) showing that emotions may be one of the reasons why individuals engage with certain transport modes and (b) opening up various research directions that use emotions to promote the uptake of sustainable transport modes. Third, we show that negative emotions related to cars mediate the relationship between car attitudes and sustainable travel mode use, so that negative emotions – not attitudes- drive sustainable transport mode choice. This suggests that interventions that target emotions as the more proximate antecedent may be more promising in promoting sustainable transport modes than those that target such attitudes.

2. Literature review

2.1. Attitudes and transport mode choice

The Theory of Planned Behaviour (TPB; Ajzen, 1991) is one of the most frequently applied frameworks when studying how attitudes relate to travel mode choices (Ajzen, 2011). According to TPB, attitudes related to the behaviour (or object) of interest are associated with intentions to engage in that behaviour and, by extension, with the behaviour per se. For example, many studies found that attitudes toward cars are positively associated with car use (Kroesen, 2014; Kroesen et al., 2017; Olde Kalter et al., 2020; Paulssen et al., 2014). Similarly, attitudes towards sustainable travel modes such as pro-cycling attitudes have been associated with actual engagement in cycling (Arroyo et al., 2020). In general, there is an agreement that attitudes in favour of a given sustainable travel mode will be associated with the use of that particular travel mode, thereby demonstrating the importance of attitudes in explaining travel mode choice (De Vos, 2022).

Most studies examining attitudes measure them specifically to the construct of interest so that there is an alignment between attitudes and dependent variables, as suggested by TPB (see De Vos et al., 2020; Javaid et al., 2020). Although the main purpose of TPB is to explain a particular behaviour – and from that point of view it is reasonable to focus on behaviour-specific attitudes- it overlooks the possibility that certain attitudes can affect behaviour above and beyond the behaviour that is implied with the attitudes. Given that the car has manifested itself as the dominant mode choice and as a status quo across many countries (Sheller and Urry, 2006; Urry, 2004), pro-car attitudes may themselves affect the extent to which individuals use more sustainable travel modes such as the bus, train, or cycling. Importantly, research in environmental psychology shows that attitudes towards one behaviour can be related to other behaviours as well. Bretter et al. (2022), showed that attitudes against food waste are systematically related not only to self-reported food waste (as TPB would suggest), but also to various behaviours that reduce food waste, such as labelling or meal planning. Similarly, more general pro-environmental attitudes have been related to a range of different behaviours such as energy conservation or recycling (Sánchez et al., 2016). From this perspective, it may be reasonable to speculate that pro-car attitudes are not just related to car use as shown previously (Anable, 2005; Ramos et al., 2020), but that they are also negatively related to the use of sustainable travel modes.

Indeed, there is preliminary evidence in the transport literature that supports this notion. In an earlier qualitative study, Beirão and Sarsfield Cabral (2007) found pro-car attitudes to be negatively related to public transport use while, more recently, Arroyo et al. (2020) found that attitudes in favour of cycling and walking are negatively associated with using the car. Pro-walking attitudes also seem to be negatively associated with intentions to travel by car (García et al., 2019) and pro-cycling attitudes have been shown to be negatively associated with car use (Hamidi and Zhao, 2020). In addition, some findings from studies that tangentially relate to our purpose may offer further support. Several studies found that car owners may hold different attitudes towards public transport than car non-owners (de Oña et al., 2021; Olde Kalter et al., 2020; Tao et al., 2019). Similarly, public transport users have been shown to hold different attitudes towards public transport than car users (Şimşekoğlu et al., 2015). Overall, evidence from environmental psychology and preliminary findings from the transport literature support our notion that pro-car attitudes may be associated with the frequency (and intentions of) using sustainable travel modes. We therefore build on the existing literature and hypothesise:

H_1: *Pro-car attitudes are negatively associated with frequencies (or intentions) of using sustainable transport modes.*

2.2. Emotions in transportation research

Emotions, understood as powerful motivators that drive (environmental) behaviour, have been incorporated into environmental psychological research for some time (Schneider et al., 2021; Taufik and Venhoeven, 2019). In one of the earlier studies, Carrus et al. (2008) found that negative emotions are associated with more pronounced recycling behaviour. Subsequent research has replicated these findings. The negative emotion of guilt, for instance, has been shown to be associated with wasting less food (Russell et al., 2017) and with environmental protection (Harth et al., 2013). Emotions have also been associated with actual green behaviour such as petition signings (Rees et al., 2015) and with intentions to conduct various environmental behaviours (De Miranda Coelho et al., 2016; Jabeen et al., 2023).

