Sebastian Bamberg and Peter Schmidt Regulating Transport: Behavioural Changes in the Field

ABSTRACT. The present paper offers a proposal for a conceptual framework which aims at relating, in a systematic way, the development of macro or meso level environmental policies to the empirical evaluation of such policies at the level of individual actors. For this purpose the macro-micro link model of Coleman is integrated with a general social-psychological actor theory (Ajzen's theory of planned behaviour) and the structural equation modelling approach. The proposed framework is applied and empirically tested in the context of a three-wave panel study intended to evaluate the effects of two transport policy interventions (a drastic price reduction for public transport and the introduction of a new bus route). The results of the longitudinal data analyses provide a detailed picture of the short and long term reactions to the interventions both overall and for specific subgroups.

The development and promotion of "sustainable" production and consumption patterns will be the great challenge of environmental movements and policies in the highly industrialized countries. Public and political decision-makers expect social science to contribute to the design and implementation of effective programmes to change environmentally damaging collective and individual behaviour patterns. Because of specific deficits we think that social science environmental research is only partly able to meet these expectations at the moment.

Therefore, the starting point of the present paper is a brief description of four basic deficits of social science environmental research. We will then present a research approach that we hope provides a better foundation for policy relevant research. In the empirical part of our paper we will demonstrate the application of this approach in the context of a three-wave panel study, conducted to evaluate the impact of two transport policy measures on the travel mode choice of 30,000 students. Finally we will summarize the main results and possible implications.

Journal of Consumer Policy **22**: 479–509, 1999.

DEFICITS OF CURRENT SOCIAL SCIENCE RESEARCH ON ENVIRONMENTALLY RELATED BEHAVIOUR

We view the following four deficits as the main obstacles to the design of effective intervention programmes aimed at changing environmentally problematic behaviour.[1]

1. *The lack of theory-driven links between the development and implementation of macro or meso level environmental policy interventions, on the one hand, and reactions to these interventions at micro level (e.g., behavioural reactions of individual consumers), on the other hand*. Most environmental policy intervention programmes do not influence individual behaviour directly but do so indirectly via a change in structural conditions at the macro-meso level (e.g., by restricting existing or offering new opportunities). Examples are a rise in a nation's gasoline taxes (the macro level) or introduction of a new ticketing system for local transportation (meso level). Theory-driven approaches which allow the derivation of empirically testable hypotheses for such macro-micro links are very rare (Chen, 1990).

2. *Lacking "policy relevance" of behavioural models developed in the social sciences.* Behavioural models are relevant for policy-making only if they offer direct intersections with such dimensions of the objective setting as can be influenced by environmental policy interventions. They must contain empirically testable causal hypotheses as to how people's subjective perception and evaluation of specific aspects of the objective setting influence their observable behaviour. Many behavioural models, psychological ones in particular, which have been advanced to explain environmental behaviour, do not fulfil this prerequisite (such as is the case with models of travel mode choice, for example; Kutter, 1985; Verron, 1986).

3. *Lack of dynamics in the theoretical models and the empirical tests*. From a strict point of view, all social science theories are dynamic theories because they postulate causal relationships between independent and dependent variables. At the moment, though, social science is dominated by static models and by cross-sectional data collection through survey research, in spite of the fact that the time lag is not only of theoretical but often of great practical significance. Thus empirical research has shown that the long-term effect of policy interventions (e.g., Goodwin, 1992, on an increase in gas prices) can be much stronger than the short-term effect. The same holds true for possible negative side effects which often occur in the long term.

4. *Insufficient theory-driven identification of target groups with different behavioural reactions.* Practitioners know that most interventions do not affect everybody in the same way. Some groups react more strongly to a specific intervention than others, and some groups do not react at all. Hence it is very important to identify, *a priori*, those subgroups where different reactions can be expected. Most social science theories (marketing theory may here constitute an exception) do not contain any theoretical assumptions as to how special subgroups may react differently to changes in specific variables of the model.

