Theory-Driven Subgroup-Specific Evaluation of an Intervention to Reduce Private Car Use[1]

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In the context of a 2-wave panel study, we used Ajzen's (1991) theory of planned behavior (TPB) as the theoretical framework for deriving and systematically testing hypotheses as to how an intervention (a "free" ticket for public transportation) influences the travel-mode choice of students. The empirical results show that this intervention caused a drastic decrease in students' car use. The effect of the intervention on behavior is mediated by the causal chain postulated by the TPB. In the second step, we analyzed whether there were subgroup-specific reactions to the intervention. Surprisingly, the subgroup analysis shows that students with more negative attitudes toward policy measures restricting car use reacted more strongly to the intervention than did students with a more positive attitude.

The focus of the present study is the evaluation and theory-driven explanation of the effects of an environmental policy measure aiming to reduce students' car use for university routes. At present, in the literature one finds only weakly interconnected lines of research on this question. One line concentrates on environmental behavior change, as targeted by behavior analysts and others designing interventions to encourage environmental preservation behavior (Dwyer, Leeming, Cobern, Porter, & Jackson, 1993; Geller et al., 1990; Geller, Winett, & Everett, 1982; Kruse & Arit, 1984). If Dwyer et al. are right, this research had its first peak in the late 1970s and 1980s, and it is stagnating at the moment. According to Dwyer et al., behavioral scientists became discouraged by the lack of support and the difficulty of working with large systems, public policies, and deeply ingrained cultural practices, in spite of some successful demonstrations. Another problem that can be identified in much of the work in this area is the lack of a clear theoretical framework for developing and studying the effects of social-science-based interventions.

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The other research program consists of research on the determinants of environmental behavior. One main goal of this research is the development of models to explain and predict environmental behavior. Especially in the 1970s and 1980s, many of these studies were exploratory in nature (for an overview, see Hines, Hungerford, & Tomera, 1986/1987). As such, a good deal of them examine variables without providing a strong theoretical basis for doing so. In the 1990s one can observe a shift toward the application of well-established psychological theories for explaining and predicting environmental behavior, like Schwartz's (1977) norm-activation model (e.g., Hopper & Nielsen, 1991; Stern, Dietz, & Kalof, 1993; Vining & Ebreo, 1992) or Rosenstock's (1966) health belief model (Lindsay & Strathman, 1997). As in many other behavioral domains, the theory of reasoned action (TRA; Ajzen & Fishbein, 1980) and its generalization, the theory of planned behavior (TPB; Ajzen, 1991) also have been applied successfully to the explanation of environmentally relevant behaviors (Allen, Davis, & Soskin, 1993; Bagozzi & Dabholkar, 1994; Goldenhar & Connell, 1992/1993; Jones, 1990). In a recent study, Taylor and Todd (1997) showed that Ajzen's TPB is a very useful theoretical framework to organize and systematically relate research findings concerning the determinants of environmental behavior.

In the context of our study, using theoretical models such as the TRA or TPB is promising because these models do not only claim that they can explain and predict human behavior, but they also can be used to influence human behavior systematically. Compared with the myriad published and unpublished studies in which the TRA or TPB model is used to explain and predict behavior, up-to-date studies that attempt to influence behavior on the basis of interventions derived systematically from these models are surprisingly rare.

In the context of his extensive meta-analysis, Van den Putte (1991) reported that he found only five studies that actually attempted to change behavior using the TRA (Brubaker & Fowler, 1990; Fishbein, Ajzen, & McArdle, 1980; Hoogestraten, De Haan, & Ter Horst, 1985; Siero, Boon, Kok, & Siero, 1989; Strader & Katz, 1990). According to Van den Putte, the results of these limited studies are mixed. Not all of the studies show that the effect of theory-based interventions (persuasive messages) was more effective than was the effect of intuitively introduced interventions.

In the last few years, Fishbein and colleagues (Fishbein et al., 1995; Fishbein & Middlestadt, 1989; Fishbein, Middlestadt, & Trafimow, 1992; Fishbein, Trafimow, Mittlestadt, Helquist, & Francis, 1993) used the TRA intensively for the development and understanding of community interventions to reduce AIDS risk behavior. In the domain of environmentally relevant behavior, there seem to be only two studies (Hopper & Nielsen, 1991; Vining & Ebreo, 1992) in which a theoretical model (Schwartz's norm-activation model, 1977; Schwartz & Howard, 1981) has been used as a theoretical framework guiding the development and evaluation of an intervention aimed at influencing environmental behavior. For the TRA or TPB model, there seems to be no such study in the field of environmental behavior. Summarizing, we think that more theory-based studies may not only contribute information on how to design effective interventions to change ecologically damaging behaviors, but may demonstrate to the public more convincingly the problem-solving capability of social psychological models in the field of environmental problems.

The Present Study

Giessen is a small university town (77,000 inhabitants), 70 km north of Frankfurt, Germany. With 30,000 college and university students it has the highest proportion of students in Germany. The university facilities and buildings are scattered all over the town. Approximately one half of the students live in the rural surroundings of Giessen. These two conditions are the structural background of the serious traffic problems caused by the university: Every day, 30,000 students and 10,000 employees must reach their university facilities. From the results of earlier studies (Bamberg & Schmidt, 1993, 1994), we have calculated that on an average day, the students make approximately 15,000 university-related car trips. In 1993, cooperating with the local city and university administration, we began to develop an intervention to reduce students' car use for university routes by increasing the attractiveness of public transportation.

Because previous studies (Bamberg & Schmidt, 1993, 1994) confirmed empirically the ability of Ajzen's (1991) TPB to explain and predict individual travel-mode choice, we decided to use this model as a theoretical framework for developing and evaluating the planned regional traffic policy intervention. Very briefly, the TPB stipulates that people in a decision situation consider the likely consequences of available alternatives; they weigh the normative expectations of important reference individuals or groups; and they consider required resources and potential impediments or obstacles. These considerations or beliefs result, respectively, in the formation of attitudes toward the behavior of interest, subjective norms with respect to the behavior, and perceived behavioral control (PBC). Expectancy-value formulations are used to describe the ways in which salient beliefs combine to produce the more general constructs. It is assumed that people form behavioral intentions based on their attitudes, subjective norms, and perceptions of behavioral control, and that these intentions, together with behavioral control, are the immediate determinants of behavior. Applied to the behavioral domain "travel-mode choice," one can derive from the TPB the following, empirically testable hypotheses:

> *Hypothesis 1.* The higher the probability that a person associates positively evaluated consequences with the use of a specific means

of transportation in a situation, the more positive will be the attitude toward the use of this means.

Hypothesis 2. The more a person believes that important reference persons or groups expect the use of a specific means of transportation, the higher will be the subjective norm to use this means.

Hypothesis 3. The higher the perceived resources and opportunities to use a specific means of transportation in a situation, the higher will be the PBC to use this means.

Hypothesis 4. The more positive the attitude toward using a specific means of transportation, the greater will be the intention to use it.

Hypothesis 5. The greater the perceived subjective norm to use a specific means of transportation, the greater will be the intention to use it.

Hypothesis 6. The greater the PBC concerning a specific means of transportation, the greater will be the intention to use it.

Hypothesis 7. The higher the intention to use and the PBC over a specific means of transportation, the greater will be the probability that this means is actually used.

It can be seen that the TPB emphasizes the reason-based antecedents of behavior. The model assumes a series of processes that are largely of a controlled nature. Salient beliefs (i.e., beliefs available to conscious introspection) determine attitudes, subjective norms, perception of behavioral control, and intention.

The Introduced Intervention

The intervention "semester ticket" consists of an innovative concept for financing the collective good "public transportation." It is based on the solidarity principle that all students must pay a contribution so that the individual burden is small. In exchange, the possession of a valid student identification card entitles all students to use public transportation "free of charge." In Giessen, the semester ticket entitles the students to use all means of public transportation (buses and trains) within a radius of approximately 50 km and it costs students an additional 38 DM (approximately $22) to their normal university fees for one semester. This represents a drastic price reduction because the normal bus user must pay the same amount of money for the ordinary monthly ticket valid for the community buses in Giessen alone. Furthermore, the semester ticket facilitates the use of public transportation because it is no longer necessary to purchase a bus ticket. Taken together, we hoped that the drastic price reduction and the simplification of public transportation use would create such a drastic situational change that habitual nonusers of public transportation would be motivated to reevaluate their behavioral choice.