Although such general environmental psychological research has shown that emotions can be seen as underlying motivations for engaging in particular behaviours (Schneider et al., 2021), transportation research has mostly treated emotions as outcomes of travel mode decisions (Souche-Le Corvec and Zhao, 2020). For example, Mouratidis et al. (2023) found that when people use their preferred travel mode, they experience more positive emotions. Morris and Guerra (2015) examined how travel affects emotional experiences and found that public transport users experience negative emotions the most as a result of their travel choices. This has also been found in other studies (Carrus et al., 2008). Another example of how emotions have been treated as outcomes in transportation research is the study by Böcker et al. (2016) who have shown that nicer weather is associated with more positive emotions during travel. More recently, Barría et al. (2023) developed a framework to better understand mode choice and again conceptualised emotions as outcomes of travel mode choice rather than as determinants.

By integrating environmental psychological research with transportation research, we conceptualise emotions as antecedents – not as outcomes – of sustainable travel mode choices. Here, we focus on

negative emotions, given their central role in environmental psychological research, and that they seem to correlate more strongly with sustainable travel modes than positive emotions (Carrus et al., 2008). Aligned with findings of past research (Passafaro et al., 2014), we hypothesise an attitude-affect relationship. Specifically, we hypothesise that pro-car attitudes are negatively associated with (negative) emotions related to the car:

H_2: *Pro-car attitudes are negatively associated with negative emotions related to cars.*

A lot of research has found a positive association between negative emotions and various pro-environmental behaviours. For example, Liang et al. (2019) found that the more individuals experienced negative emotions, the higher were their green purchasing intentions. Moreover, negative emotions have been found to be positively associated with pro-environmental behavioural intentions (Onwezen et al., 2013) green petition signings (Rees et al., 2015), with fewer donations to environmentally damaging causes (Ibanez and Roussel, 2021), less food waste (Jabeen et al., 2023), and higher degrees of water conservation (De Miranda Coelho et al., 2016). Aligned with this evidence, we also hypothesise a positive association between negative emotions related to cars and sustainable travel mode choices:

H_3: *Negative emotions related to cars are positively associated with frequencies (or intentions) of using sustainable transport modes.*

Attitudes and emotions, however, may not be associated with sustainable travel mode choices simultaneously. Instead, it may be that pro-car attitudes, for example, give rise to particular emotions related to cars, which then affect sustainable travel mode choice. Therefore, emotions might mediate the effect of attitudes on, in our case, sustainable travel mode choice (see Holbrook and Batra, 1987). Indeed, emotions have been shown to mediate the effects of attitudes on environmental behaviours. For example, Passafaro et al. (2014) have demonstrated that negative emotions are the most direct predictor of environmental behaviours and that attitudes only have an indirect effect via emotions. Similarly, Onwezen et al. (2013) also found that emotions play a mediating role in predicting environmental behaviours. Other psychological research has further demonstrated that emotions mediate the effect of attitudes on behaviour (Hynie et al., 2006). We therefore hypothesise that negative emotions related to cars mediate the effect of pro-car attitudes on sustainable travel mode choice. In other words, we hypothesise that it is not attitudes per se that drive sustainable travel mode choice, but rather the emotions such attitudes elicit.

H_4: *Negative emotions related to cars mediate the effect of pro-car attitudes on frequencies (or intentions) of using sustainable transport modes.*

In sum, we argue that pro-car attitudes are negatively related to the frequency (and intentions) of using sustainable travel modes. Moreover, we show that negative emotions can be conceptualised as antecedents of sustainable travel mode choices and, finally, we argue that negative emotions related to cars mediate the relationship between pro-car attitudes and sustainable travel mode use so that negative emotions – not attitudes – drive sustainable transport mode choice. To re-iterate, the aim of this paper is not to explain the adoption of sustainable transport modes as adequately as possible, but rather to draw out a psychological mechanism where emotions serve as an antecedent for sustainable mode choices. Our conceptual model illustrating our hypotheses is displayed in Fig. 1.

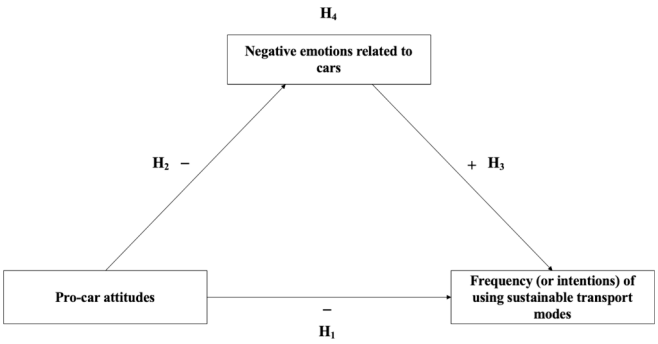

Fig. 1. Conceptual model illustrating the hypothesised mediation.

