What drives people to carpool? Explaining carpooling intention from the perspectives of carpooling passengers and drivers

Bachmann, Friedel ; Hanimann, Anina ; Artho, Jürg ; Jonas, Klaus

Abstract: The negative impact of motorized private mobility on the environment can be decreased successfully by encouraging more people to carpool. From a psychological perspective, only little is known about the determinants of carpooling. Therefore, this study investigated carpooling behavior based on a theoretical background that integrates (1) the theory of planned behavior, (2) the norm activation model, and (3) dispositional trust. Additionally, we studied carpooling from two separate perspectives: Passengers sharing rides, and the drivers offering rides. We conducted a survey with a representative sample of 342 participants in Switzerland. The results showed that for both, passengers and drivers, normative aspects such as descriptive and personal norms, in combination with perceived behavioral control predicted carpooling intention. Attitude toward carpooling behavior, however, did not have any predictive power regarding carpooling intention, neither for passengers nor drivers. Dispositional trust displayed an indirect effect on intention to carpool as a passenger or driver via perceived behavioral control. Based on these results, we discuss practical implications for designing measures to promote carpooling successfully in the future.

DOI: https://doi.org/10.1016/j.trf.2018.08.022

Transportation Research Part F 59 (2018) 260–268

Contents lists available at ScienceDirect

Transportation Research Part F

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

What drives people to carpool? Explaining carpooling intention from the perspectives of carpooling passengers and drivers

Friedel Bachmann [a,*], Anina Hanimann [b], Jürg Artho [a], Klaus Jonas [c]

[a] Sozialforschungsstelle, Department of Psychology, University of Zurich, Binzmuhlestrasse 14/13, 8050 Zurich, Switzerland
[b] Department of Political Science, Faculty of Humanities and Social Sciences, University of Lucerne, Frohburgstrasse 3, 6002 Lucerne, Switzerland
[c] Social and Business Psychology, Department of Psychology, University of Zurich, Binzmuhlestrasse 14/13, 8050 Zurich, Switzerland

ARTICLE INFO

Article history:
Received 23 October 2017
Received in revised form 3 April 2018
Accepted 31 August 2018

Keywords:
Carpooling
Theory of planned behavior
Descriptive norm
Personal norm
Dispositional trust
Structural equation modeling

ABSTRACT

The negative impact of motorized private mobility on the environment can be decreased successfully by encouraging more people to carpool. From a psychological perspective, only little is known about the determinants of carpooling. Therefore, this study investigated carpooling behavior based on a theoretical background that integrates (1) the theory of planned behavior, (2) the norm activation model, and (3) dispositional trust. Additionally, we studied carpooling from two separate perspectives: Passengers sharing rides, and the drivers offering rides. We conducted a survey with a representative sample of 342 participants in Switzerland. The results showed that for both, passengers and drivers, normative aspects such as descriptive and personal norms, in combination with perceived behavioral control predicted carpooling intention. Attitude toward carpooling behavior, however, did not have any predictive power regarding carpooling intention, neither for passengers nor drivers. Dispositional trust displayed an indirect effect on intention to carpool as a passenger or driver via perceived behavioral control. Based on these results, we discuss practical implications for designing measures to promote carpooling successfully in the future.

1. Introduction

In the past few decades, people in almost all industrialized countries consumed more resources than our planet can provide long-term (Global Footprint Network, 2016). Exemplarily, if everyone consumed like a person living in Switzerland, annually 3.3 times the resources the earth can provide would be required (e.g., US: 4.8, UK: 2.9; World Wide Fund For Nature, 2014). Clearly, more sustainable ways of living have to be found and consumers' behavior has to change.

New forms of shared mobility such as carsharing, carpooling or bikesharing have emerged over the last years and are believed to be a "potential new pathway to sustainability" (Heinrichs, 2013, p. 228). In the case of carpooling – the sharing of a ride so that two or more persons travel together in a vehicle – studies have shown that it can contribute to a more sustainable way of living: For example, in San Francisco, 1.7–3.5 million liters of fuel are being conserved per year through the use of carpooling systems (Minett & Pearce, 2011). Regarding the actual energy saving potential of carpooling, it is estimated that carpooling uses nearly 30% less energy than alternative ways of transportation, such as driving alone (Arnold, Bachmann, & Haefeli, 2017). However, in Switzerland, it is still unclear how many people are using carpooling as their means

* Corresponding author.
E-mail address: friedel.bachmann@uzh.ch (F. Bachmann).

https://doi.org/10.1016/j.trf.2018.08.022
1369-8478/

of transport, as there is no official data record on that specific topic. Based on the rather low vehicle occupancy rate of 1.6 persons per vehicle, we can only assume that few people are currently carpooling (Swiss Federal Statistical Office, 2017). Consequently, the majority of vehicles not being used to their full capacity constitutes an energy saving potential that could still be exploited through better dissemination of carpooling. To exploit this energy saving potential, specific measures to promote carpooling should be developed and implemented. However, the current state of research does not provide an in-depth psychological understanding of carpooling behavior that would allow the development of specific measures to that end.

At least two reasons for this gap of research can be identified, which our study aims to address: First, to our best knowledge, carpooling behavior has so far not been studied in light of a rigorous theoretical background. In recent years, only few studies have focused on psychological factors such as psychological barriers associated with riding with strangers, poor schedule flexibility, or sociable travel (Abrahamse & Keall, 2012; Becker, Ciari, & Axhausen, 2017; Correia & Viegas, 2011; de Almeida Correia, de Abreu e Silva, & Viegas, 2013). But most of these studies considered only attitudinal factors. When trying to explain behavior, the use of theory provides a systematic approach to identifying relevant determinants of the behavior of interest and thereby allows an advanced understanding of it (Michie, West, Campbell, Brown, & Gainforth, 2014). Especially for research that ultimately aims at changing behavior, theory-driven approaches are more effective for designing specific measures and interventions (e.g., Michie, Johnston, Francis, Hardeman, & Eccles, 2008; Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016).