The semester ticket was introduced in May 1994. Prior to that, the student representatives had organized a vote in which the students themselves decided whether or not the semester ticket should be introduced. Among the participating students, 65% voted in favor of the semester ticket plan.

Hypotheses Concerning the Effect of the Introduced Intervention

From the description of the semester-ticket intervention one can conclude that the behavioral consequence "cheap" forms the central target of this intervention. So our first intervention hypothesis postulates the following:

Intervention Hypothesis 1. The introduction of the semester ticket will increase the subjective probability with which students associate the behavioral belief "cheap" with the use of public transportation for university routes.

We assume that the drastic price reduction caused by the semester ticket will motivate former non-bus-users to test public transportation. Through this test they acquire information about the bus system (e.g., timetable, bus routes, bus stops), which facilitates the use of public transportation. Thus, the second intervention hypothesis postulates the following:

Intervention Hypothesis 2. The introduction of the semester ticket will increase the subjective probability with which students think that they possess knowledge about timetables or existing bus connections (control beliefs), which are necessary prerequisites for the use of public transportation for university routes.

Intervention Hypothesis 3. Because of the intensive public discussion and the subsequent vote about the introduction of the semester ticket, the perceived social expectations of significant others to use public transportation for university routes will increase following the introduction of the semester ticket.

Intervention Hypothesis 4. The changes in the probabilities of these behavioral, normative, and control beliefs caused by the introduction of the semester ticket in their turn change the attitude, subjective norm, and PBC toward using public transportation for university routes in the same direction. Changes in attitude, subjective norm, and PBC should cause an increase in the actual use of public transportation for university routes via intention.

Are There Any Subgroup Specific Effects of the Intervention?

The hypotheses formulated so far do not contain any assumption of how the semester-ticket intervention will affect different student groups. Generally, the theoretical reasoning as to how individual-difference variables like personality traits, values, or general attitudes may affect the components of the TRA and TPB model is underdeveloped (see the critiques of Eagly & Chaiken, 1993). Ajzen and Fishbein (1980; Ajzen, 1988) concede that the perception and evaluation of behavioral, normative, and control beliefs may be influenced by such individual-difference variables. Because they view these variables as external to their model, Ajzen and Fishbein do not analyze the relation between the model components and these external variables more systematically. Whereas neglecting potential group differences may be acceptable in the context of basic research, the consideration of such group differences is very important in the context of developing effective interventions.

In the domain of environmentally relevant behaviors, there is growing empirical evidence that the consequences associated with performing environmentally relevant behaviors are influenced by individual-difference variables such as social-value orientations (Stern, Dietz, & Kalof, 1993; Van Lange, Van Vugt, Meertens, & Ruiter, 1998; Van Vugt, Meertens, & Van Lange, 1995; Van Vugt, Van Lange, & Meertens, 1996), motives (Vining & Ebreo, 1990), and general attitudes such as environmental concern (Vining & Ebreo, 1992). Howenstine (1993) proposed using such research finding more systematically within a market-segmentation approach to identify subgroups with specific sociodemographic, attitudinal, and value profiles. According to Howenstine, identifying such subgroups and targeting their specific living conditions, needs, values, and concerns may be very useful for designing more effective intervention programs.

But what individual-difference variable should be used in the present study for building student subgroups? In an earlier study, Bamberg (1996) showed that students' general attitudes toward policy measures restricting private car use (e.g., increasing parking fees or gasoline prices) are systematically related to students' importance judgments of specific travel-mode attributes, such as "fast," "cheap," or "ecological," and their perceived association of these attributes with the travel-mode alternatives "car," "bus," and "bike" in the context of university routes. Furthermore, in that study, attitudes toward policy measures restricting private car use completely mediate the impact of further attitudinal variables (e.g., materialistic vs. postmaterialistic value orientations; Ingelhart, 1989; the perceived impact of traffic-related air pollution and noise on personal quality of life; or the perceived responsibility of one's own behavior for traffic-related environment problems) on students' specific travel-mode preferences.

Students with a more negative attitude toward policy measures restricting private car use have a more materialistic value orientation, perceive a lesser impact of traffic-related air pollution and noise on their personal quality of life, and tend to deny the responsibility of their own behavior for traffic-related environmental problems. Furthermore, the attitude toward policy measures *restricting private* car use correlates negatively with reported support of the planned semester-ticket intervention.

These results confirm the view that students' attitudes toward policy measures restricting private car use can be used as a traffic-domain-specific measure of environmental concern. Thus, attitudes toward these measures will be used to divide the total student sample into two subgroups: one group supporting private-car-use restrictions, and the other group opposing such restrictions. Of special interest in the context of the present study is the question as to whether these two subgroups show any differences in their behavioral reaction to the introduced semester-ticker intervention. We expect students with a more positive attitude toward private-car-use restrictions generally to have a greater preference for using the ecologically less damaging public transportation. Giving them an additional financial incentive to use public transportation should facilitate the decision of this subgroup to change from private car to public transportation.

Method

Participants

The study was conducted as a longitudinal panel study. The data collection of the first panel wave took place during the second week of February 1994, before the introduction of the semester-ticket intervention. Over a period of 8 working days, a questionnaire was distributed to 3,491 randomly selected students. Of these 3,491 questionnaires, 1,874 (53.7%) were completed and returned. Participants in the first panel wave were 41.1% male and ranged in age from 20 to 37 years, with a mean age of 24.4 years. As 19,902 students (without the first semesters) were enrolled in the summer semester 1994, this corresponds to 9.4% of all registered university students. The second panel wave was conducted in the first week of February 1995, 10 months after the introduction of the semester ticket. Because of residential mobility and a change in the student registration system, only 1,316 students received the questionnaire a second time. The response rate in the second wave was 78.8%, resulting in a sample of 1,036 students.

Measures

In the mentioned prestudies (Bamberg & Schmidt, 1993, 1994), the free-elicitation method (Ajzen & Fishbein, 1980) was used to sample the salient behavioral and control beliefs associated by the students with using the three travel-mode options: car, bike, and public transportation for university routes. The results were used to construct the standardized TPB-items documented in Appendix A.

It should be mentioned that in the present study the perceived normative expectations of specific important others and the motivation to comply with these expectations were not measured.

Table 1

Stability and Change of Travel-Mode Decisions Between 1994 and 1995

Travel mode 1995	Travel mode 1994				
	CAR 1994	BIKE 1994	BUS 1994	PEDE 1994	1995
CAR 1995	167	23	8	6	204 (30.0%)
BIKE 1995	24	168	12	14	218 (32.1%)
BUS 1995	88	31	77	13	209 (30.8%)
PEDE 1995	17	14	7	10	48 (7.1%)
1994	296 (43.6%)	236 (34.8%)	104 (15.3%)	43 (6.3%)	679 (100%)

Note. $N = 679$. BUS = public transportation, PEDE = pedestrians.

Behavior. Travel-mode behavior was measured by the use of a standardized protocol of all routes a student had traveled during the day in chronological order (Social-Data, 1993). From these protocols, we selected the first journey starting at the apartment and ending at the university. The travel modes used for this trip were saved in the data file. So, strictly speaking, we measured past behavior; that is, the causal order underlying the TPB was not fulfilled. We think that in the context of travel-mode choice, using past behavior is acceptable because travel-mode choice as a habitual behavior should be stable, so the situational conditions do not change.

Attitude toward policy measures restricting private car use. This measure, which will be used for subgroup building, was tapped with the following three items: How do you evaluate the following traffic policies? (a) increases in parking fees in inner cities; (b) reducing the number of public parking places in inner cities; and (c) increases in gasoline prices. The response range was a 5-point unipolar scale ranging from 1 (*bad*) to 5 (*good*).