3. Materials and method

3.1. Participants

Like previous research (see Bretter et al., 2023b), we used Qualtrics for data collection and the panel provider Prolific to gain access to participants. All survey participants were based in the UK. The survey took participants roughly 7.5 min to complete. Aligned with ethical standards and good research practices (Bretter et al., 2022), we paid participants as compensation for their time. Importantly, our conceptual model above assumes that people have formed an opinion on cars. Therefore, only individuals who had a driving license, used their car for at least an hour a week, and were employed at the time of the survey (either full-time or part-time) were eligible to participate. We calculated the required minimum sample size *a priori* using G*Power (Faul et al., 2007). As input variables, we used a small effect size of $f = 0.12$, $\alpha = 0.05$, and a power of 80 %, and the results showed that our study's minimum sample size was $N_{req} = 1188$ participants. We collected data from 1294 participants and displayed their demographic information and a comparison to the general UK population in Table 1 (i.e., not the population comprising only workers and regular drivers). The UK's distribution for age, gender, and ethnicity closely matches the distribution of our sample. Thus, our sample is broadly representative of the UK population.

3.2. Measurements

Car attitudes. We measured car attitudes as a latent construct using four items (e.g., "*I think cars are…*") adapted from previous environmental psychological literature (Bretter et al., 2022; Russell et al., 2017). Participants were then asked to complete these four items on a 5-point Likert scale from (1) = "*Very bad/harmful/unpleasant/unsatisfying*" to (5) = "*Very good/beneficial/pleasant/satisfying*".

Negative emotions. Negative emotions were measured as a latent construct using five negative emotions often applied in the environmental psychology and transport literature (e.g., ashamed, upset, frustrated, guilty, sad). Participants answered the question "When you think

Table 1
Demographic information of our survey participants and a comparison with the general UK population.

Demographic information	Study (N = 1294)	UK population
Gender		
Female	48.5 %	51.0 %
Male	51.4 %	49.0 %
Other/prefer not to say	0.2 %	–
Ethnicity		
White	91.0 %	81.7 %
Mixed	1.8 %	2.9 %
Asian	4.4 %	9.3 %
Black	2.2 %	4.0 %
Other/Prefer not to say	0.6 %	2.1 %
Education		
National Vocation Qualification	12.2 %	
GCSE or similar	9.7 %	
A-Level	14.1 %	
Undergraduate degree	43.8 %	
Postgraduate degree	18.2 %	
PhD	2.0 %	
Age	$M = 40.38$ ($SD = 11.35$)	40.1 years
Annual Gross Income (in £000)	$M = 36.31$ ($SD = 19.88$)	–

Note. M = mean, SD = standard deviation.

about cars, to what extent to you feel the following emotion?" on a 5-point Likert scale from (1) = "*I do not feel this at all*" to (5) = "*I strongly feel this*".

Frequency of using sustainable travel modes. We measured how often participants used three sustainable travel modes: Bus, train, and bicycle. For each of these, we asked participants "How often do you use the following transport mode to get to anywhere where you need to get to?". Participants then answered these questions on a 5-point Likert scale from (1) = "*Less than once per week*" to (5) = "*Five times or more per week*".

Intentions to use car-sharing. Car-sharing is widely considered a more sustainable transport mode, compared to using a privately owned vehicle (Ferrero et al., 2018; Svennevik et al., 2020). For some, it is because of their potential to reduce private vehicle ownership and emissions (Becker et al., 2018; Zhou et al., 2020). For others, it is because car-sharing improves air quality and the 'livability' within cities (Musso et al., 2012). Therefore, we can consider car-sharing a sustainable transport mode. Participant's intentions to use car-sharing were measured as a latent construct. Participants responded to three items (e.g., "I intend to use car-sharing") on a 5-point Likert scale from (1) = "*Strongly disagree*" to (5) = "*Strongly agree*".

Covariates. We measured several covariates to be able to control for their variance in our mediation models. As already shown in Table 1, we measured several demographics such as participants' age and income. Moreover, we measured the extent to which participants value the natural environment, that is, their biospheric values, a key predictor for various environmental behaviours (Bretter et al., 2023a; Bretter and Schulz, 2023). Biospheric values were measured using four items (e.g., "Preserving nature") on a 7-point Likert scale from (1) = "*Not important at all to me*" to (7) = "*Very important to me*" following the instructions of de Groot and Steg (De Groot and Steg, 2007, 2008). Finally, we measured the quality of the local public transport system as perceived by participants. Participants answered the question "How would you rate the quality of the public transport network where you live to get to where you need to get to?" on a 5-point Likert scale from (1) = "*Very bad*" to (5) = "*Very good*".

3.3. Analytical approach

Our analytical approach follows three steps. First, we will examine the reliability and discriminant validity of our composite measures via a confirmatory factor analysis (CFA). Second, we use a linear regression model to test the hypothesised main effect of pro-car attitudes on the frequencies (and intentions) of using sustainable travel modes (H_1). Third, we employ Structural Equation Modelling to test our hypothesised mediation for each of our sustainable travel modes separately and for all of them simultaneously ($H_2 - H_4$). For additional robustness, we will do so with and without adding covariates.