Second, to our knowledge, carpooling has so far not been studied in light of both relevant groups of people, namely (1) passengers who use carpooling rides ('passengers'), and (2) drivers who offer carpooling rides ('drivers'). This distinction is important because the determinants of carpooling behavior might be different across both groups: While passengers might experience uncertainty about a driver's driving skills or security in general, drivers may need to spend additional time for detours or experience uncertainty regarding a passenger's willingness to pay. Also, it is crucial to look at the behavior as specifically as possible so as to make the best prediction (e.g., Ajzen, 1991; Donald, Cooper, & Conchie, 2014).

This study contributes to the existing body of knowledge twofold: First, it provides a clear estimation of how many people actually engage in carpooling. Second, it identifies determinants of carpooling intention and possibly behavior on the basis of established psychological theories while looking at carpooling passengers and carpooling drivers separately.

1.1. Model for explaining carpooling intention and behavior

The theory of planned behavior (TPB) has been shown to be strong in predicting intentions and behavior (e.g., Armitage & Conner, 2001) and useful for designing behavior change interventions (Steinmetz et al., 2016). The basic idea of the TPB is that intention to perform a certain behavior is the main driver of behavior. Intention in turn is predicted by three determinants: attitude toward the behavior ("[...] the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question."), subjective norm ("[...] the perceived social pressure to perform or not to perform the behavior."), and perceived behavioral control ("[...] the perceived ease or difficulty of performing the behavior [...]") (Ajzen, 1991, p. 188). When the behavior is not under complete volitional control, the TPB states that, if perceived behavioral control reflects actual control over the behavior, it can be correlated with the behavior itself (e.g., de Leeuw, Valois, Ajzen, & Schmidt, 2015). The TPB was successfully applied to other forms of mobility behaviors such as travel mode choice (Bamberg, Ajzen, & Schmidt, 2003), use of public transportation (Heath & Gifford, 2002), and car use (Bamberg & Schmidt, 2003). Thus, the TPB appears well suited for our purpose of explaining carpooling behavior.

However, although the TPB has served as a useful theoretical framework to explain a wide range of behaviors, potential shortcomings need to be addressed to thoroughly study carpooling intention and the respective behavior. One shortcoming of the TPB is that it "remains under-defined with regard to the functioning of norms" (Nigbur, Lyons, & Uzzell, 2010, p. 259). A meta-analytic review found the normative component of the TPB, the subjective norm, to be the weakest determinant of intention (Armitage & Conner, 2001). Considering the theory of normative conduct (Cialdini, Reno, & Kallgren, 1990), which distinguishes two types of social norms, namely injunctive (specifying what others approve or disapprove of) and descriptive norm (specifying what most others do), Ajzen's original operationalization of the subjective norm only covers the injunctive type (Ajzen, 1991, p. 195; Ajzen & Driver, 1992). Studies have shown (for an overview see Rivis & Sheeran, 2003) that descriptive norms play an important role in predicting intention, which has also been shown for the context of mobility behavior (Heath & Gifford, 2002). Some studies even found only the descriptive norm to be a significant predictor of intention. Exemplarily, de Leeuw et al. (2015) found that pro-environmental behaviors such as showering for less than 20 minutes or recycling were, besides attitude and perceived behavioral control, predicted only by the descriptive norm and not the injunctive norm.

A second shortcoming of the TPB lies within the fact that social norms are not the only normative predictors of behavior related to the environment. People also act upon feelings of moral obligation to engage in a certain behavior (Schwartz, 1977). Schwartz's norm-activation model (NAM) describes these feelings as a *personal norm*, defining it as self-expectations based on internalized values. In the context of travel mode choice, studies have shown that personal norm influences intention above and beyond the determinants of the TPB and therefore enhances the predictive power of the model (e.g., Bamberg, Hunecke, & Blöbaum, 2007; Harland, Staats, & Wilke, 1999; Nigbur et al., 2010; Nordlund & Garvill, 2003). It is therefore worthwhile investigating the effect of personal norm on intention, in addition to the determinants of the TPB.

A third shortcoming is that the theory offers no specification where the attitudinal, normative, and control beliefs originate. Individual differences such as factors of personal nature (e.g., Cristea, Paran, & Delhomme, 2013; de Leeuw et al., 2015; Rhodes, Courneya, & Hayduk, 2002) have been shown to influence intention indirectly through attitude, social norm and perceived behavioral control when added to the TPB as a proximal determinant (Ajzen, 2011). Especially when people face situations of uncertainty, individual differences regarding trust in others have been shown to play an important role when making decisions (Acar-Burkay, Fennis, & Warlop, 2014; Sorrentino & Roney, 2000). Trust in others may therefore influence people's formation of underlying behavioral beliefs. Specifically, higher trust in others may influence people's attitudinal beliefs regarding a more positive evaluation of behavioral consequences, normative beliefs regarding a higher emphasis on others behaviors, and control beliefs in terms of assessing carpooling behavior to be easier as you are confident of what to expect from your carpooling partner. Additionally, we are looking at carpooling interactions that initially occur over internet platforms, where, according to McKnight, Choudhury, and Kacmar (2002), trust in others is a necessary prerequisite. This includes disposition to trust, defined as "the extent to which a person displays a tendency to be willing to depend on others" (McKnight et al., 2002, p. 339). Therefore, we assume that implementing dispositional trust as a proximal determinant to the model furthers our understanding of carpooling intention.

1.2. Model and hypotheses

Fig. 1 shows the model to be tested regarding carpooling passengers and carpooling drivers. We expect the intention to carpool as a passenger or as a driver to be the main predictor of a person's carpooling behavior. Intention, in turn, is expected to be determined by attitude toward the behavior, descriptive norm, perceived behavioral control and personal norm. Dispositional trust is expected to influence intention indirectly through the TPB constructs.