Results

Descriptive Results

Table 1 shows the self-reported travel-mode choice of those students participating in both panel waves before (1994) and 10 months after the introduction of the semester ticket (1995), protocoling at both time points at least one university trip and without missing values in the model variables ($N = 679$). As can be seen from the marginals, the proportion of public transportation has significantly ($p <$ .00) increased from 1994 (15.3%) to 1995 (30.8%). In the same time period, car use significantly ($p < .00$) decreased from 43.6% in 1994 to 30.0% in 1995, whereas the proportion of bike users (p = .10) and pedestrians (p = .55) remained stable. These results indicate a substantial effect of the semester-ticket intervention on travel-mode choice of the students, especially of former car users. Is this behavioral change associated with changes in the TPB variables, as stated in the intervention hypotheses? Table 2 presents the means and standard deviations of the TPB variables before (1994) and after (1995) the introduction of the semester-ticket intervention.

As can be seen from Table 2, after the introduction of the semester ticket, the probability with which the students associate the behavioral belief "cheap" with the use of public transportation for university routes increased drastically (1994, M = -0.84; 1995, M = 0.78). After the intervention, the probability of the beliefs "fast" (1994, M = -1.19; 1995, M = -1.07) and "ecological" (1994, M = 0.23; 1995, M = 0.40) also increased significantly. No significant changes occurred in the attributes "comfortable" and "without stress."

Let us now look at the means of the subjective probability of the control beliefs associated with the use of public transportation. The subjective likelihood of knowing when the next bus departs increased significantly (1994, M = -0.36; 1995, M = 0.14), whereas the perceived quality of bus connections decreased significantly (1994, M = 0.05; 1995, M = -0.66).

From these results, the following can be concluded: Through their direct experience with the public transportation system, more students knew the departure times of the buses in 1995 than in 1994, but this direct experience led to an even more critical evaluation of these bus services, too. As predicted by the TPB, these changes in the perceived subjective probability of the behavioral consequences and control beliefs correspond with a significant increase in the means of the indicator items of the latent constructs "attitude," "subjective norm," "PBC," and "intention."

Specification and Test of a Structural Equation Model

In this section, we want to test the causal structure postulated by the TPB more explicitly. For the empirical test of theories like the TPB, which contains a chain of mediating causal variables, structural equation models (SEM) deliver an appropriate statistical tool of analysis (for a discussion, see Van den Putte & Hoogstraaten, 1997). The starting point of our SEM analysis is the specification of the path model depicted in Figure 1.

Because of the complexity of the path diagram, we have left out the measurement models for the latent variables. We want to stress two points that should be considered when interpreting the following analyses. As one can see from Figure 1, we have specified a cross-sectional TPB model for each panel wave. Both models are connected longitudinally by the paths between the same constructs measured on different occasions. A second specific attribute of our model refers to the

Table 2

Means and Standard Deviations of TPB Variables for Bus Use Before (1994) and After Introduction of the Semester Ticket (1995)

	1994 before		1995 after		*p*-value of no difference*
	M	*SD*	*M*	*SD*	
Evaluation of behavioral beliefs					
Fast	1.42	0.83	1.46	0.76	n.s.**
Comfortable	0.50	1.06	0.59	1.11	.05
Without stress	0.95	1.00	1.03	0.96	n.s.
Cheap	1.42	0.86	1.47	0.84	n.s.
Ecological	1.26	1.14	1.22	1.08	n.s.
Subjective probability of behavioral beliefs					
Fast	-1.19	1.01	-1.07	1.05	<.05
Comfortable	-0.10	1.28	-0.02	1.29	n.s.
Without stress	-0.26	1.22	-0.33	1.26	n.s.
Cheap	-0.84	1.23	0.78	1.47	<.01
Ecological	0.23	1.18	0.40	1.00	<.01
Evaluation of control beliefs					
Good bus connection	0.05	1.54	-0.66	1.42	<.01
Departure knowledge	-0.36	1.61	0.14	1.65	<.01
Subjective probability of control beliefs					
Good bus connection	0.05	1.54	-0.66	1.42	<.01
Departure knowledge	-0.36	1.61	0.14	1.65	<.01
Indicators of latent constructs: attitude, norm, perceived behavioral control (PBC), and intention					
Attitude 1	-0.65	1.10	-0.34	1.21	<.01
Attitude 2	-0.73	1.06	-0.51	1.12	<.01
Norm 1	-0.67	1.18	-0.39	1.27	<.01
Norm 2	-0.87	1.13	-0.76	1.20	<.05
PBC 1	-0.49	1.49	-0.16	1.61	<.01
PBC 2	-0.39	1.57	0.10	1.63	<.01
Intention 1	-1.39	1.14	-0.97	1.46	<.01
Intention 2	-1.38	1.15	-0.89	1.49	<.01

Note. The means are based on those subjects ($N = 622$) who participated in both waves and have no missing values in the variables. All response scales range from -2 to +2. The labels "Attitude 1," "Attitude 2," etc. refer to the two items measuring each TPB-construct (Appendix A).

**p* refers to the result of a *t*-test comparing the mean at wave 1 with that at wave 2.

**n.s. = not significant; $p > .05$.

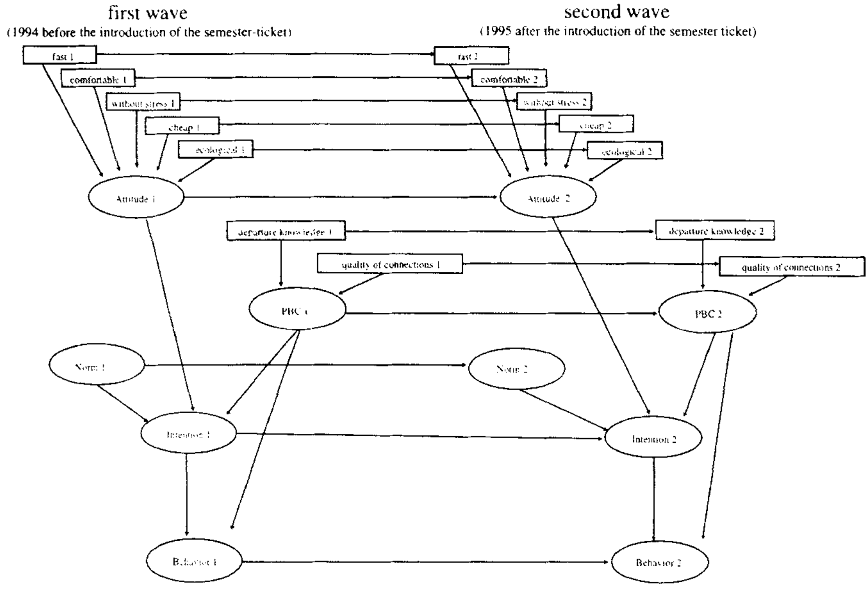


Figure 1. Specification of the path model.

specification of the relation between the behavioral beliefs and the direct attitude construct and between the control beliefs and the direct PBC construct, respectively. Ajzen and Fishbein (1980; Ajzen, 1991) used the sum of the multiplied probabilities and evaluations of these beliefs as predictors of the direct attitude and control measure. Instead, we regress attitude and behavioral control directly on the product terms, without summing them. The rationale for this specification is that we want to have direct estimates for the independent effects of the single behavioral and control beliefs on attitude and behavioral control, respectively.

Following the two-step approach proposed by Anderson and Gerbing (1988), we first tested the quality of the theoretically derived measurement models via confirmatory factor analyses. Table 3 presents the results of the measurement-model tests for the latent constructs of the TPB. We used the LISREL 8.20 program (variance–covariance matrix as input and the maximum likelihood estimator).