4. Results

To examine the reliability and the discriminant validity of our latent constructs, we conducted a Confirmatory Factor Analysis (CFA) with our main variables of interest (i.e., car attitudes, negative emotions, and car-sharing intentions). The results are displayed in Table 2 and firstly show an acceptable model fit ($\chi^2 = 438.21$; $df = 51$; $p < 0.001$; $SRMR = 0.038$; $CFI = 0.96$; $RMSEA = 0.077$; $TLI = 0.94$). Each latent construct further shows a strong reliability ($\alpha > 0.82$) and sufficient discriminant validity, as shown by the Average Variance Extracted (AVE), which meet the threshold set by Fornell and Larcker (1981) of >0.50.

Having established that our measures are reliable and show discriminant validity, we examined the main effect of car attitudes on sustainable travel mode choices, thereby testing H_1. We hypothesised a negative association between pro-car attitudes and the frequencies (and intentions) of using sustainable travel modes. We conducted a linear regression model using our car-attitude latent construct as the independent variable and, separately, each of the three sustainable travel mode frequencies and participant's intentions to engage in car-sharing as the dependent variable. We also computed an overall sustainable travel measure by calculating the mean of these four sustainable travel modes. As detailed in Table 3, the results show the expected negative effect of car attitudes on the frequency of using sustainable transport modes ($\beta < -0.05$), on participant's intentions to use car sharing ($\beta = -0.05$), and on our overall sustainable travel measure ($\beta = -0.10$). Therefore, our findings support the notion that positive attitudes towards the car have a negative spillover effect on the usage of other travel modes, particularly on sustainable travel modes. Accordingly, H_1 is supported.

We then examined the mediation model via Structural Equation Modelling (SEM). We did so via two distinct models. First, we entered car attitudes as the exogenous variable, negative emotions as the mediator, and, separately, each of the three sustainable travel mode frequencies as well as participant's intention to use car-sharing as the dependent variables. In the second model, we used our overall sustainable travel measure as the dependent variable. The results of the first

Table 3
Main effects model using pro-car attitudes as the independent variable.

Dependent variable	B	β	SE	F
Car-sharing intention	−0.08	−0.05*	0.04	3.74
Train usage	−0.07	−0.05*	0.04	3.29
Bus usage	−0.06	−0.05*	0.04	2.73
Cycling	−0.13	−0.10***	0.04	14.00
Overall sustainable travel	−0.09	−0.10***	0.02	12.86

Note. ***p < 0.001; *p < 0.10.

Table 2
Results of the Confirmatory Factor Analysis for our latent constructs.

Latent Factor	Indicator	B	SE	Z	β	δ	α	AVE
Pro-car attitudes	Good				0.80	0.36***	0.83	0.56
	Beneficial	1.05	0.05	23.47	0.66***	0.56***		
	Pleasant	0.90	0.03	29.11	0.81***	0.34***		
	Satisfying	0.84	0.03	27.58	0.77***	0.41***		
Negative emotions	Ashamed				0.82	0.33***	0.86	0.55
	Upset	0.88	0.03	30.13	0.78***	0.40***		
	Frustrated	0.94	0.04	21.74	0.59***	0.65***		
	Guilty	1.11	0.04	28.26	0.74***	0.46***		
	Sad	1.03	0.03	33.49	0.85***	0.28***		
Car-sharing intentions	I try to use car-sharing				0.80***	0.35***	0.92	0.80
	I intend to use car-sharing	1.14	0.03	41.17	0.95***	0.11***		
	I plan to use car-sharing	1.19	0.03	40.84	0.93***	0.13***		

Note. $\chi^2 = 438.21$; $df = 51$; $p < 0.001$; $SRMR = 0.038$; $CFI = 0.96$; $RMSEA = 0.077$; $TLI = 0.94$; ***$p < 0.001$.

model are illustrated in Fig. 2A while the results of the second are shown in Fig. 2B. Importantly, both models show acceptable fit (Model 1: $\chi^2 = 509.36$; df = 78; $p < 0.001$; SRMR = 0.034; CFI = 0.95; RMSEA = 0.065; TLI = 0.94; Model 2: $\chi^2 = 678.32$; df = 87; $p < 0.001$; SRMR = 0.053; CFI = 0.94; RMSEA = 0.072; TLI = 0.92). For additional robustness, we repeated the analysis and added our covariates (e.g., biospheric values, public transport quality, age, and income) to the structural equation models. The results are presented in Table 4.