HOW TO HANDLE THE DEFICITS

A Methodological Approach for Policy-Relevant Social Science Environmental Research

To deal more adequately with the first research deficit we have based our own research on a conceptual framework developed by Coleman (1990, Ch. 1). Figure 1 provides a graphical representation of this framework.

Coleman postulates a two-level model, in which the upper part represents the macro level with attributes characterizing the social system or context (S). The lower part consists of an action theory for the individual (micro level) which in a causal way connects attributes of the actor (the perceived consequences of actions, PCA) with the observable action (A). The connection between the macro and micro levels is constructed by an analysis of the "logic of the situa-

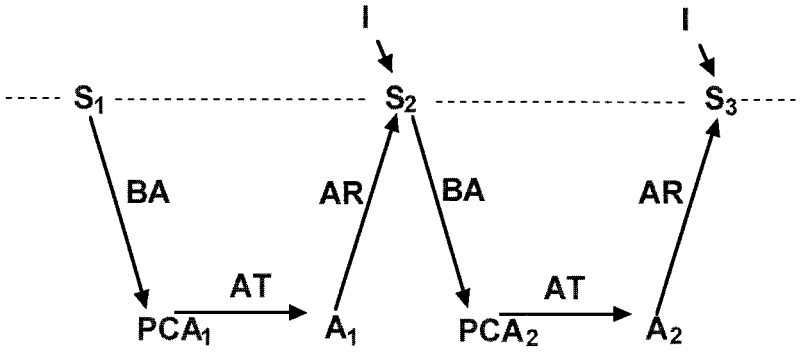

Figure 1. A dynamic micro–macro model.

tion" (Esser, 1993), in which an attempt is made to determine the restrictions and opportunities that are characteristic for the social situation, objectively defined, and how these restrictions and opportunities are subjectively perceived by an individual actor, and how the actor evaluates these restrictions and opportunities. The goal of the reconstruction of the social situation of the actor is the formulation of so-called "bridging assumptions" (BA) concerning the effect of variables at the macro level (the objective environmental conditions) on the actor's perception of these variables (his "logic of the situation"). A general action theory is then used to explain the causal relationship between the perceived logic of the situation and the individual decision to choose a specific behavioural alternative. In the third step one must develop hypotheses as to how the sum of individual actions on the micro level leads to collective, aggregated consequences at the macro level. These "aggregation rules" (AR) can be very simple (summation of single actions) or very complicated (e.g., social diffusion processes).

A dynamic micro-macro model consists of a sequence of such steps as just described. At one point in time, an external event "I" (an intervention) can occur, which changes specific attributes of the objective social situation. With the help of the bridging assumption one can then derive empirically testable hypotheses for how the changes will affect the subjective perception of the situation.

The Theory of Planned Behaviour as a General Theory of the Individual Actor

Coleman leaves open the choice of which action theory one should use. For our part, we have decided to use Ajzen's (1985, 1991) Theory of Planned Behaviour (TPB) as our individual actor theory (see Figure 2). It is one of the most frequently used actor theories in social psychology (e.g., Conner & Armitage, 1998; Eagly & Chaiken, 1993; Manstead, 1996). Figure 2 presents a graphical representation of the TPB (cf., Bamberg & Schmidt, 1998a).

Very briefly, the TPB stipulates that when confronted with the need to decide on a course of action, a person considers the likely consequences of available alternatives; weight the normative expectations of important reference individuals or groups; and consider required resources and potential impediments or obstacles (left side of Figure 2). These considerations or beliefs result, respectively, in preferences