Because the attributes "fast," "comfortable," "without stress," "cheap," "ecological," "good bus connection," and "departure knowledge" were measured with only one indicator, these attributes cannot be corrected for measurement errors. After adding 35 measurement-error correlations (mainly autocorrelations of the indicators), the fit of the simultaneously tested measurement models were acceptable, $\chi^2(169, 622) = 186.25$, $p = .17$. Next, we tested the stability of the measurement models of the TPB constructs over the two time points. For this

Table 3

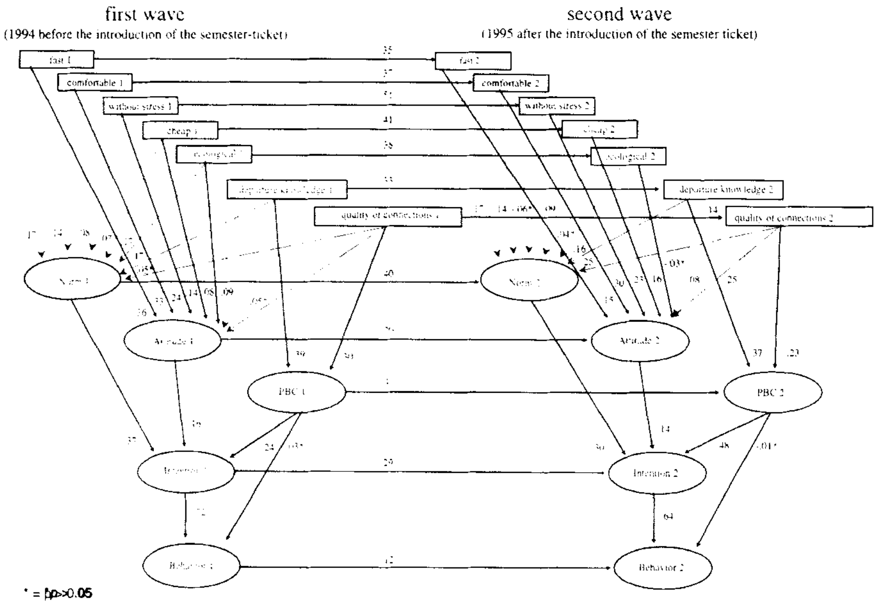
Unstandardized (b) and Standardized (β) Factor Loadings of the Measurement Models for Wave 1 (1994) and Wave 2 (1995)

	Wave 1		Wave 2	
	b	β	*b*	β
Attitude[a]				
Attitude 1[b]	1.00	0.90	1.00	0.92
Attitude 2	0.85	0.78	0.85	0.85
Control				
PBC 1	1.00	0.89	1.00	0.89
PBC 2	0.81	0.68	0.81	0.71
Norm				
Norm 1	1.00	0.93	1.00	0.86
Norm 2	0.96	0.93	0.96	0.89
Intention				
Intent 1	1.00	0.98	1.00	0.97
Intent 2	1.01	0.97	1.01	0.97

Note. p values of all estimated parameters are less than .05.
[a]Latent construct. [b]Indicator.

purpose, we constrained the free estimated unstandardized factor loadings of the indicator items at Time 2 (1995) to be equal to the factor loadings of the same indicators at Time 1 (1994). The chi-square difference between the model with and without equality constraints was not significant, $\chi^2(4, 622) = 5.02$, n.s. Therefore, we can assume equal factor loadings for the respective constructs over time. As Table 3 shows, the factor loadings of the indicator items on the latent constructs were all above .60.

In the second step, we simultaneously tested the measurement models and the structural model depicted in Figure 1. This model does not fit with the data. Inspecting the modification indexes showed that adding additional paths would increase the model fit significantly. In the present data set, the behavioral beliefs seem not only to have effects on the latent attitude, but additional effects on the latent subjective norm construct. The same holds for the behavioral control beliefs. They not only influence the latent PBC, as postulated by the TPB, but additionally the attitude and subjective norm construct. After setting these additional three paths free, the model fit was acceptable, $\chi^2(302, 622) = 324.04, p = .18$.



* = p>0.05

Figure 2. Graphical presentation of the accepted path model.

Finally, we tested how stable the estimated relations between the TPB constructs are over the two time points. For this purpose, we set the structural coefficients at Time 2 equal to the corresponding structural coefficients at Time 1, successively. From the 20 structural coefficients reflecting the weights of the effects between the constructs of the TPB, 13 could be set equal without a significant decrease of model fit. The chi-square difference between the model with and without equality constraints was not significant, $\chi^2(13, 622) = 19.90$, n.s. The following structural coefficients cannot be set equal without causing a significant deterioration of the model fit: Compared with Time 1, the effect of behavioral control on intention was significantly stronger at Time 2, just like the effects of the control belief "perceived quality of bus connections" on attitude and subjective norm. The effect of the behavioral belief "fast" on attitude was significantly weaker at Time 2, compared with Time 1. At Time 2, the effects of "without stress" on norm and of "ecological" on attitude and norm not only got weaker, compared with Time 1, but at Time 2, these effects were statistically insignificant. Figure 2 depicts a graphical presentation of the finally accepted model. Because of the complexity of Figure 2, the path coefficients are presented in Appendix B as a table.

From our point of view, four results of the SEM analysis deserve special interest. First, at both time points, PBC did not exert a significant effect on

Table 4

Explained Variances of TPB Constructs in Wave 1 (1994) and Wave 2 (1995)

Wave 1		Wave 2	
Construct	Explained variance	Construct	Explained variance
Attitude 1	0.73	Fast 2[a]	0.12
Control 1	0.28	Comfortable 2[a]	0.14
Norm 1	0.26	Without stress 2[a]	0.26
Intention 1	0.49	Cheap 2[a]	0.16
Behavior 1[a]	0.47	Ecological 2[a]	0.14
		Departure knowledge 2[a]	0.11
		Quality of connections 2[a]	0.02
		Attitude 2	0.79
		Control 2	0.55
		Norm 2	0.54
		Intention 2	0.67
		Behavior 2[a]	0.47

[a]These constructs were measured only by one indicator.

behavior. Second, whereas in many other behavioral domains the effect of the social-norm construct on intention is low, in the present study social norm was a strong predictor of intention to use the bus for university routes at both time points. Third, compared with the more personal well-being-oriented behavioral consequences (e.g., fast or comfortable), the overall effect of the more collective well-being-oriented behavioral consequence "ecological" on global attitude toward the use of public transportation was low (1994). After the introduction of the intervention, it was not even statistically significant. Fourth, the stability coefficients between Times 1 and 2 were low, especially of attitude, intention, and behavior. After the intervention, many students seem to have changed their relative position. This may be a first empirical hint that the intervention caused different reactions in different subgroups. Table 4 shows the explained variance of the TPB constructs at Times 1 and 2.

Whereas attitude can be explained to a considerable degree, this is less the case for PBC, norm, intention, and behavior. The explanation of the beliefs is least sufficient in the model.

Table 5

Mean Differences in the Three Attitude Items (Wave 1, 1994) Between Cluster Membership

	Cluster 1 (n = 486)		Cluster 2 (n = 554)	
	Supporters		Opponents	
Attitude item	*M*	*SD*	*M*	*SD*
Increase in parking fees	4.22	0.88	1.84	1.00
Reduction in parking places	3.68	1.20	1.55	0.80
Increase of gasoline tax	3.98	1.13	1.86	1.12

Note. Responses to items are presented on a 5-point scale ranging from 1 (*bad*) to 5 (*good*).

Subgroup-Specific Reactions to the Semester-Ticket Intervention

To analyze whether the total student sample can be divided into two subgroups, we applied a cluster analysis to the response pattern of the three items used to measure the attitude toward measures restricting private car use. The cluster analysis is based on the data of those 1,040 students of the first panel wave who reported at least one trip from their apartment to university campus using either car, bike, or public transportation and had no missing values in the model variables. Of these, 558 participated in the second panel wave and once again reported a trip from home to university using car, bike, or public transportation. A solution with two clusters seemed most appropriate for our data.[3] In Table 5, means and standard deviations of the three attitude items are presented for the two clusters.