First, we examined the first step of our hypothesized mediation, that is, the effect of car attitudes on negative emotions related to cars, thereby assessing H_2 (see Fig. 1). We hypothesised a negative association between pro-car attitudes and negative emotions where the more individuals perceive cars as 'good', the fewer negative emotions they experience when thinking about cars. Indeed, as shown in Fig. 1, car attitudes are strongly and negatively related to negative emotions ($\beta = -0.43$; $p < 0.001$) even after controlling for covariates ($\beta = -0.40$; $p < 0.001$). Therefore, our results provide strong support for H_2. Although not related to our hypotheses, it is also interesting to note that biospheric values were positively associated with negative emotions ($\beta = 0.11$; $p < 0.001$). This implies, as one would expect, that the more important the environment is to individuals, the more they experience negative affect when thinking about cars. We then examined the second step of our mediation model (see Fig. 1) separately for each of our four dependent variables, thus testing H_3 and H_4. Recall that we hypothesised a positive association between negative emotions and the frequency (and intentions) of using each sustainable travel mode.

As expected, the direct negative effect of pro-car attitudes on all our sustainable travel modes (see Table 3) disappeared once we entered negative emotions as an additional predictor in the SEM model. We found a positive association between negative emotions and the frequency of using the bus ($\beta = 0.08$; $p = 0.017$), the train ($\beta = 0.09$; $p = 0.009$), cycling ($\beta = 0.11$; $p = 0.001$), and participants' intention to use car-sharing ($\beta = 0.15$; $p < 0.001$). Importantly, these effects remained after controlling for our covariates (see Table 4). This supports H_3 across all our sustainable travel modes and demonstrates that the more individuals experience negative emotions when thinking about cars, the more often they go cycling, use buses, and trains, and the stronger their intentions are to use car-sharing services. Given the negative association between pro-car attitudes and negative emotions (see H_2), these findings also support our mediation hypotheses (H_4). In other words, pro-car