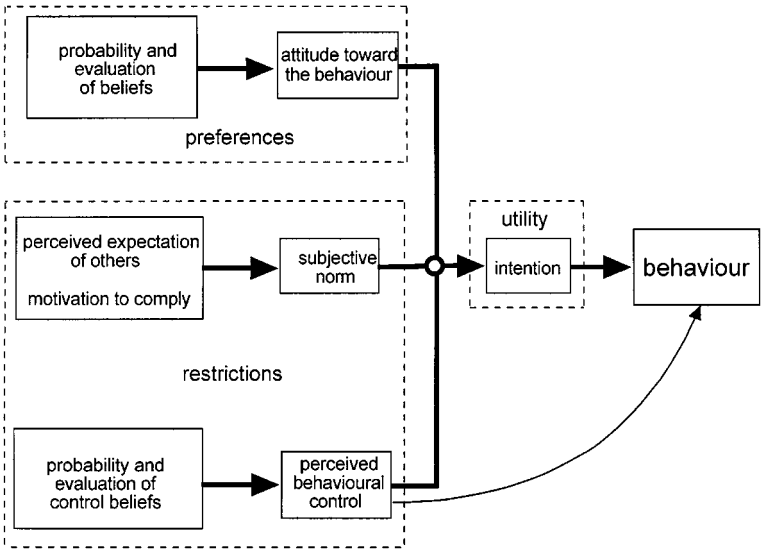

Figure 2. The theory of planned behaviour (TPB).

(the formation of attitudes toward the behaviour of interest), and restrictions (subjective norms with respect to the behaviour, and perceived behavioural control). Expectancy value formulations are used to describe the ways in which salient beliefs produce the more general constructs. It is assumed that people form behavioural intentions based on their attitudes, subjective norms, and perceptions of behavioural control and that these intentions, together with behavioural control, are the immediate determinants of behaviour. The question of whether perceived behavioural control affects behaviour only through interaction with intention has still not been answered satisfactorily (Ajzen, 1991). It can be seen that the TPB 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 behavioural control, and intention. Accurate prediction is expected to the extent that the same or similar beliefs are salient also at the time and place of behaviour.

EMPIRICAL APPLICATION: DEVELOPMENT AND EVALUATION OF TWO TRANSPORT POLICY INTERVENTIONS

The Problem

Giessen is a small university town (77,000 inhabitants), fifty miles north of Frankfurt. With 30,000 college and university students the population has the highest proportion of students in Germany. The university facilities are scattered all over the town. Approximately half of the students live in the rural surroundings of Giessen. These two conditions provide the reason for the difficult traffic problems that exist: Every day 30,000 students and 10,000 employees must reach their university facilities. On the basis of earlier studies, we calculated that on an average day the students alone make approximately 15,000 university-related car trips. In 1993 we started to develop plans for interventions that would reduce the use of private cars for trips to and from the university by increasing the attractiveness of public transportation. This initiative was taken in co-operation with the local government and the university administration.

In this context an empirical study was conducted. The study had two goals. The first was to collect information that could be used for the theory-driven development of effective interventions to reduce private car use by students. The second goal was the later empirical evaluation of the effect of these interventions.

Research Design and Sample

To achieve these two goals, the study was designed as a longitudinal panel study. Figure 3 presents the design of the study. The data collection of the first wave took place during the second week of February 1994, before intervention. It serves as the baseline measurement. Over a period of eight working-days a questionnaire was distributed to 3,491 randomly selected students. As one can see from Figure 3, 1,874 (53.7%) of these students returned a completed questionnaire. As 19,902 students attended the summer semester (disregarding those attending their first semester), this corresponds to 9.4% of all registered university students.

The second panel wave was conducted during the first week of February 1995, one year after the introduction of the first intervention, the semester ticket. Because of residential mobility and a change

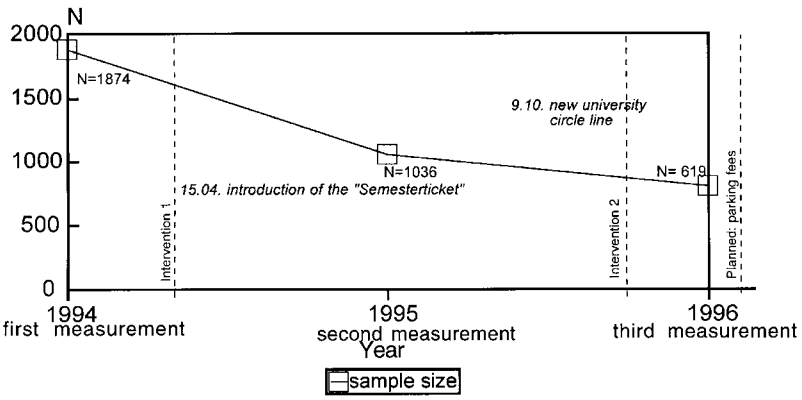

Figure 3. Design of the three-wave panel study.