2. Method

2.1. Sample and procedure

The data was collected in Switzerland in two waves: In the first wave (May/June 2015), data on all the factors up to and including intention were collected. In the second wave, six months later, self-reported behavior was measured in order to approximate the causal process of first forming an intention and then exhibiting a behavior at some point later. Participants were recruited with the help of the Swiss Federal Statistical Office, which provided 3000 postal addresses representative for the French and German speaking part of the Swiss population. Potential participants were invited by letter to register for the study by mailing back a pre-paid envelope containing their consent to participate and their e-mail address for further correspondence. A total of 504 persons registered for the study, resulting in a response rate of 17%. Participants subsequently received the invitation to the online questionnaire via e-mail.

Participants filled out only one version of two questionnaires, depending on their prior experience with carpooling: If they had ever offered rides via carpooling platforms, they were directed to the 'driver' version of the questionnaire, and if they had carpooled as a passenger, they were directed to the 'passenger' version. Participants that had experience with both types of carpooling behaviors or none at all were assigned to a questionnaire version randomly. This was done to prevent having persons who had actual experience as drivers offering rides or as passengers from filling out the questionnaire for the other type of carpooling behavior.

After excluding persons who (a) did not retrieve the online questionnaire at all, and (b) spent less than a minute or more than an hour answering (mean answering time in the first wave was 21 minutes), the total sample comprised 342

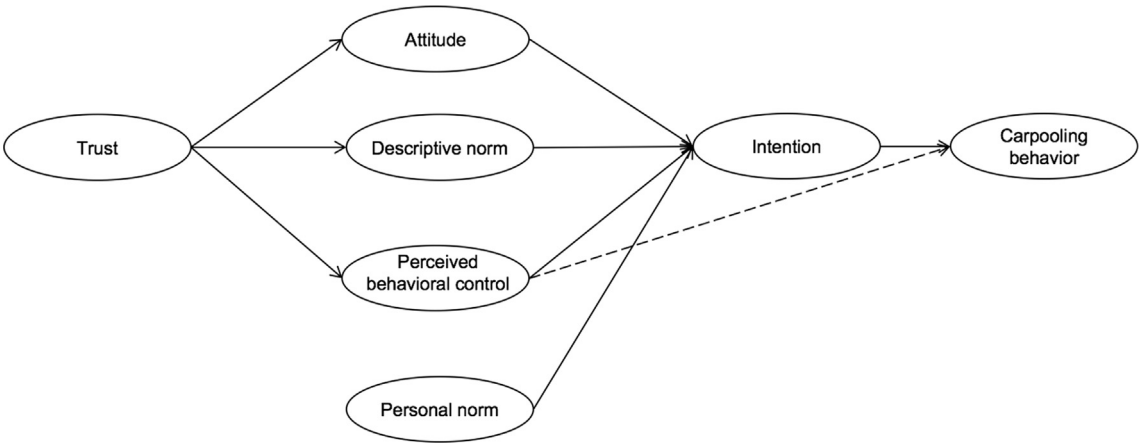

Figure 1. Proposed behavioral model for explaining carpooling behavior as a passenger and as a driver.

participants (response rate 68%) with 181 participants in the carpooling passenger subsample and 161 participants in the carpooling driver subsample. In the second wave 51% of the initial participants completed the questionnaire containing the measure for self-reported carpooling behavior. In the passenger subsample, 53% were women, and their age ranged from 18–65 ($M = 42.8$, $SD = 12.8$). In the driver subsample, 49% were women, and their age ranged from 19–65 ($M = 43.5$, $SD = 11.8$). Based on age and gender, both subsamples can be considered close to representative of the Swiss population (Swiss Federal Statistical Office, 2015).

2.2. Measures

The two versions of the questionnaire, the driver and the passenger version, contained the same items, which only differed in the wording "use a ride as a passenger" versus "offer a ride as a driver" (see examples below). All variables of interest were measured using a five-point rating scale with the verbal anchors "strongly disagree" and "strongly agree", if not mentioned otherwise.

The scales for attitude towards the behavior, descriptive norm, perceived behavioral control, and intention were constructed following Ajzen (2006). **Attitude** was measured by four items using a five-point semantic differential (e.g., "Generally, using/offering a ride as a passenger/driver via a carpooling platform is good ... bad"). **Descriptive norm** (e.g., "Most people who are important to me will be using/offering a ride as a passenger/driver via a carpooling platform within the next six months") and **perceived behavioral control** ("If I wanted, I could use/offer a ride as a passenger/driver via a carpooling platform within the next six months") were measured by four items, respectively. **Intention** was measured by three items (e.g., "I intend to use/offer a ride as a passenger/driver via a carpooling platform within the next six months").

Three items to measure **personal norm** were in part adapted from previous studies (Abrahamse, Steg, Gifford, & Vlek, 2009; De Groot & Steg, 2007) and in part developed for this particular study to fit the context (e.g., "I feel an obligation towards the environment to use/offer a ride as a passenger/driver via a carpooling platform").

Dispositional trust was measured using six items (e.g., "In general, most folks keep their promises") that are part of an elaborate scale developed specifically for measuring trust in the context of e-commerce (McKnight et al., 2002) which suits our investigation of using and offering a ride via an internet carpooling platform.

Carpooling behavior was measured by asking the participants, "How many times did you use/offer a ride in the past six months?". They indicated the actual number of having been a carpooling passenger or driver in the past six months.

Additionally, both versions of the questionnaire captured the demographic variables age and gender.