Whereas students in the first cluster evaluated all items positively on average, students belonging to the second cluster evaluated them negatively. These results confirm our hypothesis that the student sample could be divided into two groups. From here on, we will refer to the group with a positive attitude toward

[3]The analysis was conducted using CONCLUS (Bardeleben, 1991). Based on responses to the attitude items, the program computes Euclidean distances between all pairs of respondents. In an iterative algorithm, the distances are used as a criterion to group respondents in the same or different clusters. Nonhierarchical cluster solutions were calculated using the hill-climbing method. Two to 10 cluster solutions were calculated. For each solution, CONCLUS reports descriptive indexes, such as the explained variance of a cluster solution, cluster homogeneity, and correlation of the clusters. Using these indexes, a solution with two clusters seemed most appropriate for our data. The cluster membership can explain 54% of the variance of the distances.

restrictions of private-car use as *supporters*, and the second group with a negative attitude as *opponents*.[4]

In the next step, we analyzed whether the two subgroups differed in their evaluations of the three travel-mode alternatives—car, bike, and bus—for university routes and in their actual use of these transportation means for university routes before the introduction of the semester ticket. As can be seen in Table 6, there are indeed significant mean differences between the two subgroups before the intervention. Supporters evaluate "ecological" as the most important outcome ($M = 1.57$), followed by the outcomes "cheap" ($M = 1.47$), and "fast" ($M = 1.32$). On the other hand, opponents evaluate the outcome "fast" as most important ($M = 1.52$). The next ranks are "cheap" ($M = 1.33$) and "ecological" ($M = 1.03$).

Table 6 also presents the means of the subjective likelihood with which the four outcomes were associated with the means of transportation (car, bike, and bus). Using a car was evaluated as less ecological, less cheap, less fast, and less comfortable by the supporters than by the opponents. Furthermore, bike riding was evaluated by supporters as faster, more comfortable, and cheaper. Table 7 reports the travel-mode decisions before and after the introduction of the semester ticket separately for the supporters and opponents subgroups.

Before the introduction of the semester ticket, 61.4% of the opponents used the car, 27.6% used the bike, and only 11.0% chose public transportation. As expected, the rank order was different in the supporters group. In the supporters group, 53.0% used the bike, 27.8% used the car, and 19.1% used public transportation. The differences between the two groups are remarkable and significant, $\chi^2(2, 1{,}040) = 118.01, p < .00$.

As can also be seen from Table 7, the introduction of the semester ticket did indeed have different effects in the behavior of the two student subgroups. In the supporters group, the use of public transportation increased after the introduction of the semester ticket slightly from 21.1% to 26.6%. But in the opponents group, the behavioral change was much more drastic: In this group, the use of public transportation increased from 9.3% to 26.8%. This result completely opposes our expectations. It was not the students with more positive attitudes toward policy measures restricting private car use who reacted most strongly to the introduced intervention, but the students with more negative attitudes toward such measures.

What might be the reasons for this unexpected result? To find an answer to this question, we analyzed whether the introduced intervention caused different

[4]General attitudes should be stable across situations. Therefore, if the three items really do reflect a stable attitude, cluster structure and membership should not change in time. To prove this assumption, a second cluster analysis was applied on the same three items measured in the second panel wave. In this analysis, the number of clusters was restricted in advance to two. As expected, the cluster means for the items of the second panel wave were very similar to those of the first wave. Additionally, the stability of cluster membership was high. Nearly 81% of the students belonged to the same group as 1 year before.

Table 6

Differences in Evaluation and Perception of Travel-Mode Outcomes Between the Supporters and Opponents Subgroups

Variable	Supporters (n = 86)		Opponents (n = 554)		p-value of no difference*
	M	*SD*	*M*	*SD*	
Evaluation of outcomes					
Ecological	1.57	0.74	1.03	1.00	<.01
Cheap	1.47	0.84	1.33	0.94	<.05
Fast	1.32	0.92	1.52	0.81	<.01
Comfortable	0.28	1.24	0.58	1.21	<.01
Probability of outcomes					
Bus is ecological	0.25	1.17	0.23	1.17	n.s.**
Bus is cheap	-0.63	1.20	-0.66	1.17	n.s.
Bus is fast	-0.83	0.93	-0.82	0.91	n.s.
Bus is comfortable	0.01	1.34	-0.22	1.27	<.01
Car is ecological	-1.02	0.52	-0.85	0.95	<.01
Car is cheap	-0.87	0.98	-0.51	1.27	<.01
Car is fast	0.17	1.50	1.21	1.18	<.01
Car is comfortable	1.04	1.28	1.58	0.82	<.01
Bike is ecological	1.91	0.50	1.84	0.60	n.s.
Bike is cheap	1.91	0.43	1.84	0.59	<.05
Bike is fast	0.70	1.36	-0.01	1.36	<.01
Bike is comfortable	-0.19	1.28	-0.70	1.04	<.01

Note. Responses to importance are presented on a 5-point scale ranging from -2 (*not important*) to +2 (*important*). Responses to probability are presented on a 5-point scale ranging from -2 (*not likely*) to +2 (*likely*).
*p refers to the result of t-test comparing the mean at wave 1 with that at wave 2.
**n.s. = not significant; $p > .05$.

changes in the association of attributes with the three travel-mode alternatives within the two subgroups. Table 8 shows the association of the outcomes with the three travel means—public transportation, car, and bike—before and after the introduction of the semester ticket for both groups separately.

As can be seen, the introduction of the semester ticket caused a significant increase in the likelihood with which the outcomes "cheap" and "ecological"

Table 7

Subgroup-Specific Stability and Change of Travel-Mode Decisions Between 1994 (Before) and 1995 (After) Introduction of the Semester Ticket

Travel mode 1995	Travel mode 1994							
	Bus		Car		Bike		1995	
	%	*n*	%	*n*	%	*n*	%	*n*
Supporters								
Bus	64.8	(35)	18.8	(19)	10.1	(14)	26.6	(68)
Car	1.9	(1)	51.6	(33)	6.5	(9)	16.8	(43)
Bike	33.3	(18)	18.8	(12)	83.3	(115)	56.6	(145)
1994	21.1	(54)	25.0	(64)	53.9	(138)	100.0	(256)
Opponents								
Bus	60.7	(17)	25.0	(49)	19.2	(15)	26.8	(81)
Car	21.4	(6)	67.3	(132)	16.7	(13)	50.0	(151)
Bike	17.9	(5)	7.7	(15)	64.1	(50)	23.2	(70)
1994	9.3	(28)	64.9	(196)	25.8	(78)	100.0	(302)

were associated with public transportation in both groups. There were two additional, subgroup-specific changes in the probabilities of the outcomes. Whereas in the supporters group the association of the outcome "cheap" with car use significantly decreased further after the introduction of the semester ticket, in the opponents subgroup there was a significant increase in the strength with which the outcome "fast" was associated with the use of public transportation.

The changes in the behavioral consequences caused by the intervention seem to be practically the same for both groups. In both groups, the main effect of the intervention consisted of a slight increase in the attribute "ecological" and a much bigger increase in the attribute "cheap" for public transportation. Thus, the only explanation for the stronger behavioral reaction of the opponents' subgroup to the introduced semester-ticket intervention is a greater responsiveness of this subgroup to the incentive "price reduction."

To test this assumption, we conducted a logistic regression analysis based on the 260 students who used the car for university routes before the introduction of the semester ticket. The reported change from the car to public transportation after the introduction of the semester ticket was used as dependent variable. Students who changed were scored as 1, and students who did not change were scored as 0. The differences of the subjective probabilities of the travel-mode outcomes (variable at Time 2 minus variable at Time 1) were used as the

Table 8

Subgroup-Specific Changes in Outcomes Associated With Three Travel Modes Before and After Introduction of the Semester Ticket

	Supporters (n = 256)			Opponents (n = 302)		
Variable	1994 *M*	1995 *M*	*p*-value of no difference*	1994 *M*	1995 *M*	*p*-value of no difference*
Bus is ecological	0.22	0.42	<.01	0.31	0.47	<.05
Bus is cheap	-0.87	0.94	<.01	-0.75	0.72	<.01
Bus is fast	-1.10	-1.04	n.s.**	-1.22	-1.10	<.05
Bus is comfortable	0.04	0.10	n.s.	-0.16	-0.11	n.s.**
Car is ecological	-1.66	-1.72	n.s.	-1.10	-1.06	n.s.
Car is cheap	-1.00	-1.15	<.05	-0.45	-0.45	n.s.
Car is fast	0.12	0.17	n.s.	1.18	1.24	n.s.
Car is comfortable	1.09	1.13	n.s.	1.61	1.55	n.s.
Bike is ecological	1.87	1.89	n.s.	1.82	1.87	n.s.
Bike is cheap	1.88	1.88	n.s.	1.81	1.83	n.s.
Bike is fast	0.51	0.61	n.s.	-0.35	-0.36	n.s.
Bike is comfortable	-0.22	-0.25	n.s.	-0.89	-0.93	n.s.