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 percent, resulting in a sample of 1,036 students. The third panel wave was conducted during the first week of February 1996 (five months after the introduction of the second intervention, the circular university bus route). We sent a questionnaire to 829 of the 1,036 students of the second panel wave. Of these, 618 (74.5%) completed the questionnaire in the third wave. We did not find a strong sample selection bias due to panel mortality (Bamberg & Schmidt, 1997).

Results of the Baseline Study (the First Panel Wave)

Objective obstacles to the use of public transport and the subjective perception of these obstacles. Following the logic outlined in the first section of this paper, the first step was an intensive analysis of the objective conditions pertaining to Giessen students' travel mode. This analysis showed that using public transport was, in 1993, not very attractive. The reasons given by students living in the city of Giessen were different from those of students living outside the city. The community bus system had a radial structure which connected the main dwelling areas with the city centre. Because of the scattered locations of the university facilities, most student trips have a tangential structure, that is their trips go from one town district to another. Using the community bus system would mean that students must first take

a bus to the city centre and then take another bus to get to the university facility. Seen in relation to the relatively short bus routes in the city of Giessen (maximally 5 km), the structure of the community bus system caused long travelling times for trips to and from the university (for most connections approximately 30 minutes) with long waiting times when changing the bus.

For students living outside Giessen the obstacles to using public transport were even greater. They had to use one of the regional bus routes to reach the city. The bus services on these routes were infrequent and the times of arrival and departure were seldom compatible with the onset and ending of university lectures. Arriving at Giessen, students from the outlying districts were confronted with the same structural deficits of the connecting community bus system as were the students living in the city.

Given this poor service quality, the prices of public transport were relatively high. For the use of the community bus system in 1993, students had to pay approximately US $2 for a single return ticket.

From this analysis of the objective infrastructural conditions we derived the hypothesis that students at that time must have perceived the use of public transport as slow, inflexible, uncomfortable, expensive, and as more stressful than the use of car or bike.

Results from the first panel wave: Students' perception of the various modes of transportation. One goal of the first wave of our empirical study was to test our "bridging assumptions," that is to see how closely our analysis of the objective macro-structural conditions determining the travel mode choice corresponded with the situation as perceived by the students. The second goal of the first wave was to conduct an empirical test of the validity of the chosen action theory (TPB). Table I shows the extent to which the students interviewed in 1994 (the baseline measurement) associated the five attributes "quick," "comfortable," "without stress," "flexible," and "cheap" with the use of car, bike, and bus for trips to and from the university.

From Table I it can be seen that the car was perceived as the quickest and most comfortable transportation means for trips to and from the university. The bike was perceived as the least stressful, the cheapest, and the most flexible means of transportation. As expected the bus was perceived as the slowest, most inflexible, and most expensive means of transportation. Table II reports the perceived existence of important resources and obstacles promoting or hindering

TABLE I
The Degree to Which Students Associate the Use of the Three Transportation Modes (Car, Bike, and Bus) With Various Attributes. Baseline Measurement 1994, Prior to the Introduction of Interventions. N = 1,494

Attribute	Car		Bike		Bus	
	M	*SD*	*M*	*SD*	*M*	*SD*
Quick	0.70	1.46	0.20	1.62	–1.14	1.07
Comfortable	1.30	1.08	–0.50	1.27	–0.18	1.31
Without stress	–0.46	1.28	–0.02	1.37	–0.27	1.28
Flexible	1.08	1.32	1.16	1.28	–1.46	0.83
Cheap	–0.76	1.20	1.85	0.60	–0.80	1.25

Note: All rating scales ranged from –2 (unlikely) to +2 (likely); the exact question wordings can be found in the Appendix.