2.3. Data analysis

We analyzed the data using latent variable modeling (LVM) because this method allows to test multivariate models in a methodologically rigorous manner and, also, allows for the acknowledgement for measurement error (Kline, 2011). First, we checked whether the assumptions of LVM held by (1) checking for the amount of missing data and (2) investigating whether the data were multivariately normally distributed. Second, to assess the fit of the proposed measurement model to the empirical data, confirmatory factor analyses (CFA) were conducted. Additionally, in light of the two groups considered in our data collection, namely carpooling passengers and drivers, we also tested whether measurement invariance held across these two groups to assess the adequacy of a multigroup comparison approach. Third, structural equation modeling (SEM) was used to test the substantive relationships between the constructs and, thus, our hypotheses. Dependent on whether measurement invariance across the two groups can be assumed, we followed the multigroup SEM approach (Steinmetz, 2014).

All of the statistical analyses were conducted using the software R (Version 3.4.3; R Core Team, 2017) and, specifically, the R package *lavaan* (Version 0.6-1.1157; Rosseel, 2012) as well as the R package *semTools* (Version 0.4-14; semTools Contributors, 2016) for the LVM.

3. Results

3.1. Descriptive statistics and tests for assumptions

Table 1 displays the descriptive statistics and alpha reliabilities as well as the zero-order correlations for the carpooling passenger as well as the carpooling driver subsample. Concerning self-reported behavior, only 5 (6%) and 3 (4%) participants in the passenger and driver subsample, respectively, reported having used carpooling one or more times. Although this is a relevant result, which will be discussed in more detail in the discussion section, the behavioral variable was excluded from further analysis due to a lack of variance. A missing values analysis revealed less than 5% missing data, which was addressed by using the full information maximum likelihood estimator in the subsequent LVM (Kline, 2011). As the assumption of multivariate normality was not met, LVM was conducted using the robust maximum likelihood estimator (MLR) as recommended by Steinmetz (2014). Further, addressing the model's complexity as well as the rather small sample size, we reduced the indicator-to-sample size ratio by creating parcels following the construct-to-item-balance approach (Little, Cunningham, Shahar, & Widaman, 2002; Little, Rhemtulla, Gibson, & Schoemann, 2013).

Table 1
Means, Standard Deviations, Alpha Reliabilities, and Zero-Order Correlations for Carpooling Passengers and Carpooling Drivers.

	M	*SD*	1	2	3	4	5	6	7	8	9
Demographic Variables											
1. Gender (female = 1, male = 2)	1.47/1.51	0.50/0.50	–	.11	−.02	.11	.11	−.14	.00	−.02	−.11
2. Age	42.76/43.49	12.75/11.76	.20*	–	.09	−.07	−.10	−.01	.18*	−.08	−.04
Model Variables											
3. Attitude	3.77/3.82	0.77/0.82	−.18*	.02	**(.77/.81)**	.27***	.40***	.41***	.39***	.38***	.20
4. Descriptive Norm	2.26/1.98	1.03/0.93	−.02	.07	.25**	**(.90/.86)**	.32***	.42***	.10	.61***	.19
5. Perceived Behavioral Control	3.31/3.06	0.93/1.05	.04	−.17*	.33***	.33***	**(.71/.75)**	.31***	.20*	.59***	.22
6. Personal Norm	2.28/2.56	1.04/1.12	−.16*	.08	.40***	.34***	.23**	**(.86/.84)**	.20*	.65***	.26*
7. Dispositional Trust	3.45/3.55	0.73/0.73	−.12	.07	.29***	.10	.25**	.16*	**(.83/.82)**	.10	.14
8. Intention	2.15/2.13	1.00/1.07	−.05	−.05	.46***	.54***	.51***	.62***	.17*	**(.90/.92)**	.28*
9. Carpooling Behavior	0.45/0.09	3.31/0.51	.12	−.06	.00	.00	.12	−.14	−.18	.07	–

Note. Values from the passengers subsample (n = 181) before slash (M, SD) and below diagonal (correlations); values from the drivers subsample (n = 161) after slash and above diagonal. When appropriate, Cronbach's alpha values are shown on the diagonal in parentheses.
* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-tailed).

3.2. Confirmatory factor analyses and measurement invariance

First, we conducted a confirmatory factor analysis to evaluate the fit of our proposed model including the six factors attitude, descriptive norm, perceived behavioral control, personal norm, trust, and intention. To evaluate acceptable model fit the CFAs were analyzed based on five fit indices following Hu and Bentler's (1999) recommendations: (1) absolute test of fit, χ^2, (2) comparative fit index (CFI) $\geq$.95, (3) Tucker Lewis index (TLI) $\geq$.95, (4) root mean square error of approximation (RMSEA) $\leq$.06, and (5) standardized root mean square residual (SRMR) $\leq$.08. Results show acceptable fit of our data to the CFA model (χ^2 (208) = 292.98, $p < .001$; CFI = .97; TLI = .96; RMSEA = .05 [.04 .06, p = .52]; SRMR = .05).

Additionally, as shown in Table 2, the postulated model was compared to other, plausible measurement models: The six-factor solution showed a better fit to our data than a five-factor model where both norm factors (descriptive norm and personal norm) were combined or a four-factor model with all of the TPB factors (attitude, descriptive norm, perceived behavioral control) combined. These results support the notion of discriminant validity of the proposed six-factor measurement model.

Furthermore, we tested for measurement invariance to establish whether our data from the two subsamples, regarding becoming a carpooling passenger or a driver, can be fitted to one model using multigroup comparison. We tested measurement invariance through a series of model comparisons (e.g., van de Schoot, Lugtig, & Hox, 2012) and results indicated that metric invariance can be assumed, meaning that respondents in the carpooling passenger as well as in the carpooling driver subsample attribute the same meaning to our latent constructs under study. Therefore, our data can be analyzed in one model using the multigroup SEM approach in the next step (see Table 3).

Table 2
Confirmatory Factor Analyses and Comparison of Three Measurement Models Using CFA.