Note. Responses to importance are given from +2 (*important*) to -2 (*not important*); responses to associations and restrictions are given from +2 (*likely*) to -2 (*not likely*).
*p refers to the result of t-test comparing the mean at wave 1 with that at wave 2.
**n.s. = not significant; $p > .05$.

independent variable. Via specifying conditional main effects (product term of the difference variables × the dummy "group membership"), it is possible to estimate separate regression equations for the two subgroups (opponents vs. supporters) simultaneously. Results are reported in Table 9.

In the supporter group, only the difference variable "bus is ecological" exerted a significant effect on the probability that a student would change from car to public transportation after the introduction of the semester ticket. If at Time 2 the supporters were more likely to associate public transportation with the outcome "ecological" than at Time 1, the probability of change from car to public transportation increased. However, the perceived strong increase of the attribute "cheap" had no significant effect on the probability of change from car to public transportation in this group. In the opponents group, the opposite was true.

Table 9

Logistic Regression of Changes From Car to Bus

Predictor	Supporters (n = 64) b^a	Opponents (n = 196) b	p-value of no difference
Changes in associations			
Bus is ecological	0.77*	—	<.05
Bus is cheap	—	0.19*	<.05
Car is ecological	—	-0.46*	<.01
Intercept	1.06*	1.06*	

Note. Predictive power (LR index): $\rho 2 = 6.5\%$, $\chi^2(3, N = 260) = 14.46, p < .01$.
[a]Unstandardized logistic regression coefficient.
*$p < .05$.

Changes in the subjective probability of the public transportation outcome "ecological" had no effect, but changes in the outcome "cheap" did.

Summarizing these results confirms the hypothesis that opponents were more responsive to changes in the outcome "public transportation is cheaper," whereas supporters seemed to be more responsive to perceived changes in the outcome "public transportation is more ecological." In the opponents subgroup, the difference variable "car is ecological" had an additional, significant, but negative effect on the probability of changing from car to public transportation. If at Time 2 a student of the opponent subgroup was more likely to associate the car with the outcome "ecological" than at Time 1, this decreased the probability of changing from car to public transportation.

Discussion

The present study focuses on two questions: (a) How useful is the application of a well-established psychological theory in the context of evaluating the effects of an intervention? and (b) Does subgroup analysis increase our understanding of the intervention effects? To answer the first question, we used the TPB to model the psychological processes that mediate the effects of an objective intervention (a drastic price reduction in public-transportation use) on the actual travel-mode choice of students for university routes. According to the TPB, the individual travel-mode choice relies finally on the likelihood with which salient outcomes are associated with available means of transportation. If the assumptions of the TPB are valid, changes in the perceived outcomes of using travel-mode options should cause changes in the observable travel-mode choice via their effects on attitude, subjective norm, perception of behavioral control, and intention. By stressing the importance of salient behavioral outcomes, the TPB provides a theory-driven starting point for the development and evaluation of interventions. One must concentrate on the questions as to which are the salient outcomes associated with performing the interesting behavior and how these outcomes may be affected by the planned intervention. These expectations can and should be tested empirically after the introduction of the intervention.

The intervention analyzed in the present study consists of a drastic price reduction for students' public-transportation use. Thus, the central intervention hypothesis concerning this intervention was that it would cause a change in the subjective price perception of public transportation that is strong enough to induce students to change from cars to public transportation.

One important result of the present study is its clear empirical evidence for the success of the semester-ticket intervention. The proportion of university routes for which students used public transportation increased significantly from 15.3% before the introduction of the semester ticket to 30.8% afterward. During the same time period, car use decreased from 43.6% to 30.0%. The proportion of bike users and pedestrians remained stable. Thus, for the students in Giessen, a price reduction seems to be an effective incentive to motivate them to change from cars to public transportation. Until today, semester tickets have been introduced for one third of the 1.9 million German students. However, at the other universities, no systematic evaluation of the effects has been performed. As expected, the intervention resulted mainly in a strong increase in the likelihood with which the outcome "cheap" was associated with using public transportation for university routes. A second outcome whose likelihood increased significantly is knowing the departure schedule of the bus.

The results of the SEM provide further empirical evidence for the assumption of the TPB that these changes in outcomes associated with using public transportation influenced the actual use of public transportation only indirectly via the causal chain postulated by the TPB. The changed outcomes influenced only attitude, subjective norm, and PBC directly, and the effects of these constructs on actual bus use were completely mediated by the intention.

In our study, the coefficients of the measurement and the structural model were rather stable over both time points. The decision process underlying the travel-mode choice of the students seemed to be much the same over the two waves. The effects of intention on behavior and of attitude and subjective norm on intention can be set equal over the two time points. Interestingly, at both time points, the effect of subjective norm on intention was stronger than that of attitude. In the present study, perceived social support seems to have played an important role in the decision processes of students to use public transportation for university routes.

Only the regression weight of the PBC construct on intention to use public transportation for university routes changed after the introduction of the semester ticket. Whereas the effect of behavioral control on intention was the weakest before the introduction of the semester ticket, behavioral control exerted the strongest effect on intention after the semester-ticket introduction. We interpret this change as a direct consequence of the intervention. Whereas before the intervention perceived negative outcomes were the main reason for not using public transportation, after the intervention perceived situational obstacles (missing control) were the most important reason for not doing so. This interpretation is confirmed by the significant increase in the regression weight of the control belief "perceived quality of bus connections" on attitude and social norm at Time 2. If one wants to increase students' use of public transportation further, this result gives a clear hint as to what should be done: The number and quality of bus connections must be improved.

But at the same time, the results of the present study question some aspects of the causal structure postulated by the TPB. Thus, the relationship between the normative, behavioral, and control beliefs associated with using means of transportation and the overall attitude, norm, and PBC concerning these means of transportation seems to be more complex than postulated by the TPB. Changes in behavioral outcomes like "cheap," "fast," or "comfortable" seem to influence not only attitude as postulated by the TPB, but subjective norm as well. And control beliefs influence not only the PBC, but attitude and subjective norm, too. Students' attitude and perceived social support toward using a specific means of transportation seemed to be "colored" by different types of cognitive beliefs simultaneously. These results question the assumption of Fishbein and Ajzen (1980) that attitude and subjective norm are completely independent theoretical constructs. This assumption has been questioned in the past by other authors (e.g., Liska, 1984; Minard & Cohen, 1981), too. Thus, further theoretical clarification concerning the processes underlying the formation of attitudes and social noms and their relationship is needed.

Whereas the results reported thus far for the total sample are quite consistent with our expectations, the results of the subgroup analysis surprised us. The cluster analysis confirmed our assumption that attitude toward policy measures restricting private-car use can be used as a individual-difference variable to divide the total sample into two subgroups: those who support such restrictions, and those who oppose them. We further expected people who oppose private-car restrictions to show a greater preference for using the car for university routes and actually to use it more than people who support private-car restrictions. These expectations were confirmed empirically, too. We further expected students who show a greater preference for means of transportation like bike or public transportation to react more strongly to the introduced semester ticket than students who oppose the restriction of private-car use. This expectation was not confirmed. There was a slight increase in use of public transportation in the supporter subgroup, but the change from car to public transportation was very much stronger in the opponent subgroup. An explanation for this surprising result seems to be the greater susceptibility of opponents for the financial incentive offered by the introduction of the semester ticket. Only in the opponents' subgroup did the changed perception of the outcome "price" exert a significant effect on the probability of changing from car to public transportation.

