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Applying the Campbell Paradigm to Sustainable Travel Behavior: Compensatory Effects of Environmental Attitude and the Transportation Environment

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Abstract

Both personal propensities and transportation-environment-based factors shape people's sustainable travel behavior. However, little is known about the interplay of these two types of factors. In contrast to many of the commonly used behavior models in transportation research, the Campbell Paradigm directly accounts for constraining or supporting effects of the transportation environment with the concept of behavioral "costs" and proposes an additive, compensatory interplay with a person's environmental attitude (i.e., attitude toward environmental protection). The current research (three studies, n = 529, n = 382, and n = 176) provides both quasi-experimental and experimental evidence for this compensatory hypothesis. Drawing on participants' self-reports, an online scenario, and behavioral observation, we exclusively found that the main effects of the transportation environment and a person's environmental attitude explained his or her sustainable travel behavior. In all three studies, the interaction effect was never significantly different from zero, and across studies ($|r_p|$ = .04), it was even significantly smaller than a conventional small effect. These findings support the Campbell Paradigm as a useful theoretical account and as a policy framework for inducing more sustainable travel behavior.

Keywords: environmental attitudes, conservation (ecological behavior), ground transportation, car use, nudges, Campbell Paradigm

1. Introduction

Individual mobility causes considerable environmental damage worldwide. Car use in particular is associated with relatively high levels of fuel consumption, thereby majorly contributing to global warming and air pollution (e.g., Chapman, 2007). Consequently, a multitude of interventions have aimed to induce people to engage in *eco-driving* to minimize the amount of fuel used on trips (e.g., Strömberg, Karlsson, & Rexfelt, 2015), to switch to more sustainable modes of transportation (e.g., Avineri & Waygood, 2013), or to travel shorter distances (e.g., Ericsson, Larsson, & Brundell-Freij, 2006). Scholars widely agree that both a personal propensity and the environment in which people travel (i.e., the transportation environment) shape the extent to which people engage in sustainable travel behavior (e.g., the extent to which they avoid using a car; see Gehlert, Dziekan, & Gärling, 2013). Unfortunately, research on the interplay of such propensities and environmental factors in determining individual sustainable travel behavior has, thus far, almost exclusively drawn on people's perceptions of the transportation environment's influence rather than its actual effect (for a notable exception, see Hunecke, Blöbaum, Matthies, & Höger, 2001; for an overview, see, e.g., Panter & Jones, 2010).

This omission may in part have resulted from the lack of formalized behavioral models that specify the interplay of personal propensities and environmental factors. Indeed, two of the most frequently employed behavior models in transportation research have failed to directly account for the constraining or supporting effects of the transportation environment (for a recent review, see Chng, Abraham, White, Hoffmann, & Skippon, 2018). Whereas the *norm activation model* does not address any factors that are external to the person (see e.g., Schwartz, 1977), the *theory of planned behavior* assesses them indirectly by means of *perceived* behavioral control (see e.g., Ajzen, 1991). The theory of planned behavior also proposes a statistical interaction between the personal propensity (i.e., intention) and the factor representing the constraints of the transportation environment (i.e., perceived behavioral control).

In this paper, we test the extent to which the *Campbell Paradigm* (Kaiser, Byrka, & Hartig, 2010), an alternative behavior model, can account for sustainable travel behavior. So far, the Campbell Paradigm has been applied to explain people’s acceptance of nature-preservation-related restrictions (Byrka, Kaiser, & Olko, 2017), their health performance (Byrka & Kaiser, 2013), and some other measures (see, e.g., Smolders, de Kort, Tenner, & Kaiser, 2012). The Campbell Paradigm speaks of two compensatory (i.e., statistically additive) factors that control a person’s sustainable travel behavior: a personal propensity (in our case, people's environmental attitude) and the constraints imposed by the transportation environment (the figurative behavioral “costs”). Notably, the Campbell Paradigm directly accounts for the effect of the transportation environment via people’s engagement frequencies and not via their perceptions of the environment.

In the following sections, we will discuss an exemplary list of features of the transportation environment that have been found to support or constrain sustainable travel behavior. Next, we will review how the effectiveness of such features is typically considered in models of sustainable travel behavior. Finally, we will introduce the Campbell Paradigm, which we believe is unfamiliar to many readers.

1.1 Behavioral Effectiveness of the Transportation Environment

Individuals who aim to increase the environmental sustainability of their travel behavior engage in many different behaviors. They can adapt their driving style, choose more sustainable modes of transportation, purchase fuel-efficient vehicles, carpool, or choose more sustainable routes (see e.g., Gehlert et al., 2013). Engaging in such behaviors is differentially constrained by the transportation environment in which the behavior takes place.

Eco-driving (see Study 1), for example, which describes behaviors that more efficiently utilize the power of the engine (Strömberg et al., 2015), can be facilitated by certain car features, such as in-vehicle information systems. Such systems provide reminders of the driving style that offers the best fuel economy (e.g., Young, Birrell, & Stanton, 2011). Advanced cruise control systems automatically adapt the car's speed to upcoming traffic signals and road elevation (e.g., Asadi & Vahidi, 2011). Likewise, a stop/start system automatically turns off the engine when the car comes to a full stop, thus saving fuel that would otherwise be wasted when idling at traffic lights or railroad crossings (e.g., Fonseca, Casanova, & Valdes, 2011).

As another example, travel mode choice (see Study 2) depends on relative prices (e.g., Steg & Schuitema, 2007) and relative travel time (e.g., Frank, Bradley, Kavage, Chapman, & Lawton, 2008). Inhabitants of rural areas with little access to public transportation and longer commuting distances typically use their cars more often than inhabitants of urban areas (e.g., Kaiser & Keller, 2001). Not surprisingly, seasonal changes in weather also shape travel mode choice. Car use has been found to increase in winter, probably so that car drivers can avoid exposure to inclement weather (e.g., Børrestad, Andersen, & Bere, 2011).

As a final example, route choice (see Study 3) tends to be guided by relative prices (i.e., tolls) and relative travel time. Typically, people choose the fastest route (Bovy & Stern, 1990), which is also the route that navigation systems commonly suggest by default (Ericsson et al., 2006).

In summary, there is abundant evidence that the transportation environment effectively constrains or supports sustainable travel behavior. As we will discuss next, however, behavioral models describing the effect of some personal propensity to engage in sustainable travel behavior typically do not directly account for any such effects of the transportation environment (Panter & Jones, 2010; Steg & Vlek, 2009). Whereas transportation researchers have often assessed the impact of environmental factors while controlling for some sociodemographic factors (e.g., sex or income, see e.g., Bhat, 1998), behavioral models popular in transportation research tend to either disregard environmental factors entirely or consider them only indirectly and subjectively via people's personal appraisals of their behavioral control. In the following section, we will explain some issues we see in both approaches in more detail.

1.2 Sustainable Travel Behavior in Conventional Behavioral Models

The norm activation model (NAM; Schwartz, 1977) suggests that people's sustainable travel behavior is determined by individual propensities. Specifically, such behavior is thought to be a function of either personal norms exclusively or personal norms conditional on perceived personal responsibility. The NAM has been widely employed in the study of environmentally protective behavior in general (see Steg & Vlek, 2009) and sustainable travel behavior more specifically (see Bamberg, Fujii, Friman, & Gärling, 2011). However, neither the NAM nor its offshoot, the value-belief-norm theory (Stern, Dietz, Abel, Guagnano, & Kalof, 1999), take into consideration any effect of the transportation environment.

By contrast, the theory of planned behavior (TPB; Ajzen, 1991) suggests that people's propensity to engage in a specific sustainable travel behavior (i.e., behavioral intention) and their subjective appraisal of the transportation environment's constraining influence on this behavior (i.e., perceived behavioral control; PBC) jointly determine the very behavior. The TPB has received abundant empirical support, has accounted for a wide array of behavior ranging from smoking cessation to financial investment decisions, and is—next to the NAM—one of the most widely employed behavioral models in transportation research (Bamberg et al., 2011; Chng et al., 2018). Notably—and in contrast to the NAM, the TPB accounts for the constraints of the environment in which the sustainable travel behavior takes place but does so via a person's appraisal of his or her own ability to act in the given environment (Ajzen, 1991). This idea is in line with widespread assumptions in transportation research that the transportation environment needs to be perceived, deliberately reflected upon, and evaluated in order to be behaviorally effective (see e.g., Avineri & Waygood, 2013; Bamberg et al., 2011).