TABLE II
Perceived Resources and Objective Constraints Promoting or Hindering the Use of the Three Transportation Modes (Car, Bike, and Bus). Baseline Measurement 1994, Prior to the Introduction of Interventions. N = 1,494

	M	*SD*
Ownership of a car	0.66	0.50
Ownership of a bike	0.80	0.17
Availability of a car for university trips	0.45	0.50
Existence of a good bus connection	–0.09	1.58
Distance does not prevent bike use	0.07	1.64
Familiarity with time-table	–0.25	1.65

Note: With the exception of "Ownership of a car/bike," all rating scales ranged from –2 (unlikely) to +2 (likely). "Ownership of a car" and "Ownership of a bike" are dichotomous items (1 = yes; 0 = no).

the use of the various means of transportation. The table indicates that in our student sample the ownership or availability of a car as well as the ownership of a bike was rather high, whereas the perceived likelihood of a good bus connection between the apartment and university campus was rather low as was the self-reported knowledge of the schedule for bus departures. To summarize, there is good correspondence between the objective and the subjectively perceived quality of public transport.

Multivariate results from the first panel wave: Testing the Theory of Planned Behaviour. In the next step we empirically tested the actor

theory, the TPB. This theory specifies how the perceived consequences of using the three modes of transportation are causally related to the actual use of the modes of transport. Applying TPB to the explanation of travel mode choice leads to the following hypotheses:

H1: The higher the likelihood that a person associates positively evaluated consequences with the use of a specific mode of transportation, the more positive is the attitude toward its use.

H2: The more a person believes that important reference persons or groups expect him to use a specific mode of transportation, the stronger is the subjective norm to use it.

H3: The greater the perceived resources and the greater the opportunities to use a specific mode of transportation, the higher is the perceived behavioural control over its use.

H4. The more positive the attitude toward using a specific mode of transportation, the stronger is the intention to use it.

H5: The stronger the subjective norm to use a specific mode of transportation, the greater is the intention to use it.

H6: The higher the perceived behavioural control over a specific mode of transportation, the stronger is the intention to use it.

H7: The stronger the intention to use a specific mode of transportation, the higher is the probability that it is actually used.

H8: The higher the perceived behavioural control over a specific mode of transportation, the higher is the probability that it is actually used. According to Ajzen (1991), this hypothesis should only hold true when perceived behavioural control is a valid indicator of objective behavioural control.

The operationalization of the theoretical constructs of the TPB is documented in the Appendix (see also the documentation of the scales and the theory in the ZUMA-Information-System, Bamberg *et al*., 1999). Figures 4 to 6 show three structural equation models with the help of which the hypotheses were tested empirically for the three travel modes. For technical details of model specification and model estimation, see Jöreskog and Sörbom (1993); Bamberg and Schmidt (1998a, 1998b); for a discussion of different model specifications for the TPB, see van den Putte and Hoogstraaten (1997).

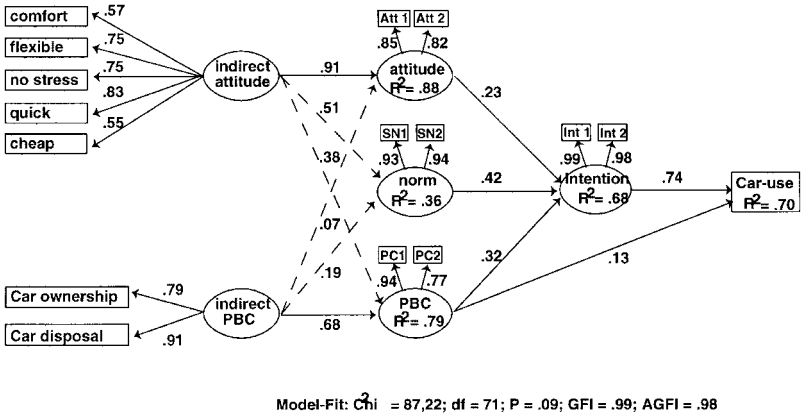

Figure 4. The TPB model for car use.