Model	χ^2	*df*	*p*	CFI	TLI	RMSEA	CI 90%		SRMR
							Lower	Upper	
6 factors*	292.98	208	<.001	.97	.96	.05	.04	.06	.05
5 factors	567.52	218	<.001	.87	.84	.10	.09	.11	.08
4 factors	736.79	226	<.001	.82	.78	.12	.11	.13	.09

Note. N = 334 (complete sample); CFI, comparative fit index; TLI, Tucker Lewis index; RMSEA, root-mean-square error of approximation; CI, confidence interval; SRMR, standardized root-mean-square residual. The 90% confidence interval refers to the RMSEA and tests whether close fit of the model to the data (RMSEA $\leq$ .08) can be assumed.
* Indicates the postulated measurement model. This model was used for further analyses.

Table 3
Test of Measurement Invariance across Carpooling Passengers and Drivers.

Model	Factors	χ^2	*df*	*p*	CFI	RMSEA	AIC	BIC
1	Configural Invariance	302.77	208		.97	.05	13.147	13.650
2	Metric Invariance (loadings)	322.10	219	.06	.96	.05	13.145	13.606
3	Scalar Invariance (loadings, and intercepts)	344.47	230	.02*	.96	.05	13.145	13.564
4	Full Uniqueness Invariance (loadings, intercepts, and means)	370.67	236	.00***	.95	.06	13.159	13.556

Note. CFI, comparative fit index; RMSEA, root-mean-square error of approximation; AIC, Akaike information criterion; BIC, Bayesian information criterion; n(carpooling passenger) = 176; n(carpooling driver) = 158.

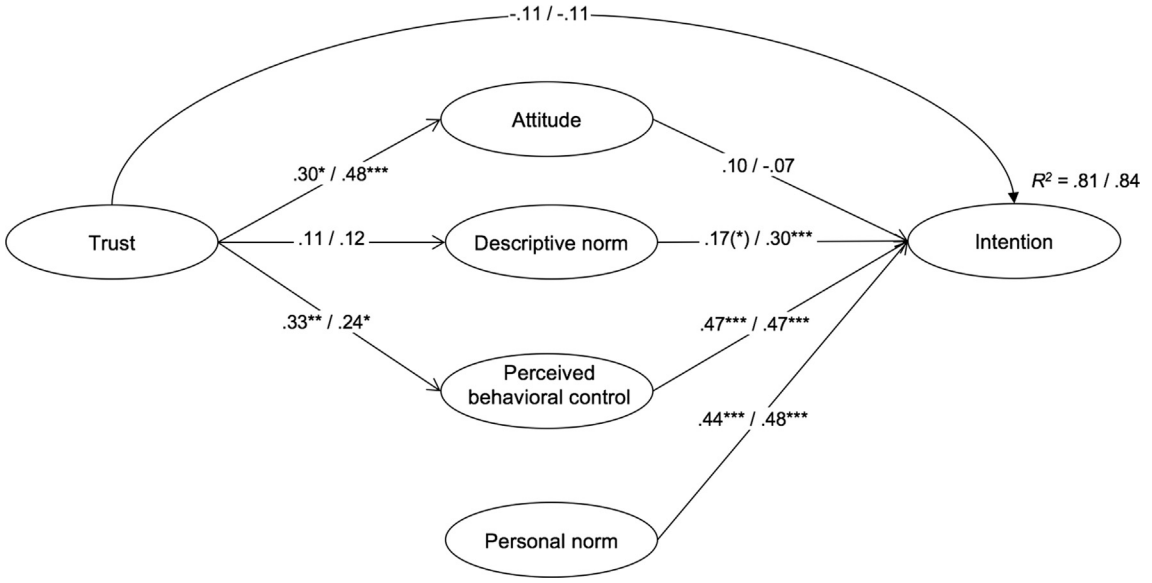

Figure 2. Standardized structural path coefficients of the final structural equation model. Values from the passengers subsample (n = 176) before slash, values from the drivers subsample (n = 158) after slash. (*) $p < .1$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

3.3. Multigroup structural equation model

The model was tested using the multigroup SEM approach (e.g., Steinmetz, 2014). The overall fit of the model is acceptable (χ^2 (208) = 292.98, $p < .001$; CFI = .97; TLI = .96; RMSEA = .05 [.04 .06, $p = .52$]; SRMR = .05) and was therefore considered to be a valid representation of the data (see Fig. 2).

Carpooling passengers. For passengers, 81% of the variance in intention to use carpooling could be explained by our model. While behavioral control and personal norm had a strong significant influence on intention to carpool as a passenger, the descriptive norm only yielded a marginally significant influence ($p < .1$). However, attitude did not have a significant influence on intention to use carpooling. The background factor trust was tested for indirect effects on intention through attitude, descriptive norm, or perceived behavioral control, and a significant indirect influence on intention to use carpooling through perceived behavioral control was detected (trust-attitude-intention: $b^{*} = -.03$; trust-descriptive norm-intention: $b^{*} = .04$; trust-perceived behavioral control-intention: $b^{*} = .12$, $p < .05$).

Carpooling drivers. For drivers, 84% of the variance in intention to offer carpooling rides as a driver could be explained by our model, with the descriptive norm, behavioral control, and personal norm having a significant influence on intention to carpool as a driver. Again, attitude did not have a significant influence on intention to offer carpooling rides as a driver. The background factor trust was tested for indirect effects on intention through attitude, descriptive norm, or perceived behavioral control, and a significant indirect influence on intention to offer carpooling rides through perceived behavioral control was detected (trust-attitude-intention: $b^{*} = .03$; trust-descriptive norm-intention: $b^{*} = .02$; trust-perceived behavioral control-intention: $b^{*} = .15^{*}$, $p < .05$).