Thus, the central message of the subgroup analysis is that not all students reacted equally to the introduced price reduction. Students with a greater preference for car use who primarily opposed the introduction of the semester ticket reacted more strongly after its introduction than did students with a greater preference for transportation means like bike and bus, who were primarily more supportive of the semester ticket. If these different reactions to price changes can be replicated with other samples, it has great potential significance for a wide range of environmental policies.

At the same time, this result raises a question concerning the factors that cause the different susceptibility of the two subgroups for the financial incentive. One possible explanation is that the travel-mode choice of the supporters prior to the introduction of the semester ticket caused a kind of ceiling effect in this subgroup: For the 19% of this subgroup who used public transportation before the intervention was introduced, there was no incentive to change this mode. The great majority (53%) who preferred the bike also may have seen little reason to change from their favorite cheap and ecological alternative to public transportation. Finally, the 19% who used cars did so primarily because of perceived restrictions, such as a very long distance or the lack of bus routes. Because the semester-ticket intervention did not change these restrictions, there was again no real incentive to change travel mode. However, in the opponents subgroup, the travel-mode choice prior to the semester ticket may have left more room for behavioral change: Because they did not perceive bike versus public transportation as the main alternatives (only 28% used bikes), but rather car versus public transportation, there may have been a greater motivation to change from the car to the now significantly cheaper public transportation.

Another explanation can be derived from the work of Van Lange and colleagues (Van Lange et al., 1998; Van Vugt et al., 1995, 1996). Van Lange et al. examined whether differences in social-value orientation (i.e., preferences for particular patterns of outcomes for oneself and others) are reflected in the extent to which considerations of personal well-being and considerations of collective well-being underlie preferences for public transportation and carpooling. Van Lange et al. proposed that considerations relevant to collective well-being and those relevant to personal well-being were differentially important to individuals with prosocial versus proself orientations. *Proselfs*, who are inclined to evaluate interdependence situations in terms of their personal well-being, should be particularly responsive to actual or perceived variations in outcomes relevant to their own personal well-being. That is, travel-mode preferences by proselfs should be strongly determined by the extent to which available options differ in consequences for their personal well-being. In contrast, *prosocials*, who are inclined to evaluate interdependence situations in terms of collective well-being, should be relatively more responsive to actual or perceived variations in outcomes relevant to collective well-being.

If attitude toward measures restricting private car use is interpreted as a domain-specific expression of social-value orientations, the results of the logistic regression analysis reported in Table 9 fit Van Lange et al.'s (1998) expectations quite well: Only opponents who are inclined to evaluate travel-mode options in terms of their personal well-being reacted to variations of the outcome "cheap," which are relevant to their own personal well-being; whereas the behavioral change of the supporters was influenced only by the outcome "ecological," which is the consideration of collective well-being. Further studies should use Van Lange et al.'s work as an interesting starting point for a more theory-driven approach to using individual-difference variables for subgroup segmentation.

References

Ajzen, I. (1988). *Attitudes, personality, and behavior.* Milton Keynes, UK: Open University Press.

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

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice-Hall.

Allen, J., Davis, D., & Soskin, M. (1993). Using coupon incentives in recycling aluminum: A market approach to energy conservation policy. *Journal of Consumer Affairs*, **27**, 300-318.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, **103**, 411-423.

Bagozzi, R. P., & Dabholkar, P. A. (1994). Consumer recycling goals and their effect on decisions to recycle: A means–end chain analysis. *Psychology and Marketing*, **11**, 313-340.

Bamberg, S. (1996). Allgemeine oder spezifische Einstellungen bei der Erklärung umweltschonenden Verhaltens? [General or specific attitudes in explaining ecologically responsible behavior?]. *Zeitschrift für Sozialpsychologie*, **27**, 47-60.

Bamberg, S., & Schmidt, P. (1993). Verkehrsmittelwahl. Eine Anwendung der Theorie geplanten Verhaltens. [Travel mode choice. An application of the TPB]. *Zeitschrift für Sozialpsychologie*, **24**, 25-37.

Bamberg, S., & Schmidt, P. (1994). Auto oder Fahrrad? Empirischer Test einer Handlungstheorie zur Erklärung der Verkehrsmittelwahl [Car or bike? Empirical test of an action theory]. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, **46**, 80-102.

Bardeleben, H. (1991). Conclus 3.0 Professional cluster analysis. Unpublished user's guide, University of Giessen, Giessen, Germany.

Brubaker, R. G., & Fowler, C. (1990). Encouraging college males to perform testicular self-examination: Evaluation of a persuasive message based on the revised theory of reasoned action. *Journal of Applied Social Psychology*, **17**, 1411-1422.

Dwyer, W. O., Leeming, F. C., Cobern, M. K., Porter, B. E., & Jackson, J. M. (1993). Critical review of behavioral interventions to preserve the environment. *Environment and Behavior*, **25**, 275-321.

Eagly, A. E., & Chaiken, S. (1993). *The psychology of attitudes*. Forth Worth, TX: Harcourt Brace Jovanovich.

Fishbein, M., Ajzen, I., & McArdle, J. (1980). Changing the behavior of alcoholics: Effects of persuasive communication. In I. Ajzen & M. Fishbein (Eds.), *Understanding attitudes and predicting social behavior* (pp. 217-242). Englewood Cliffs, NY: Prentice-Hall.

Fishbein, M., Guenther-Grey, C., Johnson, W., Wolitski, R. J., McAlister, A., Rietmeijer, C. A., O'Reilly, K., & The AIDS Community Demonstration Projects. (1995). Using a theory-based community intervention to reduce AIDS risk behaviors: The CDC's AIDS Community Demonstration Project. In S. Oskamp & S. Thompson (Eds.), *Understanding and preventing HIV risk behavior* (pp. 20-35). Thousand Oaks, CA: Sage.

Fishbein, M., & Middlestadt, S. E. (1989). Using the theory of reasoned action as a framework for understanding and changing AIDS-related behaviors. In V. M. Mays, G. W. Albee, & S. F. Schneider (Eds.), *Primary prevention of AIDS: Psychological approaches* (pp. 93-110). Newbury Park, CA: Sage.

Fishbein, M., Middlestadt, S. E., & Trafimow, D. (1992). *Getting people to use condoms: Recommendations for a media campaign based on data from a KABP survey in St. Lucia*. Washington, DC: Academy of International Development.

Fishbein, M., Trafimow, D., Mittlestadt, S. E., Helquist, M., & Francis, C. (1993). Social norms for condom use. Implications for HIV prevention intervention of a KABP survey with heterosexuals in the eastern Caribbean. *Advances of Consumer Research*, **20**, 292-296.

Geller, E. S., Berry, T. D., Ludwig, T. D., Evans, R. E., Gilmore, M. R., & Clark, S. W. (1990). A conceptual framework for developing and evaluating behavioral change interventions for injury control. *Health Education Research*, **5**, 125-137.

Geller, E. S., Winett, R., & Everett, P. (1982). *Preserving the environment. New strategies for behavioral change*. New York, NY: Pergamon.

Goldenhar, L. M., & Connell, C. M. (1992/1993). Understanding and predicting recycling behavior: An application of the theory of reasoned action. *Journal of Environmental Systems*, **22**, 91-103.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1986/1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education*, **18**(2), 1-8.

Hoogestraten, J., De Haan, W., & Ter Horst, G. (1985). Stimulating the demand for dental care: An application of Ajzen and Fishbein's theory of reasoned action. *European Journal of Social Psychology*, **15**, 401-414.

Hopper, J. R., & Nielsen, J. M. (1991). Recycling as altruistic behavior. Normative and behavioral strategies to expand participation in a community recycling program. *Environment and Behavior*, **23**, 195-220.