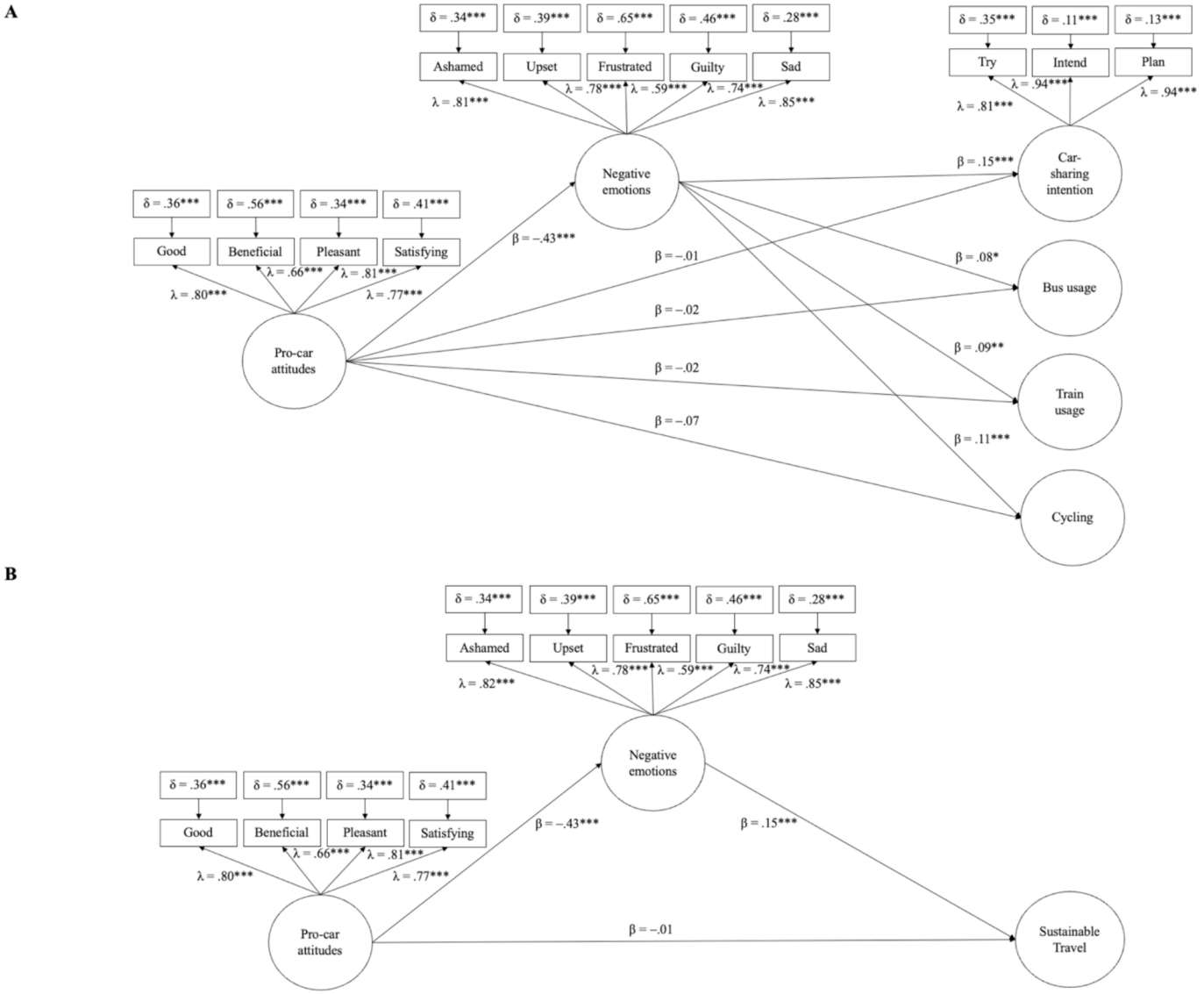

Fig. 2. Structural Equation Models testing the hypothesized mediation separately for each sustainable travel mode (A) and across all travel modes (B). The models showed acceptable model fit indices (A: $\chi^2 = 509.36$; df = 78; $p < 0.001$; SRMR = 0.034; CFI = 0.95; RMSEA = 0.065; TLI = 0.94; B: $\chi^2 = 678.32$; df = 87; $p < 0.001$; SRMR = 0.053; CFI = 0.94; RMSEA = 0.072; TLI = 0.92); ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

Table 4
Results for both structural equation models when controlling for biospheric values, public transport quality, age, and income.

Model	Dependent variable	Predictor variable	B	β	SE
1/2	Negative emotions				
		Pro-car attitudes	−0.41	−0.40***	0.03
		Biospheric values	0.07	0.11***	0.02
		Public transport quality	−0.02	−0.03	0.02
		Age	−0.01	−0.05	0.01
		Income	−0.01	−0.02	0.01
1	Bus usage				
		Negative emotions	0.11	0.08*	0.05
		Pro-car attitudes	−0.06	−0.04	0.05
		Biospheric values	0.03	0.03	0.03
		Public transport quality	0.16	0.19***	0.02
		Age	−0.01	−0.08**	0.01
		Income	0.01	0.05	0.01
1	Train usage				
		Negative emotions	0.16	0.09**	0.05
		Pro-car attitudes	−0.06	−0.04	0.05
		Biospheric values	0.02	0.03	0.03
		Public transport quality	0.19	0.21***	0.03
		Age	−0.01	−0.13**	0.01
		Income	0.01	0.20***	0.01
1	Cycling				
		Negative emotions	0.14	0.11***	0.04
		Pro-car attitudes	−0.06	−0.05	0.05
		Biospheric values	0.04	0.05	0.02
		Public transport quality	0.01	0.02	0.02
		Age	0.01	0.05	0.01
		Income	0.01	0.09***	0.01
1	Car-sharing intention				
		Negative emotions	0.17	0.13***	0.05
		Pro-car attitudes	0.01	0.01	0.05
		Biospheric values	0.16	0.20***	0.03
		Public transport quality	0.04	0.05	0.02
		Age	−0.01	−0.14***	0.01
		Income	0.01	0.07**	0.01
2	Overall sustainable travel				
		Negative emotions	0.04	0.13***	0.01
		Pro-car attitudes	0.01	0.01	0.01
		Biospheric values	0.03	0.20***	0.01
		Public transport quality	0.01	0.05	0.01
		Age	−0.01	−0.14***	0.01
		Income	0.01	0.08**	0.01

Note. The models showed acceptable model fit indices (model 1: $\chi^2 = 743.11$; df = 170; $p < 0.001$; SRMR = 0.030; CFI = 0.96; RMSEA = 0.051; TLI = 0.94; model 2: $\chi^2 = 1076.36$; df = 191; $p < 0.001$; SRMR = 0.047; CFI = 0.93; RMSEA = 0.060; TLI = 0.92); ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

attitudes are positively related to negative emotions, and it is these negative emotions – and not car attitudes – that then affect the use (and intentions of) using sustainable travel modes.

Overall, our results provide support for our hypotheses separately for all of our travel mode frequencies as well as for participants' intentions to use car-sharing. To examine whether the hypothesised mediation holds across all sustainable travel modes simultaneously, we assessed the model using our overall sustainable travel mode measure. Recall that we already established support for H_1 (see Table 3) suggesting that the more individuals perceive the car as something 'good', the less often they use sustainable travel modes overall. The results of the structural model without our covariates are presented in Fig. 1B and the results with covariates are presented in Table 4. We found that the negative association between pro-car attitudes and sustainable travel modes diminishes ($\beta = -0.01$; $p = 0.718$) when adding negative emotions. Indeed, negative emotions are positively associated with sustainable travel modes ($\beta = 0.15$; $p < 0.001$), even after controlling for our covariates ($\beta = 0.13$; $p < 0.001$), thus supporting H_3. Given the established negative association between pro-car attitudes and negative emotions (see Table 4; H_2), our results again demonstrate that negative emotions mediate the effect of car attitudes on overall sustainable travel mode choice, thus supporting H_4. Accordingly, negative emotions, and not car attitudes, seem to be the main antecedent of overall sustainable travel modes. We also found further interesting effects of our covariates. Age was negatively associated with sustainable travel mode choice ($\beta = -0.14$; $p < 0.001$) while biospheric values ($\beta = 0.20$; $p < 0.001$) and income ($\beta = 0.08$; $p = 0.011$) were positively associated with using sustainable travel modes.