3.4. Comparing the TPB to the extended version

To test whether the theoretical extension of the TPB by adding personal norm as a direct predictor of carpooling intention does in fact enhance the predictive power of carpooling intention, the postulated model was tested against a model where only the original TPB constructs were set as free parameters to explain carpooling intention and the coefficient for the path between personal norm and carpooling intention was set to zero (Kline, 2011). Results show that the model fit of the restrained model (i.e., the original TPB) was significantly worse (χ^2 (214) = 449.26, $p < .001$; CFI = .92; TLI = .89; RMSEA = .08 [CI 90%: .07 .09, $p < .001$]; SRMR = .14; $\Delta\chi^2$ (6) = 175.44, $p < .001$). Additionally, adding personal norm as a direct predictor of carpooling intention to the framework of the TPB enhanced the explained variance on carpooling intention from 68.1% to 81.1.0% (ΔR^2 13.0%) in the carpooling passengers subsample and from 69.5% to 84.0% (ΔR^2 14.5%) in the carpooling drivers subsample.

4. Discussion

The main goal of this study was to explain carpooling intention and behavior on a theory-informed basis. Especially in Switzerland and presumably in other countries as well, carpooling could play an important role in the transition to a more

sustainable way of living. By drawing on existing research in the field of transportation research and research on environmentally related behaviors, a behavioral model based on the TPB and NAM was applied to identify relevant determinants of carpooling intention. This was done looking separately at carpooling passengers and drivers. Below, three main findings are discussed.

First, the theoretical framework proved to be useful in providing new insights into the underlying determinants of carpooling behavior. Our results support the notion from previous research that the predictive power of the TPB constructs can be improved by adding personal norm (Bamberg & Schmidt, 2003). This adds to the existing literature in the field of mobility research showing that the normative component of feeling an obligation to engage in carpooling behavior (personal norm) is not covered in the original TPB (Nigbur et al., 2010).

Second, attitude toward the behavior does not predict carpooling intention neither for carpooling passengers nor for carpooling drivers. This is a rather interesting result, as it contradicts other studies which mainly looked at attitudinal factors and found them to be important in predicting carpooling intention or travel mode choice in general (Becker et al., 2017; de Almeida Correia et al., 2013). This clearly emphasizes the importance of considering a wider range of determinants with a possible influence on intention or behavior. Also, when it comes to behavior that is rather infrequent, people possibly tend to form their intention by relying more on what their social environment is doing (descriptive norm) or what their own moral values suggest that they do (personal norm). Attitude, reflecting underlying attitudinal beliefs, is a more cost-benefit kind of consideration, where financial benefits, travel comfort, expenditure of time, social contact, and so on are considered, and this becomes more difficult the less people are familiar with the actual behavior. This is in line with the finding that people tend to use normative information in situations of uncertainty as opposed to more systematic information processing by weighing attitudinal beliefs (Smith, Hogg, Martin, & Terry, 2007). With the aim of encouraging more people to carpool, the identification of normative factors as key predictors, especially for becoming a carpooling driver, is an important piece of information.

Third, dispositional trust has an indirect influence on intention to carpooling as a passenger as well as a driver through perceived behavioral control. This indicates that people who are more trusting toward strangers see themselves more capable of becoming a carpooling passenger or driver and, therefore, are more inclined to form an intention to actually do so. Given dispositional trust as an important factor for promoting carpooling, it is also important to note that dispositional trust can be considered to be a form of personality trait, which could be more difficult to influence or even change (Evans & Revelle, 2008). Therefore, when planning to promote carpooling, trust needs to be addressed by shaping the carpooling program (rather than trying to influence persons themselves) in such a way that even people with lower trust toward strangers are not discouraged from joining or offering carpooling rides.

4.1. Practical implications

In the case of carpooling, commuters who drive to work in their private vehicle are the group with the most promising energy saving potential (Arnold et al., 2017). Therefore, one of the most effective ways to exploit these energy saving potentials would be for private companies or public institutions to implement carpool programs. Based on our data and the literature on carpooling, we draw practical conclusions and would emphasize four aspects for designing an effective carpool program:

(1) Make it as simple as possible. As our data suggests, people who perceive carpooling to be easy to use and consider themselves being able to carpool have an increased intention to carpool as a passenger or as a driver (perceived behavioral control). Hence, eliminating possible obstacles, such as not being able to find a carpooling partner, by offering a suitable app or, in a company, by organizing meetings to match people who live near each other, could be a possible solution. A company can also offer to compensate for the trip back home if no carpool is found.
(2) Create conditions of trust. The implementation of a carpooling program within a company carries a particular advantage: People are more likely to participate in carpool programs, as working at the same company establishes a base level of trust between the participants (Correia & Viegas, 2011; Kurth & Hood, 1977). Therefore, even people with lower dispositional trust could be encouraged to carpool.
(3) Make carpoolers visible. People have higher intentions to carpool when they believe others are carpooling (descriptive norm). Making carpoolers visible, therefore, could encourage more people to start carpooling. Car stickers showing that a vehicle is used for carpooling, for example, could provide a signal to other drivers. A company could also publish percentages of how many employees are carpooling.
(4) Emphasize environmental benefits. People who feel a moral obligation to protect the environment have a higher intention to carpool as a passenger or as a driver, when they are informed that carpooling is in fact a more sustainable alternative to driving alone (personal norm). This could be done by displaying CO_2 savings when carpooling in an app or, in a company, by informational presentations, company newsletters, and so on.

4.2. Limitations and future research

This study gained new insights into why people engage in carpooling and did so on a more specific and theoretically informed basis. Nevertheless, it falls short in two main aspects: First, due to too few users of carpooling, it was not possible to explain carpooling *behavior* neither for the passenger nor the driver subsample. However, by recruiting a representative

sample, we were able to provide a percentage on how many people engage in carpooling, which, to our knowledge, has not been done yet. For future research, choosing another sampling method and recruiting more carpooling users to further our knowledge on the intention-behavior relationship seems crucial. However, it is important to note that becoming a carpool passenger or driver is a process. According to Bamberg's model of self-regulated behavior change (Bamberg, 2013), people pass through several stages of decision making prior to taking action. Explaining carpooling intention on a theory-informed basis is a first step in understanding this whole process. It produced valuable insights, especially showing the importance of normative components when explaining carpooling intention.