According to the TPB, people's PBC and their intention to act in a particular way interact statistically (see left panel of Figure 1 for a prototypical representation). Specifically, the intention to act is expected to predict behavior better when actors perceive that they have high behavioral control (i.e., when environmental constraints are perceived to be low; Ajzen, 1991). The implication of this interaction hypothesis is that people are expected to respond individually to constraints imposed by the transportation environment, depending on their intention to engage in sustainable travel behavior (i.e., their propensity to act). Indeed, university students' use of public transportation has been found to be more strongly predicted by their intentions at higher levels of PBC (Heath & Gifford, 2002; see also, e.g., Steinmetz, Davidov, & Schmidt, 2011). Several other studies in transportation research, by contrast, either failed to report the test of the interaction (e.g., Elliott, Armitage, & Baughan, 2003) or found that the interaction was nonsignificant (e.g., Lo, van Breukelen, Peters, & Kok, 2016).

Building on both the TPB and the NAM, Klöckner and Blöbaum (2010) suggested the comprehensive action determination model (CADM), a meta-theory of ecological behavior that considers both objective and subjective environmental constraints. When applying the CADM to predict people's travel mode choices, Klöckner and Blöbaum (2010) found a significant interaction between participants' intention to use alternative travel modes (rather than a car) and self-reported car access (but not between PBC and intentions). Unfortunately—and in line with most research that was based on the TPB or the NAM—a recent meta-analytical test of the CADM did not specify or test the effect of any objective environmental constraints (Klöckner, 2013). In the next section, we turn to an alternative behavioral model that was originally proposed by Campbell (1963) and was recently reintroduced into attitude research as the Campbell Paradigm (Kaiser et al., 2010). We will show that the Campbell Paradigm draws on the overall behavioral engagement of people acting in a given transportation environment in order to directly account for the constraining force of the environment on sustainable travel behavior.

1.3 Sustainable Travel Behavior According to the Campbell Paradigm

Why would someone engage in eco-driving, use public transportation, or generally reduce the distance he or she travels? According to the Campbell Paradigm (Kaiser et al., 2010), sustainable travel behavior (like any other behavior that people engage in to protect the environment) is the result of two compensatory (i.e., statistically additive) effects: a person's propensity to engage in environmental protection (i.e., his or her environmental attitude) and the constraints imposed by the transportation environment. The composite of all environmental constraints is called behavioral costs in the Campbell Paradigm (see right panel of Figure 1).

Apparently, some behaviors are less "costly" or, vice versa, more pleasant in one transportation environment (e.g., walking in the sun) than in another (e.g., walking in the rain). In the Campbell Paradigm, the number of people engaging in a specific behavior in a given environment is regarded as the benchmark statistic for the transportation environment's constraining force. Notably, this engagement-frequency-based definition is independent of whether or not the transportation environment's constraining or supportive force is correctly perceived or even noticed by the individuals acting in the environment.

The presumed main effect of people's environmental attitude may seem obvious. After all, attitudes have classically been described as inferred properties that can be "… equated with the probability of recurrence of behavior forms of a given type or direction" (De Fleur & Westie, 1963, p. 21; see also Campbell, 1963). Accordingly, environmental attitude represents the propensity to verbally express appreciation toward environmental protection (cf. Eagly & Chaiken, 1993) and to engage in actual environmentally protective behaviors (Kaiser et al., 2010). Note, however, that this notion is in contrast to repeated findings that speak of a relatively marginal contribution of general (as opposed to behavior-specific) environmental attitude in explaining specific sustainable travel behavior (Gardner & Abraham, 2008). Likewise, the presumed main effect of behavioral costs may also seem rather obvious in the light of the abundant examples of the supporting or constraining effects of the transportation environment (see Section 1.1). As we have argued, however, they are typically not accounted for as actually effective influences (i.e., irrespective of people's perceptions) in behavioral models in transportation research. The Campbell Paradigm accounts for both factors (i.e., environmental attitude and transportation environment) and describes the two factors as compensatorily (i.e., statistically additively) effective (see also, Kaiser, Arnold, & Otto, 2014). People's sustainable travel behavior can thus be expected to be uniformly facilitated or constrained by the specific transportation environment, irrespective of their environmental attitude. And vice versa, increasing environmental attitude levels will be reflected in more extensive sustainable travel behavior, irrespective of how much the behavior is constrained by the transportation environment.

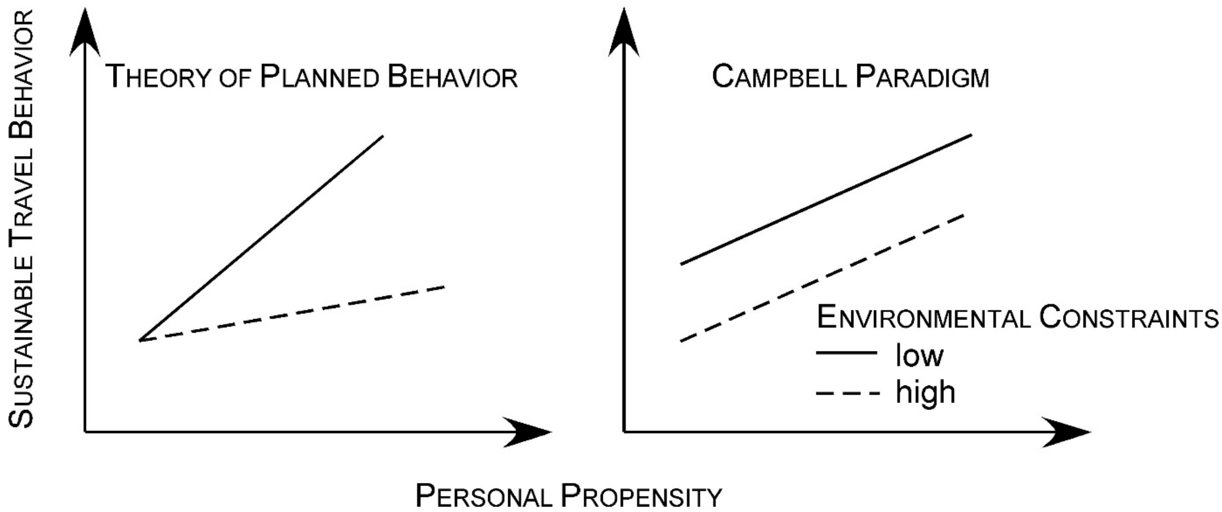

Figure 1. Sustainable travel behavior as a function of personal propensities (either intention or attitude) and the constraints imposed by the transportation environment (either as perceived behavioral control or as behavioral costs). The figure presents the prototypical predictions of the TPB (left panel, adapted from Yang-Wallentin, Schmidt, Davidov, & Bamberg, 2004) and of the Campbell Paradigm (right panel, adapted from Byrka et al., 2017). According to the TPB, people's intentions are expected to better predict their behavior when they act in a transportation environment that is perceived to be comparatively supportive of sustainable

travel behavior (when perceived behavioral control is high: solid line) rather than a transportation environment that is perceived to be comparatively constraining (when perceived behavioral control is low: dashed line). According to the Campbell Paradigm, people's attitude levels and the transportation environment predict behavior jointly and compensatorily. This effect is illustrated by the two parallel lines: one when the transportation environment supports sustainable travel behavior (behavioral costs are low: solid line) and one when it constrains it (behavioral costs are high: dashed line).