5. Discussion

5.1. Summary of results

In this paper, we set out to examine a cognitive mechanism that may help to explain the adoption of sustainable travel modes. We found that pro-car attitudes are systematically and negatively related to the frequency (and intentions) of using sustainable travel modes, thereby demonstrating the indirect cognitive effects that the dominance of the automobile elicits on the adoption of sustainable travel. We also showed that negative emotions related to cars are positively associated with the use of sustainable travel modes. Accordingly, we have established that negative emotions are antecedents of sustainable travel choices. Finally, we revealed that negative emotions related to cars mediate the effect of pro-car attitudes on sustainable travel mode choice, thus establishing negative emotions as its closest antecedent: Elicited by positive attitudes towards cars, it is the negative emotions such as guilt, shame, and sadness that people feel when thinking about cars that determine sustainable travel mode choice, not car attitudes per se.

5.2. Theoretical and practical implications

Existing literature has treated negative emotions predominantly as outcomes of travel mode choice. For example, scholars have found that individuals experience more affective reactions when travelling with their preferred travel mode (Mouratidis et al., 2023) and that users of public transport modes show negative emotions after mode use (Morris and Guerra, 2015). Our findings presented here, however, imply that negative emotions can – and should –also be understood as antecedents of sustainable travel mode choice. This is important because it changes the way transport scholars need to conceptualise and think about emotions. Crucially, however, viewing emotions as antecedents opens an array of opportunities for practitioners and researchers. For example, environmental psychologists have shown that appealing to negative emotions such as guilt in public campaigns can elicit positive change. In one study, guilt and shame-induced participants showed higher intentions to conserve water (Baek and Yoon, 2017). Across two experiments, Bretter et al. (2023c) showed participants appeals that associate food waste to climate change and found that such messages subsequently increased people's intentions and effort to reduce food waste. Although we did not conduct experiments in this paper, our findings align with such findings and point to the possibility that interventions

appealing to negative emotions may enhance individuals' use of sustainable travel modes. As exemplified in such experimental studies, practitioners could, for example, attempt to induce negative emotions related to cars via public campaigns that highlight environmental damages stemming from car use. Another example could be to deliberately induce negative emotions such as shame or guilt, of course within the boundaries of what is ethical, in campaigns to reduce car use and increase the use of public or active transport modes. Indeed, as outlined by Ibanez and Roussel (2021), practitioners have a vast array of tools at their disposal to induce negative emotions related to cars in individuals ranging from media such as films and music to working with people's past emotional experiences. We encourage practitioners to follow the advice of such emotion scholars when designing their interventions and to stay within ethical boundaries.

For scholars, understanding emotions as antecedents of sustainable transport use opens directions for future research. For example, researchers should consider the effect of discrete negative emotions on transport mode adoption. We have here focused on a composite measure of five emotions – shame, upset, frustration, guilt, and sadness – and although such a measure brings certain advantages such as its reliability, emotion research has untangled additional benefits of examining negative discrete emotions (Onwezen et al., 2013). For example, some studies show that guilt seems to be one of the more important emotions in predicting environmental behaviour (Adams et al., 2020; Shipley and van Riper, 2022). Other studies show that sadness affects environmental behaviour such as recycling less than other negative emotions (Russell and Ashkanasy, 2021). Indeed, *meta*-analytic evidence indicates that discrete emotions of the same valence can have differing effects on the variable of interest (Lench et al., 2011). Therefore, untangling differences as such among discrete negative emotions and exploring how they may or may not relate to sustainable travel mode choice remains an important area for future research that will enable a better understanding of emotions as antecedents of travel behaviour. An intriguing research question would be whether effects of shame and guilt on sustainable travel mode differ, for example.

It is important to note that, although we have focused exclusively on negative emotions, there may be value in exploring the potential of positive emotions as antecedents of travel mode choice. Environmental psychologists have found that positive emotions can be utilised to promote environmental behaviour (Brosch, 2021; Onwezen et al., 2013). For example, Bissing-Olson et al. (2016) found that pride was positively associated with various environmental behaviours such as recycling and energy conservation. Similarly, Schneider et al. (2017) found that induced pride was positively associated with a series of pro-environmental decisions. Indeed, some preliminary evidence exists for the importance of positive emotions in the transport literature. Although they have not focused on positive emotions as an antecedent, Fessler et al. (2023) found that positive emotions resulting from being part of a public transport community may be associated with stronger public transport participation. Hence, future research may disentangle how discrete positive emotions work as antecedents of travel mode choice and how their effects differ from those of discrete negative emotions. For example, do positive emotions such as pride also act as antecedents of sustainable transport mode use and if so, how does the effect compare to that of negative emotions such as shame? Such research will then enable more targeted interventions to promote sustainable travel mode choices.