Second, our findings are based on correlational data, which means that the relationships between the factors cannot be interpreted as causal relationships. Although the data fit the proposed model adequately, it cannot be excluded that other models would fit the data as well. Future studies should enhance our understanding by using experimental designs, not only testing the relationships between the factors for their coherence but also manipulating different aspects of carpool programs to find the best way to promote carpooling.

5. Conclusion

Although carpooling could play an important role in the transition to more sustainable forms of mobility, only little is known about why people engage in carpooling. This study provides a theory-informed approach to explaining carpooling behavior based on established psychological theories. Furthermore, to the knowledge of the authors, it is the first study that differentiates between carpooling passengers and carpooling drivers, which is important considering that both sides are needed to sustain a successful carpooling system. Our results suggest that for both types of carpooling behavior and in contrast to previous research, attitude toward carpooling is less important compared to the descriptive and personal norm. The importance of normative factors as determinants of carpooling behavior becomes particularly apparent when designing measures to promote carpooling behavior. Furthermore, in Switzerland, only few people engage in carpooling behavior. Therefore, the descriptive norm, reflecting carpooling as a legitimate means of transport and the personal norm, reflecting the importance of every individual's contribution to a more sustainable form of mobility, need to be established to increase the number of carpoolers who can eventually contribute to a more sustainable mobility.

Acknowledgements

The authors wish to thank Ueli Haefeli and Daniel Matti for their valuable support in this project and Grégoire Bollmann, Martin Götz, and Hans-Joachim Mosler for their insightful comments on earlier drafts of this paper. This study was financially funded by the Swiss National Science Foundation NRP 71 "Managing energy consumption" programme (No. 153677).

References

Abrahamse, W., & Keall, M. (2012). Effectiveness of a web-based intervention to encourage carpooling to work: A case study of Wellington, New Zealand. *Transport Policy, 21*, 45–51. https://doi.org/10.1016/j.tranpol.2012.01.005.

Abrahamse, W., Steg, L., Gifford, R., & Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality? *Transportation Research Part F: Traffic Psychology and Behaviour, 12*(4), 317–324. https://doi.org/10.1016/j.trf.2009.04.004.

Acar-Burkay, S., Fennis, B. M., & Warlop, L. (2014). Trusting others: The polarization effect of need for closure. *Journal of Personality and Social Psychology, 107*(4), 719–735. https://doi.org/10.1037/a0037022.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211.

Ajzen, I. (2006). Constructing a theory of planned behavior questionnaire: Conceptual and methodological considerations. Retrieved from http://people.umass.edu/aizen/tpb.html.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health, 26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995.

Ajzen, I., & Driver, B. L. (1992). Application of the theory of planned behavior to leisure choice. *Journal of Leisure Research, 24*(3), 207–224.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*, 471–499.

Arnold, T., Bachmann, F., & Haefeli, U. (2017). Sharing economy: Blosser Hype oder echtes Versprechen? [Sharing economy: Hype or promise?]. *Strasse und Verkehr, 6*, 27–33.

Bamberg, S. (2013). Changing environmentally harmful behaviors: A stage model of self-regulated behavioral change. *Journal of Environmental Psychology, 34*, 151–159. https://doi.org/10.1016/j.jenvp.2013.01.002.

Bamberg, S., Ajzen, I., & Schmidt, P. (2003). Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action. *Basic and Applied Social Psychology, 25*(3), 175–187. https://doi.org/10.1207/S15324834BASP2503_01.

Bamberg, S., Hunecke, M., & Blöbaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies. *Journal of Environmental Psychology, 27*(3), 190–203. https://doi.org/10.1016/j.jenvp.2007.04.001.

Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment & Behavior, 35*(2), 264–285. https://doi.org/10.1177/0013916502250134.

Becker, H., Ciari, F., & Axhausen, K. W. (2017). Comparing car-sharing schemes in Switzerland: User groups and usage patterns. *Transportation Research Part A: Policy and Practice, 97*, 17–29. https://doi.org/10.1016/j.tra.2017.01.004.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58*(6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015.

Correia, G., & Viegas, J. M. (2011). Carpooling and carpool clubs: Clarifying concepts and assessing value enhancement possibilities through a stated preference web survey in Lisbon, Portugal. *Transportation Research Part A: Policy and Practice, 45*(2), 81–90. https://doi.org/10.1016/j.tra.2010.11.001.

Cristea, M., Paran, F., & Delhomme, P. (2013). Extending the theory of planned behavior: The role of behavioral options and additional factors in predicting speed behavior. *Transportation Research Part F: Traffic Psychology and Behaviour, 21*, 122–132. https://doi.org/10.1016/j.trf.2013.09.009.

de Almeida Correia, G. H., de Abreu e Silva, J., & Viegas, J. M. (2013). Using latent attitudinal variables estimated through a structural equations model for understanding carpooling propensity. *Transportation Planning and Technology, 36*(6), 499–519. https://doi.org/10.1080/03081060.2013.830894.