Because a great deal of psychological transportation research is conducted in the tradition of the TPB or the NAM, few studies have simultaneously examined the effects of personal propensities to engage in sustainable travel behavior and the constraining influence of the transportation environment. Indeed, in their literature review, Steg and Vlek (2009) identified only one psychological study from the transportation domain that accounted for actual (rather than perceived) environmental effects. This study assessed people's travel mode choices in transportation environments that either supported (i.e., free travel cards and a short distance to the next station) or constrained (i.e., no free travel cards and a long distance to the next station) the use of public transportation (Hunecke et al., 2001). Contrary to the authors' expectations—but in line with the Campbell Paradigm—they did not uncover a statistically significant interaction between the distinct transportation environments and people's ecological norm orientation (i.e., personal propensity) in predicting people's travel mode choices (for further evidence from other domains of environmentally protective behavior, see e.g., Byrka et al., 2017; Vetter & Kutzner, 2016; but see Klöckner & Blöbaum, 2010, described in Section 1.2, for a contradictory finding).

However, the absence of a statistically significant interaction is not evidence that the effect does not exist (cf. Lakens, 2017). Although a nonsignificant interaction is in line with the Campbell Paradigm, it does not positively establish the compensatory effectiveness of individual attitude and behavioral costs. Thus, behavioral researchers face a decision between adopting a parsimonious model that proposes additive main effects and a more complex, interactive model. This decision can be informed by quantitative evidence by drawing on the Attitude x Transportation Environment interaction's incremental explanatory power (or lack thereof) across several studies.

2. Research Goals

In three studies, we tested the interplay between five different features of the transportation environment and our participants' environmental attitude. Specifically, we tested the influences of an engine stop/start system on whether people turned off their cars' engines at closed railroad crossings and red traffic lights (Study 1), travel distance, season, and car ownership on travel mode choice (Study 2), and a navigation system that suggested sustainable routes on participants' route choices (Study 3). In all three studies, we expected more sustainable travel behavior with linearly increasing levels of environmental attitude (Hypothesis 1). In addition to this main effect of individual attitude, we also predicted supportive or constraining main effects of the features of the transportation environment under scrutiny (Hypothesis 2). Most important, and in line with the Campbell Paradigm, we expected compensatory (i.e., statistically additive) rather than interactive effects of people's environmental attitude and the transportation environment (Hypothesis 3). Aggregating Studies 1 to 3, we subsequently provide a meta-analytic estimation of the interaction effect and an equivalence test in which we contrasted this interaction effect against a conventional small effect.

3. Study 1: Assessing Self-Reported Engine Turn-Off

An efficient way to reduce the fuel consumption and hence the CO_2 emissions of private car use is to turn off the car's engine at red traffic lights, closed railroad crossings, or more generally when the car is not moving (Fonseca et al., 2011). Accordingly, appropriate engine turn-off is amongst the behaviors that have been referred to as eco-driving (e.g., Strömberg et al., 2015). Turning off the car's engine can of course be achieved manually by drivers. However, it can also be facilitated technically via an engine stop/start system. Notably, even with a stop/start system installed, drivers can still choose to keep the motor running by disabling the system or—for manual transmission cars—holding the clutch. In the terminology of the Campbell Paradigm, this automation thereby—presumably—reduces the behavioral costs of turning off the engine compared with a car without a stop/start system, although it does not determine it.

In the current study, we drew on people's environmental attitude and whether or not their car was equipped with a stop/start system to predict the frequency with which people turned off their engines at red traffic lights and closed railroad crossings. In line with the Campbell Paradigm, we expected an additive effectiveness of individual attitudes and the constraints imposed by the transportation environment. Specifically, we expected that the frequency with which people turned off their cars' engines would increase with increasing environmental attitude levels. Furthermore, we expected that automating the turning-off process via a stop/start system would reduce the behavioral costs associated with turning off the engine and would hence increase its frequency. Importantly, we expected that people's attitude would not statistically interact with the stop/start system. This study presents a quasi-experimental test of these expectations by comparing people whose cars were equipped with engine stop/start systems with people whose cars were not.

3.1 Method

3.1.1 Participants and procedure. For Study 1, we collected data from 967 participants in four separate primary studies with different primary questions.[1] Participants completed the task online at a location of their convenience. In all four online studies, upon providing informed consent, participants filled out the environmental attitude measure and subsequently answered questions about their car (brand, year of production, and whether their car was equipped with an engine stop/start system) and the frequency of their car use, along with a list of sociodemographic questions. When participants were unsure about whether their car was equipped with a stop/start system, we gathered these data from the manufacturer (n = 22, 2%). In two of the four studies, a lottery for gift certificates was offered as an incentive for participation.

Participants who did not report driving at least once a month (n = 409, 42%), completely ignored the attitude measure, did not provide enough information about their car for us to determine whether it was equipped with a stop/start system, or did not provide answers to both of the two dependent variables (n = 29, 3%) were excluded from all analyses. The final sample consisted of 529 participants (298 women, 215 men, age: M = 34.61 years, SD = 13.91). Notably, participants whose car was equipped with an engine stop/start system (n = 67) were marginally significantly older (M = 37.94, SD = 14.26) than participants whose car was not (n = 462, M = 34.15, SD = 13.82), $t(510) = 2.01$, $p = .05$, $d = 0.27$. By contrast, the two groups did not differ significantly in their environmental attitude levels or their gender ($p = .92$ and $p = .74$, respectively).

3.1.2 Measures. We assessed participants' environmental attitude with a Rasch scale of self-reported ecological behavior. To do so, we employed four different overlapping item sets (I = 49) adopted from the General Ecological Behavior Scale (GEB: Kaiser & Wilson, 2004). The scale has been argued to represent a reliable (Rasch-based separation reliability: .71 to .88) and valid measure of environmental attitude (e.g., Kaiser et al., 2010). Items that represented unecological activities were reverse coded (e.g., "I kill insects with a chemical insecticide"). Engagement was acknowledged with a *yes/no* statement for 18 items. For the remaining 31 items, we used a 5-point frequency scale (1 = *never* to 5 = *always*). In line with the standard procedure for calibrating the GEB scale (see Kaiser & Wilson, 2004), the responses to these polytomous items were recoded into a dichotomous format by collapsing *never*, *seldom*, and *occasionally* as indicators of a low attitude level. *Often* and *always* were combined to indicate a high attitude level. When participants were unable to answer an item (e.g., when asked about the energy efficiency of the last dishwasher they purchased when they had never purchased one), they could mark *not applicable*, which was treated as a missing value. The item "I drive in such a way as to keep my fuel consumption as low as possible" was excluded in order to avoid conceptual overlap with the dependent variables. The dichotomous Rasch model served as the measurement model. Each participant's attitude level was derived on the basis of a maximum likelihood approach (see e.g., Bond & Fox, 2007) and estimated in logits, which stand for the natural logarithm of the engagement/nonengagement ratio of a person across all items. Higher environmental attitude levels were thus reflected by larger positive logit values. The separation reliability of the measure was reasonable (*rel.* = .70).

Two additional GEB items were not used to estimate participants' environmental attitude but served as the dependent variables instead. These items assessed the frequency with which participants turned off their cars' engines at red traffic lights and at closed railroad crossings on a 5-point scale (again ranging from 1 = *never* to 5 = *always*). In one of the four studies, these items were assessed in an alternating fashion, resulting in missing data by design for n = 67 (13%, traffic lights) and n = 62 (12%, railroad crossings) participants.

3.1.3 Statistical analyses. We computed two separate hierarchical linear regression analyses by regressing how often participants turned off their cars' engines at red traffic lights and closed railroad crossings on the two mean-centered predictors environmental attitude and stop/start system (present vs. absent). In the next step, the Attitude x Stop/Start System interaction term was added to complete the full model. In both steps, we controlled for participants' age due to the marginally significant bivariate association between age and whether or not the car was equipped with a stop/start system. Heteroscedasticity-consistent standard errors and bootstrapped confidence intervals (5,000 samples; see e.g., Hayes & Cai, 2007) were computed to account for substantial heteroscedasticity and substantial skewness in engine turn-off (positive and negative skew for red traffic lights and closed railroad crossings, respectively). Partial correlation coefficients, r_p, were calculated as standardized effect size measures, indicating the explanatory value that could be attributed to a given predictor after adjusting for all other predictors (see Tables 1 and 2).