Moreover, our results point to negative emotions as a more proximate antecedent than attitudes. Although scholars often suggest that behavioural interventions should at least in part aim at changing attitudes (Grilli and Curtis, 2021; Klöckner, 2013), and we do not deny the importance of attitudes in this context, our findings imply that interventions were more effective if they aimed at eliciting negative emotions about an undesirable behaviour. While attitudes seem to be important indirectly, as they give rise to negative emotions, it is the latter that then actually accounts for variation in sustainable travel mode choice. Therefore, researchers and practitioners are encouraged to design and test interventions that aim at eliciting negative discrete emotions in order to foster sustainable travel (for practical guidance, see Siedlecka and Denson, 2019). Another interesting avenue for future research, and one that further helps to untangle our findings, is the examination of changes in attitudes for changes in negative emotions. Specifically, scholars may manipulate attitude changes to explore how those affect changes in negative emotions and whether such affective changes, in turn, result in differences in sustainable travel.

Further implications arise from the effect of our covariates. For example, we found a positive association of biospheric values with negative emotions towards cars and overall sustainable transport modes. This finding does not come as a surprise given the abundance of research that demonstrates the impact of biospheric worldviews on environmental behaviours such as climate policy support (Bretter and Schulz, 2024) and food waste (Bretter et al., 2023a). To our understanding, however, biospheric worldviews and their role for sustainable transport have been less explored. Our findings underscore the importance of individually-held values for using different transport modes. They also suggest that, in order to promote car-sharing, for instance, it may be more effective to refrain from emphasising the sustainability-related aspects (Hartl et al., 2018). Given that environmentally conscious individuals already hold higher intentions to share cars, car sharing may be further promoted by focusing on other aspects such as its flexibility or, indeed, negative emotions that individuals experience in relation to sole-occupancy car use.

More broadly, our results also highlight the importance and possibilities of attitude-behaviour misalignment in transportation research. Based on the Theory of Planned Behaviour (TPB; Ajzen, 1991), when examining attitudes towards a particular behaviour, scholars in the field of transportation research typically align attitudes with that behaviour (e.g., they examine the effect of bus attitudes on bus usage). However, we hypothesised and found that attitudes can affect behaviour even when these two do not align. In particular, we demonstrated that attitudes towards *cars* are associated with the adoption of *sustainable travel modes* (e.g., frequency of using the bus, train, bicycle). Although the effect of such misalignment may seem obvious and intuitive for some, we are one of the first studies that demonstrate an effect in transportation research to our knowledge. Although there are a small number of studies exploring attitudes and sustainable travel messaging/persuasion, they draw on personality traits rather than emotions (Pangbourne et al., 2020; Pangbourne and Masthoff, 2016). This suggests the need to further explore how the effect of attitudes that are misaligned with the behaviour of interest differs from those that are aligned. It also stresses the need for a better understanding of the circumstances under which attitudes, whether aligned or misaligned, become more and less relevant in explaining sustainable travel mode choice. Our results suggest that once negative emotions are accounted for, the effect of misaligned attitudes diminishes so that emotions mediate the effect of attitudes.

5.3. Limitations

While our results seem valuable and robust, we need to highlight a few limitations on the generalisability of our findings. First, our sample comprised workers and regular drivers in the UK. Although this means we cannot generalise across the whole UK population, we believe that our sample choice makes our study particularly strong. This is because regular drivers are precisely the ones that need to transition towards more sustainable travel modes. Therefore, we have shown that the cognitive mechanism applies to the part of the population most required to transition away from the car. Second, we cannot exclude the possibility of biases such as self-report biases in our responses. However, using an online survey to collect data is common (Donaldson and Grant-Vallone, 2002) and the risk of such bias to significantly alter our results is judged minor. Finally, we do not claim causal relationships because causality is impossible to assess in a cross-sectional survey.

6. Conclusions

With this paper, we have put forward negative emotions as antecedents of sustainable travel mode choice. More importantly, we have shown that negative emotions mediate the effect of attitudes on sustainable travel so that the effect of attitudes fades. In other words, it is negative emotions – not attitudes – that explain sustainable travel. It is important to emphasise here that our aim was not to be able to best explain sustainable travel. Instead, it was to carefully draw out a cognitive mechanism that helps us to understand why people tend to use sustainable travel modes. Therefore, we invite researchers to view negative emotions as an antecedent of sustainable travel and to build on our knowledge in further examinations of sustainable travel mode choices. More generally, we hope that this paper is a first step into more fruitful emotion research in transport studies.

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CRediT authorship contribution statement

Christian Bretter: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Kate Pangbourne:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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