De Groot, J. I. M., & Steg, L. (2007). Value orientations and environmental beliefs in five countries: Validity of an instrument to measure egoistic, altruistic and biospheric value orientations. *Journal of Cross-Cultural Psychology, 38*(3), 318–332. https://doi.org/10.1177/0022022107300278.
de Leeuw, A., Valois, P., Ajzen, I., & Schmidt, P. (2015). Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. *Journal of Environmental Psychology, 42*, 128–138. https://doi.org/10.1016/j.jenvp.2015.03.005.
Donald, I. J., Cooper, S. R., & Conchie, S. M. (2014). An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use. *Journal of Environmental Psychology, 40*, 39–48. https://doi.org/10.1016/j.jenvp.2014.03.003.
Evans, A. M., & Revelle, W. (2008). Survey and behavioral measurements of interpersonal trust. *Journal of Research in Personality, 42*(6), 1585–1593. https://doi.org/10.1016/j.jrp.2008.07.011.
Global Footprint Network (2016). National footprint account results (2016 Edition). Retrieved March 8, 2017, from http://www.footprintnetwork.org/.
Harland, P., Staats, H., & Wilke, H. A. M. (1999). Explaining proenvironmental intention and behavior by personal norms and the theory of planned behavior. *Journal of Applied Social Psychology, 29*(12), 2505–2528. https://doi.org/10.1111/j.1559-1816.1999.tb00123.x.
Heath, Y., & Gifford, R. (2002). Extending the theory of planned behavior: Predicting the use of public transportation. *Journal of Applied Social Psychology, 32*, 2154–2185. https://doi.org/10.1111/j.1559-1816.2002.tb02068.x.
Heinrichs, H. (2013). Sharing economy: A potential new pathway to sustainability. *GAIA, 22*(4), 228–231.
Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118.
Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York: The Guilford Press.
Kurth, S. B., & Hood, T. C. (1977). Car-pooling programs: Solution to a problem? *Transportation Research Record, 650*, 48–53.
Little, T. D., Cunningham, W. A., Shahar, G., & Widaman, K. F. (2002). To parcel or not to parcel: Exploring the question, weighing the merits. *Structural Equation Modeling: A Multidisciplinary Journal, 9*(2), 151–173. https://doi.org/10.1207/S15328007SEM0902_1.
Little, T. D., Rhemtulla, M., Gibson, K., & Schoemann, A. M. (2013). Why the items versus parcels controversy needn't be one. *Psychological Methods, 18*(3), 285–300. https://doi.org/10.1037/a0033266.
McKnight, D. H., Choudhury, V., & Kacmar, C. (2002). Developing and validating trust measures for e-commerce: An integrative typology. *Information Systems Research, 13*(3), 334–359. https://doi.org/10.1287/isre.13.3.334.81.
Michie, S., Johnston, M., Francis, J., Hardeman, W., & Eccles, M. (2008). From theory to intervention: Mapping theoretically derived behavioural determinants to behaviour change techniques. *Applied Psychology, 57*(4), 660–680. https://doi.org/10.1111/j.1464-0597.2008.00341.x.
Michie, S., West, R., Campbell, R., Brown, J., & Gainforth, H. (2014). *ABC of behavior change theories*. UK: Silverback Publishing.
Minett, P., & Pearce, J. (2011). Estimating the energy consumption impact of casual carpooling. *Energies, 4*(1), 126–139. https://doi.org/10.3390/en4010126.
Nigbur, D., Lyons, E., & Uzzell, D. (2010). Attitudes, norms, identity and environmental behaviour: Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme. *British Journal of Social Psychology, 49*(2), 259–284. https://doi.org/10.1348/014466609X449395.
Nordlund, A. M., & Garvill, J. (2003). Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. *Journal of Environmental Psychology, 23*(4), 339–347. https://doi.org/10.1016/S0272-4944(03)00037-9.
R Core Team (2017). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.r-project.org/.
Rhodes, R. E., Courneya, K. S., & Hayduk, L. A. (2002). Does personality moderate the theory of planned behavior in the exercise domain? *Journal of Sport and Exercise Psychology, 24*(2), 120–132. https://doi.org/10.1123/jsep.24.2.120.
Rivis, A., & Sheeran, P. (2003). Descriptive norms as an additional predictor in the theory of planned behaviour: A meta-analysis. *Current Psychology, 22*(3), 218–233. https://doi.org/10.1007/s12144-003-1018-2.
Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36.
Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology, 10*, 221–279. https://doi.org/10.1016/S0065-2601(08)60358-5.
semTools Contributors (2016). semTools: Useful tools for structural equation modeling. R package version 0.4-14. Retrieved from https://cran.r-project.org/package=semTools.
Smith, J. R., Hogg, M. A., Martin, R., & Terry, D. J. (2007). Uncertainty and the influence of group norms in the attitude-behaviour relationship. *British Journal of Social Psychology, 46*(4), 769–792. https://doi.org/10.1348/014466606X164439.
Sorrentino, R. M., & Roney, C. J. R. (2000). *The uncertain mind: Individual differences in facing the unknown*. Philadelphia, PA: Psychology Press.
Steinmetz, H. (2014). *Lineare Strukturgleichungsmodelle: Eine Einführung mit R [Linear structural equation models: An introduction with R]*. München: Rainer Hampp Verlag.
Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P., & Kabst, R. (2016). How effective are behavior change interventions based on the theory of planned behavior? *Zeitschrift Für Psychologie, 224*(3), 216–233. https://doi.org/10.1027/2151-2604/a000255.
Swiss Federal Statistical Office (2015). Permanent and non permanent resident population by canton, sex, residence permit, place of birth and age. Retrieved September 28, 2017, from https://www.bfs.admin.ch/bfs/en/home/statistics/population.assetdetail.188980.html.
Swiss Federal Statistical Office (2017). Verkehrsverhalten der Bevölkerung 2015 [Population's traffic behavior 2015]. Retrieved October 16, 2017, from https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr/verkehrsverhalten.assetdetail.1840604.html.
van de Schoot, R., Lugtig, P., & Hox, J. (2012). A checklist for testing measurement invariance. *European Journal of Developmental Psychology, 9*(4), 486–492. https://doi.org/10.1080/17405629.2012.686740.
World Wide Fund For Nature (WWF) (2014). Living planet report 2014. Retrieved from http://www.icao.int/safety/Documents/ICAO_2014 Safety Report_final_02042014_web.pdf.