3.2 Results

3.2.1 Traffic lights. The full linear regression model explained a significant proportion of variance in participants' self-reports of engine turn-off at red traffic lights, $F(4, 440) = 35.98$, $p < .001$, $R^2 = .31$. In line with our expectations, the frequency with which participants turned off their engines increased as environmental attitude levels increased, $b = 0.23$, 95% CI [0.12, 0.35], thus corroborating the expected main effect of participants' attitude (Hypothesis 1; all values reported in the text pertain to the full model, see Table 1). Furthermore, as expected, participants with cars that were equipped with engine stop/start systems more frequently reported turning off their engines at red traffic lights than participants with unequipped cars, $b = 1.81$, 95% CI [1.47, 2.18] (Hypothesis 2). And finally, as predicted, the Attitude x Engine Stop/Start System interaction was not significant, $b = 0.22$, 95% CI [-0.12, 0.51] (Hypothesis 3).

Table 1

Regression of the Frequency With Which Car Engines Were Turned Off at Red Traffic Lights

	Step 1				Step 2			
	b(SE)	*t*	*p*	r_p	*b(SE)*	*t*	*p*	r_p
Constant	1.41 (0.13)	11.05	<.001		1.66 (0.13)	12.81	<.001	
Age	0.01 (0.00)	1.93	.05	.10	0.01 (0.00)	1.79	.08	.09
Attitude	0.24 (0.06)	4.20	<.001	.22	0.23 (0.06)	4.06	<.001	.21

Stop/Start System	1.82 (0.18)	9.97	<.001	.51	1.81 (0.18)	9.90	<.001	.51
Attitude x Stop/Start					0.22 (0.16)	1.37	.17	.08
R^2	.31				.31			

Note. Engine stop/start system: absent (reference) versus present. The Attitude x Stop/Start System interaction term was added in Step 2. $N = 445$.

3.2.2 Railroad crossings. The results for the second dependent variable, turning off the engine at closed railroad crossings, mirrored the results for red traffic lights. The full linear regression model explained a significant proportion of the variance, $F(4, 445) = 9.30$, $p < .001$, $R^2 = .06$. Again, and in line with our expectations, the frequency with which participants turned off their engines increased with increasing environmental attitude levels, $b = 0.24$, 95% CI [0.15, 0.33] (Hypothesis 1, see Table 2). Likewise, the effect of the engine stop/start system was again (marginally) significant, $b = 0.28$, 95% CI [0.00, 0.54] (Hypothesis 2). Note that a ceiling effect is probably responsible for the marked drop in variance explained by the presence of a stop/start system as compared with turning off the car's engine at red traffic lights: Whereas the frequency of engine turn-off at red traffic lights reported by participants whose cars were not equipped with a stop/start system suggested substantial room for improvement, $M = 1.67$, on a scale from 1 = *never* to 5 = *always*, $SD = 0.94$, there was comparatively little room for improvement at closed railroad crossings, $M = 4.07$, $SD = 1.04$. Importantly, however, the interaction was again nonsignificant, $b = -0.14$, 95% CI [-0.38, 0.10] (Hypothesis 3).

3.3 Discussion

In this quasi-experimental study, we examined the interplay of people's environmental attitude and having an engine stop/start system installed in the car on sustainable travel behavior. Specifically, we assessed self-reports of the frequency with which people turned off their cars' engines at red traffic lights and closed railroad crossings. Both participants' attitudes and the constraints imposed by the transportation environment (here, the stop/start system) showed the expected significant main effects. By contrast and in line with the Campbell Paradigm, there was no evidence of a significant interaction effect.

Table 2

Regression of the Frequency With Which Car Engines Were Turned Off at Closed Railroad Crossings

	Step 1				Step 2			
	b(SE)	*t*	*p*	r_p	*b(SE)*	*t*	*p*	r_p
Constant	3.93 (0.12)	31.76	<.001		3.97 (0.13)	31.86	<.001	
Age	0.00 (0.00)	1.26	.21	.06	0.00 (0.00)	1.35	.18	.06
Attitude	0.24 (0.05)	5.12	<.001	.21	0.24 (0.05)	5.20	<.001	.22
Stop/Start System	0.27 (0.14)	1.96	.05	.09	0.28 (0.14)	1.96	.05	.09
Attitude x Stop/Start					-0.14 (0.13)	-1.10	.27	-.05
R^2	.06				.06			

Note. Engine stop/start system: absent (reference) versus present. The Attitude x Stop/Start System interaction term was added in Step 2. $N = 450$.

From an applied perspective, the current study corroborates the idea that stop/start systems can help reduce the CO_2 emissions that derive from private car use (e.g., Fonseca et al., 2011). Interestingly, although the automation offered by the system seems to leave no room for not turning engines off, we found that the stop/start system merely facilitated engine turn-off (rather than enforcing it completely). A substantial proportion of our participants reported idling from time to time (presumably by disabling the stop/start system or holding the clutch). Specifically, only 30% of participants whose cars were equipped with a stop/start system reported that their car's engine was always turned off at red traffic lights, and only 62% reported that they never let their car's engine run at closed railway crossing.

Whereas we do not know why some of our participants disabled their cars' stop/start systems, we can speculate that such decisions may be driven by technical concerns regarding additional battery and engine wear caused by the system, safety concerns regarding a potentially delayed relaunch of the vehicle, or frustration over vibrations or noises unmasked by the system (Wellmann, Govindswamy, & Tomazic, 2013). Nonetheless, our findings suggest that the behavioral costs of turning off engines were reduced by having an engine stop/start system installed and that the extent of this reduction was independent of the driver's environmental attitude.

Future research should explore the interplay of environmental attitude and other technical features such as advanced cruise control systems (see e.g., Asadi & Vahidi, 2011) or in-vehicle information systems (see e.g., Young et al., 2011), which presumably also reduce the behavioral costs of eco-driving. Future research should also assess potential (positive or negative) "spillover" effects of such behavior change. Specifically, the facilitation of turning off the engine provided by the stop/start system may induce people to also engage in other sustainable travel behavior or, by contrast, may serve as a perceived moral or financial license to engage in sustainable behavior less often such as less often choosing to ride a bicycle over driving a car (see e.g., Klöckner, Nayum, & Mehmetoglu, 2013).

Although in line with the predictions derived from the Campbell Paradigm, the nonsignificant interaction effects obtained in the current study may—like any nonsignificant effect—also be attributable to the limited statistical power of the study. Unfortunately, widely available software packages for power analyses in multiple regression do not offer tests of single coefficients in random- or mixed-effects models (see, e.g., Faul, Erdfelder, Buchner, & Lang, 2009, for an overview of available software). Assuming a fixed-effects model in order to obtain a rough estimate suggested that the effective sample size for the two regression analyses ($n = 445$ and $n = 450$ for red traffic lights and closed railroad crossings, respectively) provided high power ($1 – ß > .99$, assuming $\alpha = .05$, two-tailed) for finding a conventional medium-sized (interaction) effect (i.e., $|r_p| = .30$) but only rather modest power ($1- ß = .56$ and .57 for red traffic lights and closed railroad crossings, respectively) for finding a conventional small effect (i.e., $|r_p| = .10$) in each of the two analyses. Moreover—although impossible to quantify due to the unknown reliability of our self-report measure of whether a participant's car was equipped with a stop/start system—the statistical power for testing interactions is generally lower than it is for testing main effects in quasi-experimental studies with predictor variables that are not perfectly reliable (Busemeyer, 1980). After Study 3, we present a meta-analysis of the interaction effect across our three studies, thus drawing on more than 900 participants for a more adequately powered test.

The internal validity of the current study was limited by the fact that having an engine stop/start system installed in one's car was confounded with participants' age. Although we controlled for the effect of age as a covariate in our regression analyses, validity considerations warranted an experimental test of the interplay of people's attitude and the transportation environment (see Study 3). Furthermore, we may have overestimated the association between people's environmental attitude and whether they turned off their engines by drawing on self-reported behavior items from the GEB scale to assess both variables (i.e., common-method variance, see e.g., Campbell & Fiske, 1959). Finally, we did not observe actual engine turn-off but relied on people's self-reports, which may be affected by social desirability (see e.g., Kormos & Gifford, 2014). In Study 2, we addressed the latter two limitations by drawing on actual, observed sustainable travel behavior.