Howenstine, E. (1993). Market segmentation for recycling. *Environment and Behavior*, **25**, 86-102.

Inglehart, R. (1989). *Cultural change*. Princeton, NJ: Princeton University Press.

Jones, R. E. (1990). Understanding paper recycling in an institutionally supportive setting: An application of the theory of reasoned action. *Journal of Environmental Systems*, **19**, 307-321.

Kruse, L., & Arit, R. (1984). *Environment and behavior: An international and multidisciplinary bibliography 1970-1981* (Vol. 1). New York, NY: K. G. Saur.

Lindsay, J. J., & Strathman, A. (1997). Predictors of recycling behavior: An application of a modified health belief model. *Journal of Applied Social Psychology*, **27**, 1799-1823.

Liska, A. E. (1984). A critical examination of the causal structure of the Fishbein/Ajzen attitude–behavior model. *Social Psychology Quarterly*, **47**, 61-74.

Minard, P. W., & Cohen, J. B. (1981). An examination of the Fishbein–Ajzen behavioral intentions model's concepts and measures. *Journal of Experimental Social Psychology*, **17**, 309-339.

Rosenstock, I. (1966). Why people use health services. *Millbank Memorial Fund Quarterly*, **44**, 94-126.

Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 221-279). New York, NY: Academic Press.

Schwartz, S. H., & Howard, J. A. (1981). A normative decision-making model of altruism. In J. P. Rushton & R. M. Sorrentino (Eds.), *Altruism and helping behavior* (pp. 189-211). Hillsdale, NJ: Lawrence Erlbaum.

Siero, S., Boon, M., Kok, G., & Siero, F. (1989). Modification of driving behavior in a large transport organization: A field experiment. *Journal of Applied Social Psychology*, **74**, 417-423.

Social-Data. (1993). Kontiv Design: A concept for surveying everyday mobility. In *SPIEGEL Documentation: Cars, traffic and environment* (pp. 191-193). Hamburg, Germany: Augstein GmbH.

Stern, P. C., Dietz, T., & Kalof, L. (1993). Value orientations, gender and environmental concern. *Environment and Behavior*, **25**, 322-348.

Strader, M. K., & Katz, B. M. (1990). Effects of persuasive communication on beliefs, attitudes, and career choice. *Journal of Social Psychology*, **130**, 141-150.

Taylor, S., & Todd, P. (1997). Understanding the determinants of consumer composting behavior. *Journal of Applied Social Psychology*, **27**, 602-628.

Van den Putte, B. (1991). *On the theory of reasoned action*. Unpublished doctoral dissertation, University of Amsterdam, The Netherlands.

Van den Putte, B., & Hoogstraaten, J. (1997). Applying structural equation modeling in the context of the theory of reasoned action. *Structural Equation Modeling*, **4**, 320-337.

Van Lange, P. A. M., van Vugt, M., Meertens, R. M., & Ruiter, R. A. C. (1998). A social dilemma analysis of commuting preferences: The roles of social value orientation and trust. *Journal of Applied Social Psychology*, **28**, 796-820.

Van Vugt, M., Meertens, R. M., & Van Lange, P. A. M. (1995). Car versus public transportation? The role of social value orientations in a real-life social dilemma. *Journal of Applied Social Psychology*, **25**, 258-278.

Van Vugt, M., Van Lange, P. A. M., & Meertens, R. M. (1996). Commuting by car or public transportation? A social dilemma analysis of travel mode judgments. *European Journal of Social Psychology*, **26**, 373-395.

Vining, J., & Ebreo, A. (1990). What makes a recycler? *Environment and Behavior*, **22**, 55-73.

Vining, J., & Ebreo, A. (1992). Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities. *Journal of Applied Social Psychology*, **22**, 1580-1607.

Appendix A

The TPB Items

Evaluation of behavioral beliefs. How important are the following attri-butes of a transportation means for university routes for you personally? (a) cheap, (b) quick, (c) comfortable, (d) without stress, and (e) ecological. The response range was a 5-point bipolar scale ranging from -2 (*very unimportant*) to +2 (*very important*).

Subjective probability of behavioral beliefs. If I use public transportation (the car/the bike) for university routes the next time, this will be: (a) cheap, (b) quick, (c) comfortable, (d) without stress, and (e) ecological. The response range was a 5-point bipolar scale ranging from -2 (*very unlikely*) to +2 (*very likely*).

Evaluation of control beliefs. How much would the following factors facilitate your decision to use public transportation for university routes? (a) a good bus connection between my apartment and the university campus; and (b) knowing when the next bus departs. How much would the following factor facilitate your decision to use the car for university routes? The availability of a car. How much would the following factor facilitate your decision to use the bike for university routes? The distance between my apartment and the university campus is not too far. The response range was a 5-point unipolar scale ranging from 0 (*not at all facilitating*) to 4 (*very facilitating*).

Subjective probability of control beliefs. If I want to use public transportation for university routes next time, there would be a good bus connection between my apartment and the university campus. If I want to use public transportation for university routes next time, I know when the next bus departs. If I want to use the car for university routes next time, a car would be available for me. If I want to use the bike for university routes next time, the distance would not be too long. The response range was a 5-point bipolar scale ranging from -2 (*very unlikely*) to +2 (*very likely*).

Attitude. If I use public transportation (the car/the bike) for university routes next time, this would be *good–bad, pleasant–unpleasant* overall. The response range was a 5-point bipolar scale ranging from +2 (*good*) to -2 (*bad*).

Subjective norm. If I use public transportation (the car/the bike) for university routes next time, most of the people who are important to me would support this. Most of the people who are important to me think that next time I should use public transportation (the car/the bike) for university routes. The response range was a 5-point bipolar scale ranging from -2 (*very unlikely*) to +2 (*very likely*).

Perceived behavioral control. Using public transportation (the car/the bike) for university routes next time would be *easy–difficult* for me. My autonomy to use public transportation (the car/the bike) next time for university routes is *small–large*. The response range was a 5-point bipolar scale ranging from -2 (*very difficult, very small*) to +2 (*very easy, very large*).

Intention. Next time I intend to use public transportation (the car/the bike) for university routes: *likely–unlikely*. My intention to use public transportation (the car/the bike) for university routes next time is *high–low*. The response range was a 5-point bipolar scale ranging from -2 (*low*) to +2 (*high*).

Appendix B

Unstandardized (b) and Standardized (β) Path Coefficients of the Two-Wave Panel Model

Path coefficients		Wave 1994		Wave 1995	
		b	β	*b*	β
Fast	→ attitude	0.34	0.36	0.15	0.15
Comfortable	→ attitude	0.25	0.33	0.25	0.30
Without stress	→ attitude	0.19	0.24	0.19	0.23
Cheap	→ attitude	0.11	0.14	0.11	0.16
Ecological	→ attitude	0.07	0.08	-0.03*	-0.03*
Fast	→ norm	0.18	0.17	0.18	0.17
Comfortable	→ norm	0.12	0.14	0.12	0.14
Without stress	→ norm	0.07	0.08	0.05*	-0.06*
Cheap	→ norm	0.07	0.07	0.07	0.09
Ecological	→ norm	0.17	0.17	0.04*	0.04*
Departure knowledge	→ attitude	0.05	0.09	0.05	0.08
Good connection	→ attitude	0.03*	0.05*	0.19	0.24
Departure knowledge	→ norm	0.11	0.17	0.11	0.16
Good connection	→ norm	0.04*	0.06*	0.19	0.25
Departure knowledge	→ PBC	0.31	0.39	0.31	0.37
Good connection	→ PBC	0.23	0.30	0.23	0.23
Norm	→ intention	0.38	0.37	0.38	0.30
Attitude	→ intention	0.18	0.16	0.18	0.14
PBC	→ intention	0.20	0.24	0.49	0.48
Intention	→ behavior	0.18	0.72	0.18	0.64
PBC	→ behavior	0.01*	0.03*	0.00*	-0.01*

Note. PBC = perceived behavioral control.
*Path coefficient is not significant; $p > .05$.