4. Study 2: Observing Actual Sustainable Travel Mode Choice

Next to eco-driving techniques such as turning off one's car's engine when not in motion, more sustainable travel behavior can consist of abandoning one's car altogether and choosing another travel mode such as a train, bus, or bike. Commuting by bike or walking obviously produces no direct emissions. However, even the use of public transportation results in less than half as many greenhouse gas emissions as commuting by car (per person kilometer). Thus, commuting by car is the least sustainable travel mode choice (Umweltbundesamt, 2016).

In Study 2, we assessed the influence of people's environmental attitude and the transportation environment on travel mode choice for the commute to work. As found in Study 1, we expected additive main effects of attitudes and behavioral costs. Specifically, we expected the likelihood of commuting by bike or public transportation rather than by car to increase with increasing environmental attitude levels. Furthermore, we expected that certain features of the transportation environment would effectively constrain or support the choice of a sustainable travel mode (i.e., determine its behavioral costs). We examined three features of the transportation environment that had previously been found to be important: a longer distance between a person's workplace and home, inclement weather in the late fall and winter seasons, and easy access to a car in households that owned at least one car.

Not surprisingly, car use has been found to be more likely when commuting distances are longer. In Germany, for example, 78% of all long-distance (i.e., more than 50 km) commuters reportedly use a car, but only 48% of short-distance (i.e., less than 10 km) commuters use one (Statistisches Bundesamt Deutschland, 2009). The seasonality of travel mode choice has received little attention so far, but initial studies have expectedly reported that bicycle use decreases and car use increases in the winter season (Børrestad et al., 2011).

Lower temperatures, more precipitation, and less daylight appear to make cycling more demanding. Furthermore, car ownership is an important and obvious factor when it comes to travel mode choice. Although commuting by car is possible without owning a car (via carpooling or renting), car ownership raises the behavioral costs of choosing a sustainable travel mode because additional financial costs and planning efforts are involved (e.g., Johansson, Laflamme, & Hasselberg, 2012).

In line with Study 1's findings, we expected that people's attitude and the constraining effect imposed by these three features of the transportation environment would not interact statistically. The current study presents a test of these expectations in a field observation of actual travel mode choice.

4.1 Method

4.1.1 Participants and procedure. A convenience sample of employees of two German research institutes who had just completed their commute to work were approached by research assistants in parking areas, at bicycle racks, or at public transportation stops. These employees were asked to complete a questionnaire, which included the environmental attitude measure, questions about car ownership and the distance of their commute, and a list of sociodemographic questions. Questionnaires also included the Motivation Toward the Environment Scale (Pelletier, Tuson, Green-Demers, Noels, & Beaton, 1998). However, this last scale was unrelated to the current research question, and the respective results are not reported below. Data were collected in two waves in the early summer and late fall seasons (i.e., June and November 2015) in order to capture a reasonable amount of variance in weather conditions. As expected, the research assistants involved in the data collection as well as online archives (see e.g., http://www.wetterkontor.de/de/wetter/deutschland/monatswerte-station.asp) correspondingly described the weather in June 2015 as sunny with an average temperature of 17 °C (63 °F) and the weather in November 2015 as mostly foggy or rainy, with an average temperature of 8 °C (46 °F). Travel mode choice was recorded unobtrusively and objectively by handing out different versions of the same questionnaire that had covertly been marked beforehand (i.e., car use or no car use). Participants were offered no compensation for their participation.

Out of the 396 employees who completed the questionnaire, $n = 14$ (4%) did not report either the distance of their commute or the number of cars in their household. They were excluded from all analyses, resulting in a final sample of $N = 382$ participants (162 women, 216 men, age: $M = 37.17$ years, $SD = 11.11$). Car users ($n = 170$) and non-car users ($n = 212$) did not differ significantly in their level of education or income ($p = .35$ and $p = .37$, respectively). However, car users were significantly older ($M = 39.12$, $SD = 10.98$) than non-car users on average ($M = 35.65$, $SD = 11.00$), $t(372) = 3.03$, $p = .003$, $d = 0.32$, and there was a higher percentage of women in the car user group (52%) than in the non-car user group (36%), $\chi^2(1) = 10.43$, $p = .001$, $OR = 1.97$. All participants had access to free parking areas, public transportation stops, and bicycle racks near their workplaces and were thus generally free to choose from all of these travel modes. Most participants (81%) also reported that their household owned at least one car, and thus, they could choose to use or not use this car for their commute. Note, however, that even employees who did not own a car could drive to work (e.g., by carpooling).

4.1.2 Measures. As in Study 1, participants' environmental attitude was assessed with 50 items adopted from the GEB scale (Kaiser & Wilson, 2004). One item pertaining to travel mode choice ("I ride a bicycle or take public transportation to work or school") was excluded from the calibration of the scale in order to avoid trivial predictions of actual travel mode choice by self-reported past choices. Nevertheless, the established measure was reasonably reliable (*rel.* = .77).

Commute distance was estimated on the basis of participants' self-reports. Originally, distance was assessed with six categories (ranging from *below 2 km* to *above 50 km*). We employed the midpoint of each distance category (e.g., 7.5 km for the *5 to 10 km* category) and arbitrarily chose the value of 75 km for the highest, open-ended category (i.e., *above 50 km*).

4.1.3 Statistical analyses. We computed a hierarchical binary logistic regression analysis, first regressing travel mode choice (car vs. non-car) on the four mean-centered predictors environmental attitude, commute distance, season, and car ownership. In the next step, we added the three interaction terms between environmental attitude and (a) distance, (b) season, and (c) car ownership to complete the full model. In both steps, we controlled for the effects of age and gender because of their significant bivariate association with travel mode choice. Notably, even for the full model—which contained the covariates, the main effects of the focal predictors, and the three interaction terms—collinearity diagnostics indicated tolerable variance inflation factors (all *VIFs* < 3) for the noncentered predictors (for guidance on collinearity diagnostics in binary logistic regression, see e.g., Midi, Sarkar, & Rana, 2010). *Pseudo* partial correlation coefficients were calculated to provide a standardized effect size measure (see Table 3; for details, see e.g., Bhatti, Lohano, Pirzado, & Jafri, 2006).

Table 3

Logistic Regression of Travel Mode Choice (Car Users vs. Non-Car Users)

	Step 1				Step 2			
	b(SE)	*W*	*p*	r_p	*b(SE)*	*W*	*p*	r_p
Constant	0.47 (0.14)	11.33	.001		0.52 (0.15)	12.53	<.001	
Age	-0.01 (0.01)	1.63	.20	.00	-0.02 (0.01)	1.76	.18	.00
Gender	0.69 (0.24)	8.14	.004	.11	0.68 (0.24)	7.95	.005	.11

Attitude	0.47 (0.17)	7.82	.005	.11	0.47 (0.19)	6.27	.01	.09
Distance	-0.02 (0.01)	8.10	.004	-.11	-0.02 (0.01)	7.03	.008	-.10
Season[2]	0.12 (0.25)	0.22	.64	.00	0.18 (0.25)	0.49	.48	.00
Cars owned	-2.62 (0.54)	23.53	<.001	-.21	-2.85 (0.59)	23.39	<.001	-.21
Attitude x Distance					-0.02 (0.01)	3.22	.07	-.05
Attitude x Season					0.36 (0.35)	1.04	.31	.00
Attitude x Cars					0.13 (0.66)	0.04	.84	.00
Nagelkerke's R^2	.28				.29			

Note. Car users were the reference category. Season: June (reference) versus November; cars owned: none (reference) versus ≥ 1 car; gender: women (reference) versus men. *W* is the Wald χ^2. The Attitude x Distance of the Commute, Attitude x Season, and Attitude x Car Ownership interaction terms were added in Step 2. $N = 370$.

4.2 Results

The full logistic regression model significantly predicted people's travel mode choice, $\chi^2(9) = 91.40$, $p < .001$, Nagelkerke's Pseudo-$R^2 = .29$. In line with our expectations, the estimated likelihood of choosing a sustainable travel mode (rather than a car) increased significantly as environmental attitude levels increased, $b = 0.47$, 95% CI [0.10, 0.84], thus corroborating the expected main effect of participants' attitude (Hypothesis 1; all values reported in the text pertain to the full model, see Table 3). Turning to the features of the transportation environment under scrutiny (Hypothesis 2), we found significant main effects of distance and car ownership but not of season (p = .48).[2] Specifically, the estimated likelihood of choosing a sustainable travel mode decreased significantly as the self-reported distance of the commute increased, b = -0.02, 95% CI [-0.03, -0.00], thus corroborating the expected main effect of behavioral costs. Moreover, as expected, the likelihood of choosing a sustainable travel mode decreased significantly if the participant's household owned at least one car, b = -2.85, 95% CI [-4.02, -1.69], thus speaking of another feature of the transportation environment shaping the behavioral costs of sustainable travel choices. Finally—and in line with Hypothesis 3—we found no evidence of significant interaction effects between environmental attitude and any of the three features of the transportation environment under scrutiny (.07 ≤ p ≤ .84, see Table 3).

4.3 Discussion

In this quasi-experimental study, we examined the interplay of people's environmental attitude and three features of the transportation environment on sustainable travel mode choice. In contrast to most psychological research on travel mode choice (e.g., Børrestad et al., 2011; Johansson et al., 2012) and in contrast to common practice in environmental psychology more generally (see Kormos & Gifford, 2014), we explored people's actual observed rather than self-reported behavior (i.e., travel mode choice for the commute to work). As such, the current study complies with repeated calls for a renewed commitment to direct behavioral observation (see e.g., Baumeister, Vohs, & Funder, 2007).

Expectedly, and in line with Study 1, people's environmental attitude significantly predicted the sustainable travel behavior under scrutiny. Moreover, also as expected, the transportation environment (at least in the form of distance and car ownership) had a significant main effect, too. By contrast, season was not found to be a significant predictor of people's travel mode choice. Thus, the behavioral costs of enduring the cold and fog were apparently negligible in our empirical example, although any switching from walking or biking to public transportation in the fall season would have gone unnoticed. Most important, all three interactions turned out to be nonsignificant (although at p = .07, the Attitude x Distance interaction was close to the conventional cutoff for significance). These nonsignificant interactions again concurred with the expected compensatory effectiveness of individual attitudes and behavioral costs inherent in the Campbell Paradigm (Kaiser et al., 2010).

However, the influences of all three features of the transportation environment under scrutiny were assessed quasi-experimentally. As in Study 1, the internal validity was thus limited, although we controlled for any effects of participants' age and gender. In Study 3, we addressed this limitation by providing an experimental test of our hypotheses.

5. Study 3: Experimentally Facilitating Sustainable Route Choices

As a final example, sustainable travel behavior can consist of choosing routes that come with a lower environmental impact (e.g., in terms of CO_2 emissions). In Study 3, we assessed the effect of a navigation system that presented more or less sustainable routes by default on people's route choices. This study provides an experimental replication of Studies 1 and 2 by randomly allocating people to different transportation environments.

Defaults are preset options that become effective if no active choice is made (see Sunstein & Reisch, 2014). For instance, under a "green" electricity default (i.e., generated from renewable sources), customers have to actively demand a different electricity plan or even switch to a different provider in order to receive conventional "grey" electricity (e.g., Vetter & Kutzner, 2016). Likewise, a printer set to a two-sided default mode will provide duplex prints unless one-sided printing is actively requested (e.g., Egebark & Ekström, 2016). Opting out of a default can involve substantial behavioral costs because it often necessitates the effort of searching for and comparing alternative options. Furthermore, some defaults are perceived as implicit recommendations (i.e., implied endorsement). Again, such defaults result in behavioral costs, this time owing to the benefit of adhering to normative pressure (Kaiser et al., 2014). Interestingly and despite frequent theoretical claims of an effectiveness that is conditional on people's preferences or attitudes (see e.g., Sunstein & Reisch, 2014), a previous study has found no evidence of a statistical interaction (Vetter & Kutzner, 2016).

Applied to the domain of sustainable travel behavior, defaults could potentially support the choice of more sustainable routes if implemented in a navigation system (Ericsson et al., 2006). A number of features of the transportation environment such as route length, road type, traffic flow, traffic density, scenery, weather, and time of the day have been suggested to determine route choice (for an overview, see Bovy & Stern, 1990). However, conventional navigation systems largely disregard these factors and typically simply suggest the fastest route by default (i.e., the route with the shortest travel time; Ericsson et al., 2006). Although in many cases the route with the shortest travel time will also be the most environmentally friendly one, these two criteria sometimes diverge. Specifically, according to GPS data, highway and freeway routes are often the fastest options, but they are typically not the shortest and—due to their more lenient speed limits—may come with higher CO_2 emissions (Ahn & Rakha, 2008). In such cases, car drivers have to choose between spending more time in the car versus emitting higher amounts of CO_2. Indeed, the fuel-saving potential of providing people with a navigation system that suggests the most sustainable rather than the fastest route was estimated to be 4%, taking into account numerous parameters such as speed limits, traffic lights, and on- and off-peak demand (Ericsson et al., 2006). However, to realize this fuel-saving potential, sustainable routes would first need to be presented as the default, and then people would need to follow their navigation system's suggestions.

In line with Studies 1 and 2, we expected that more CO_2 emissions would be saved through route choice as environmental attitude levels increased. Furthermore, we expected that by presenting sustainable routes in a navigation system by default, the behavioral costs of choosing such routes would be reduced, and the amount of CO_2 emissions saved by route choice would increase accordingly. Most important and in line with the Campbell Paradigm (Kaiser et al., 2010), we again expected additive rather than interactive effects of people's attitude and the transportation environment (here, the default route). This study presents an experimental test of these expectations.

5.1 Method

5.1.1 Participants and procedure. We recruited a convenience sample of 345 participants through social networking sites and email lists of which $N = 176$ (96 women, 71 men, age: $M = 26.43$ years, $SD = 7.31$) completed the route choice task and the environmental attitude measure. Participants were offered no compensation for their participation. They completed the task online at a location of their convenience. They were randomly assigned to either a sustainable ($n = 85$) or a conventional ($n = 91$) default condition. Participants in the two conditions did not differ significantly in environmental attitude level, income, or driving routine ($.16 \leq p \leq .74$). By chance, however, there was a higher percentage of women in the sustainable default condition (66.67%) than in the conventional default condition (48.84%), $\chi^2(1) = 5.43$, $p = .02$, $OR = 2.10$. Participants in the sustainable default condition were also significantly younger ($M = 24.99$, $SD = 3.73$) than participants in the conventional default condition ($M = 27.79$, $SD = 9.35$), $t(113) = 2.57$, $p = .01$, $d = 0.39$.

Participants were invited to take part in a route choice scenario and informed that they would be presented with actual maps from a navigation system and asked to choose routes for given starting points and destinations. Upon providing their informed consent, participants completed a test trial, which explained how to choose routes in the navigation system. Next, they chose routes for a total of three trips (i.e., three different starting points and destinations). After the route choice task, participants completed the environmental attitude measure and a list of sociodemographic questions.

For each trip, participants were first shown a default route. This route was either the most sustainable route (i.e., associated with the smallest amount of CO_2 emissions) or the route with the shortest travel time, depending on the default condition. Participants could either accept the presented route or opt out of the default. When opting out, they could choose one of four different routes, including the one that had previously been presented as the default. Because searching for and selecting alternative routes in actual navigation systems typically requires some time, the submit button was hidden for 30 s on this page of the survey.

For each route, the total distance, travel time, and amount of CO_2 emitted were displayed along with a map that presented the route. Travel time and CO_2 emissions were inversely related, r = -1.00, -.95, -.80, for Trips 1, 2 and 3, respectively. In other words, participants could minimize either their travel time or CO_2 emissions with their route choice. In order to increase the ecological validity of our route choice scenario, driving the car was simulated by watching videos of car rides, and actual CO_2 emissions were saved by means of corresponding donations to an environmental organization. Specifically, participants watched a video of a car ride filmed from the driver's perspective after selecting a route. We informed participants at the outset that longer travel times would correspond with longer videos (15 to 60 s) and that each video had to be watched to its conclusion. Furthermore, we also informed participants at the outset that we would donate 2 Eurocents to an environmental organization that compensates for greenhouse gases emitted by fostering renewable energies in developing countries for each kg of CO_2 emissions saved in comparison with the conventional route (i.e., the route with the shortest travel time). With each route choice, participants could thus actually contribute to climate protection (100 € were donated in total), but to do so, they had to accept longer travel times and thereby sit through longer videos.

5.1.2 Measures. As in Studies 1 and 2, participants' environmental attitude was assessed with 50 items adopted from the GEB scale (Kaiser & Wilson, 2004). Again, the measure was reasonably reliable (*rel.* = .77).

The dependent variable was the amount of CO_2 emissions saved by the route choice. For each trip, we subtracted the CO_2 emissions of the chosen route from the emissions of the conventional route (i.e., the route with the shortest travel time) and divided the sum of these differences by the total number of trips.

5.1.3 Statistical analyses. We computed a hierarchical linear regression analysis, first regressing the amount of CO_2 emissions saved by the route choice on the two mean-centered predictors environmental attitude and default condition (sustainable vs. conventional). In the next step, the Attitude x Default interaction term was added to complete the full model. In both steps, we controlled for the effects of age and gender because of their significant bivariate association with the default condition. In line with Study 1, heteroscedasticity-consistent standard errors and bootstrapped confidence intervals (5,000 samples) were computed to account for substantial heteroscedasticity and substantially negative skewness and excessive kurtosis in CO_2 emissions saved. Finally, to control for potential within-participant variance in the effects across the three trips, we additionally computed a repeated-measures ANOVA.

5.2 Results

The full linear regression model significantly predicted the amount of CO_2 saved by the choice of route, $F(5, 160) = 5.90$, $p < .001$, $R^2 = .15$. In line with our expectations, CO_2 emissions decreased significantly with increasing environmental attitude levels, $b = 2.49$, 95% CI [0.86, 4.16], thus corroborating the expected main effect of participants' attitude (Hypothesis 1; all values reported in the text pertain to the full model, see Table 4). For the transportation environment under scrutiny, we found a significant main effect of the default route, $b = 3.19$, 95% CI [0.42, 6.01]. Participants who were allocated to the sustainable default route condition chose routes with significantly lower CO_2 emissions than participants who were allocated to the conventional default (Hypothesis 2). Most important, we found no significant interaction between participants' attitude and the default condition, $b = -0.44$, 95% CI [-3.62, 2.63] (Hypothesis 3). Tests of within-subject effects indicated that none of the effects differed significantly across the three trips. Critically, the Attitude x Default interaction showed no significant within-subject variation (p = .39).

Table 4

Regression of CO_2 Emissions Saved by Route Choice

	Step 1				Step 2			
	b(SE)	*t*	*p*	r_p	*b(SE)*	*t*	*p*	r_p
Constant	25.43 (4.14)	6.14	<.001		31.17 (2.87)	10.85	<.001	
Gender	-4.16 (1.48)	-2.81	.006	-.22	-4.14 (1.48)	-2.79	.006	-.22
Age	0.08 (0.08)	0.99	.32	.07	0.08 (0.08)	0.97	.34	.07
Attitude	2.48 (0.83)	3.01	.003	.22	2.49 (0.85)	2.94	.004	.22
Route default	3.20 (1.43)	2.24	.03	.17	3.19 (1.43)	2.23	.03	.17
Attitude x Default					-0.44 (1.64)	-0.27	.79	-.02
R^2	.15				.15			

Note. Default: conventional (reference) versus sustainable route; gender: women (reference) versus men. The Attitude x Route Default interaction term was added in Step 2. N = 166.

5.3 Discussion

The current study again corroborates the main effects of environmental attitude and the constraints imposed by the transportation environment. This time, we experimentally manipulated the transportation environment by allocating participants to a sustainable or a conventional default route condition. Most important and in line with Vetter and Kutzner's (2016) findings, there was no evidence of a significant interaction between the default condition and people's environmental attitude in predicting the amount of CO_2 emissions saved by the route choice.

Note that although the choice of route was entirely hypothetical in that none of the routes were actually driven, it had immediate, manifest consequences for the participants. Specifically, participants could actually contribute financially to climate protection by choosing more sustainable routes, but to do so, they had to sit through longer videos. However, this boost of Study 3's ecological validity (choosing more sustainable routes is often time consuming; see Ahn & Rakha, 2008) came at the price of somewhat of a reduction in internal validity. Specifically, we confounded participants' (hypothetical) choice of more sustainable routes with their (actual) willingness to sacrifice their time in order to financially contribute to climate protection.[3] Notably, however, both behaviors (choosing sustainable routes and donating to an environmental cause) can be considered ecological behaviors that are apparently reasonably well explained by our behavioral model.

From an applied perspective, Study 3's findings support efforts to implement sustainable default routes in navigation systems (Ericsson et al., 2006). The current findings thus add to a growing body of research demonstrating the potential that defaults have in facilitating a range of ecological choices, from duplex printing to renewable energy or energy-efficient technology (see Sunstein & Reisch, 2014). The current findings also corroborate a previous study that found no evidence that environmental attitudes interact with defaults in predicting ecological choices (Vetter & Kutzner, 2016).

From a theoretical perspective, this nonsignificant interaction effect is again in line with the Campbell Paradigm (Kaiser et al., 2010). Notably, however, the expected additive effectiveness of people's attitude and the transportation environment cannot be established by frequentist inference. In order to obtain at least a more accurate estimate of the size of the interaction, the following section provides a meta-analysis of our three studies and tests the mean interaction effect against a conventional small effect.

6. Meta-Analysis: Virtually Zero Attitude x Transportation Environment Interaction

To conduct a high-powered test of the interaction effect against the standard null hypothesis of a zero effect as well as an equivalence test against an arbitrarily selected effect size, we computed a random-effects meta-analysis of Studies 1 to 3 ($N = 981$) with the *R*-package *meta* (Schwarzer, Carpenter, & Rücker, 2015). Because Hypothesis 3 pertained to the absolute size rather than the direction of the interaction effect, the absolute value was used for all individual (pseudo) partial correlation coefficients. Furthermore, to account for the dependence between the multiple effect sizes retrieved from one common sample, we aggregated the effect sizes and variances of the two Attitude x Stop/Start System interactions to account for the two behaviors in Study 1 and the three interaction effects between attitude and (a) distance, (b) season, and (c) car ownership in Study 2 before conducting the meta-analysis. This resulted in one interaction effect size for each of the three studies (see Figure 2). Specifically, we adjusted the mean variance of Study 1's mean interaction effect for the correlation between turning off the car engine at red traffic lights and closed railroad crossings, and we adjusted the mean variance of Study 2's mean interaction effect by accounting for the correlation between the three interaction terms (for formulas, see e.g., Borenstein, Hedges, Higgins, & Rothstein, 2009).

Across the three studies, we obtained a mean effect size of the Attitude x Transportation Environment interaction of $|r_p| = .04$, 95% CI [.00, .08]. This effect was not significantly different from 0, $z = 1.79$, $p = .07$ (see Figure 2). Moreover, equivalence testing using the *R*-function *TOSTr* (Lakens, 2017) revealed that the mean effect was significantly *smaller* than $|r_p| = .10$, which is a conventional small effect, $p = .03$. As such, we concluded that the size of the interaction effect was virtually zero across the three studies. In the next section, we discuss the implications of this finding for behavioral science and policy efforts that are aimed at inducing more sustainable travel behavior.

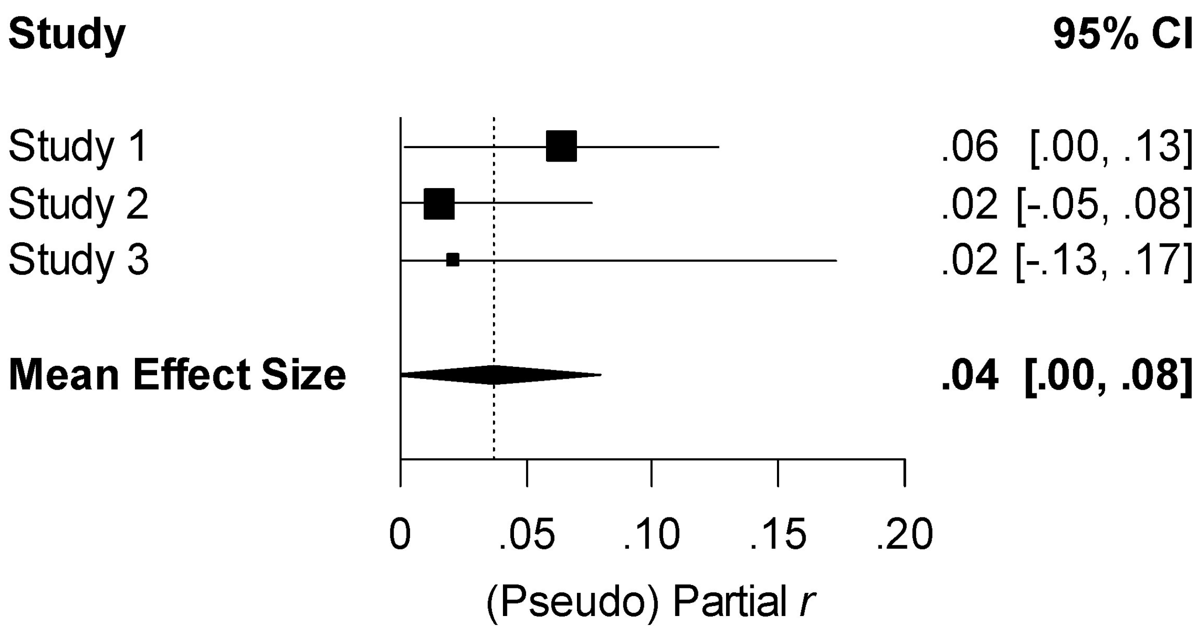

Figure 2. Forest plot of the partial correlations of the Environmental Attitude x Transportation Environment interaction in Studies 1 to 3. The two interaction terms from Study 1 and the three interaction terms from Study 2 were aggregated before they were included in the meta-analysis. The sizes of the squares in the figure indicate the study's weight in the random-effects meta-analysis. Error bars represent 95% confidence intervals (cropped at $r_p = 0$).

7. General Discussion

In this research, individual sustainable travel behavior was found to be a function of people's environmental attitude and the transportation environment. Drawing on participants' self-reports, an online scenario, and behavioral observation, and employing both quasi-experimental and experimental designs, we found that significant main effects of the constraints imposed by the transportation environment and participants' environmental attitude jointly explained their sustainable travel behavior. By contrast and in line with the Campbell Paradigm, there was no significant evidence of a statistical interaction between participants' attitudes and the transportation environment—neither within nor across studies (see Figure 2).

7.1 Implications

From a theoretical point of view, our research provides an empirical test of whether psychological propensities interact statistically with environmental factors (i.e., person-situation interactions) because this is the expectation that currently dominates social and much of environmental psychology (see e.g., Hogan, 2009; Stern, 2000). Although such interactions are rarely replicated and inherently impossible to generalize (Hogan, 2009), the interactionist perspective continues to influence theory building (for a recent example in transportation research, see e.g., Klöckner & Blöbaum, 2010). The results of our three studies, both individually and on an aggregated level, do not support the interactionist perspective. They instead concur with the Campbell Paradigm, which predicts an additive effectiveness of individual attitudes and behavioral costs. Notably, our results do not challenge the validity or the importance of previous research pertaining to the *perceived* constraints imposed by environmental factors such as the transportation environment (cf. Heath & Gifford, 2002). We rather sought to provide a new perspective by conceptualizing features of the transportation environment as determinants of behavioral costs as suggested by the Campbell Paradigm.

From a policy-making point of view, the current results imply that both lowering the behavioral costs of sustainable travel behavior by altering the transportation environment and promoting individual attitudes can be effective—and independent—ways to achieve more sustainable travel behavior. Technical solutions are already at hand for the implementation of stop/start systems (Study 1; see e.g., Fonseca et al., 2011) and more sustainable navigation systems (Study 3; see e.g., Ericsson et al., 2006). By contrast, reducing the number of cars owned per household or commute distances (Study 2) will probably require policy mixes consisting of tools such as changes to infrastructure (e.g., increased intermixing of land use, decreased numbers of low-density building projects), normative messages, and a range of economic incentives (e.g., for living close to one's job; see Garcia-Sierra & van den Bergh, 2014, for an overview), all of which would lower the respective behavioral costs. The current studies do not speak of strategies for changing people's environmental attitude. Previous research has suggested at least the potential to do so by fostering environmental knowledge (e.g., Otto & Kaiser, 2014), but this line of research awaits experimental testing.

Notably, the two approaches for achieving behavior change suggested by the Campbell Paradigm differ from the more popular differentiation between soft and hard policy measures (see e.g., Bamberg et al., 2011; Richter, Friman, & Gärling, 2011). Hard measures describe policies that, for example, increase the financial costs of car use or impose infrastructure changes that improve the quality and availability of public transportation. By contrast, soft measures describe "psychological" interventions such as the mass advertising of public transportation or educational campaigns that are aimed at increasing awareness of environmental problems related to car use. As such, the definition of soft measures confounds—in the terminology of the Campbell Paradigm—a reduction in behavioral costs (e.g., through normative pressure) and attempts to increase individuals' attitudes (e.g., through environmental education). Not surprisingly, soft measures have repeatedly been criticized for their lack of theoretical grounding (Chatterjee & Bonsall, 2009; Richter et al., 2011). As outlined above, the Campbell Paradigm can provide such a theoretical grounding and a useful framework for policy planning to induce more sustainable travel behavior (see Kaiser et al., 2010).

Finally, although ceiling and floor effects will predictably obstruct the detection of the effects of attitude and the transportation environment in the extreme range, we found no evidence of any conditional, interactive effectiveness across three independent, sociodemographically heterogeneous samples and for a number of different features of the transportation environment. The present findings thus also facilitate policy planning because they call into question the purported need to offer tailored interventions for target groups with different attitude levels (cf. Bamberg et al., 2011).

7.2 Conclusion

In this article, we presented three studies in which we tested the Campbell Paradigm, a behavioral model that—in contrast to many of the most commonly used models in transportation research (e.g., the TPB and the NAM)—accounts for the actual constraining or supporting effect of the transportation environment. In line with the Campbell Paradigm (Kaiser et al., 2010), the effects of these environmental constraints were not found to depend on a person's environmental attitude. Across three studies, the Attitude x Transportation Environment interaction was not significantly greater than zero. It was, however, significantly smaller than a conventional small effect. Although the decision between the parsimonious compensatory model suggested by the Campbell Paradigm and a more complex, interactive model is still a normative one, the incremental explanatory power of the interaction term seems to be virtually zero. This compensatory effectiveness implies that policies that shape transportation environments so that they are supportive of sustainable travel behavior will probably be effective irrespective of people's attitudes, and vice versa.

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9. Declarations of Interest

None

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Endnotes

[1] The four primary studies we pooled to create the data set for Study 1 entailed a shopping scenario in which we asked participants to select or rate everyday products (e.g., jam, paper towels; Primary Studies 1 and 2) or to explain the physical-chemical mechanism of global warming and to provide ratings of their acceptance of anthropogenic global warming after reading an explanation of the mechanism behind global warming (Primary Studies 3 and 4). The original materials are available upon request.

[2] Regressing mode choice exclusively on season essentially yielded a null effect as well, $b = -.02$ ($SE = .21$), Wald $\chi^2(1) = .01$, $p < .92$, which indicates that weather did not appear to affect travel mode choice in our case.

[3] We thank an anonymous reviewer for pointing out this limitation.