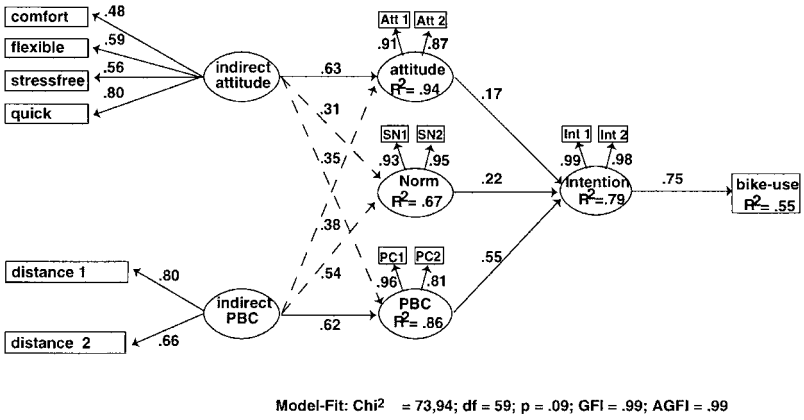

Figure 5. The TPB model for bike use.

As can be seen, the empirical results of the model testing confirm the TPB. The actual use of all three transportation modes is caused directly by the intention to use it (see *H7*). Only in the case of cars is there an additional direct effect of perceived behavioural control on the actual car use (*H8*). The higher the perceived behavioural control over the use of the car (that is the availability of a car), the more frequently it is actually used. According to Ajzen (1991), these results indicate that in the case of cars the perceived behavioural control is a reliable indicator of the actual objective behavioural control whereas in the case of buses and bikes the perceived behav-

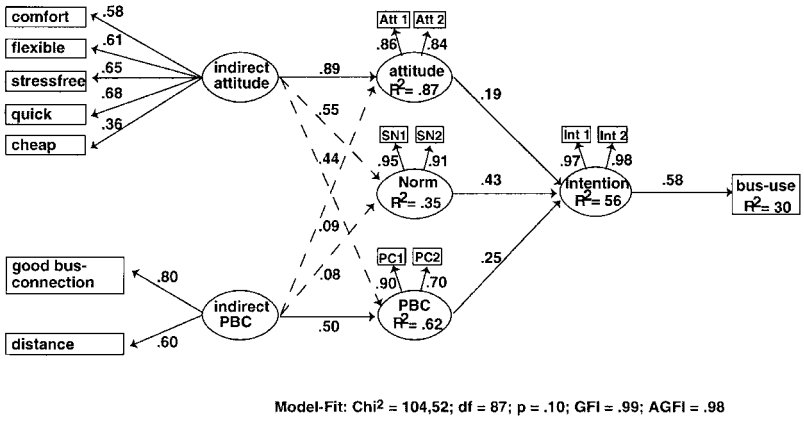

Figure 6. The TPB model for bus use.

ioural control does not seem to be a valid indicator of the actual behavioural control.

As proposed by the TPB, the intention itself turns out to be determined by the three independent constructs "attitude" (*H4*), "subjective norm" (*H5*), and "perceived behavioural control" (*H6*). Likewise, the global attitude and the perceived behavioural control are determined by, respectively, the perceived consequences and the resources/restrictions associated with the three modes (*H1*, *H3*). In our study, however, the perceived consequences do not only influence the attitude construct, as postulated by the TPB, but also influence the norm and the perceived behavioural control constructs (which is depicted by the dotted lines in Figures 4 to 6). The same holds true for the perceived resources/restrictions. At first sight these results disconfirm the causal model proposed by the TPB. But we are wary of interpreting these unexpected results as substantive effects. Due to space limitations normative beliefs were not measured in the study; hence, the postulated effect of these normative beliefs on subjective norm (see *H2*) could not be specified. From a statistical point of view the additional, unexpected paths depicted in Figures 4 to 6 may reflect the impact of a specification error (a missing variable).

Figure 7 shows the aggregated results of the students' individual travel mode decisions. The so-called "modal split" describes the proportion of all trips to and from the university using each of the three travel modes.

As could be expected on the basis of the results reported in

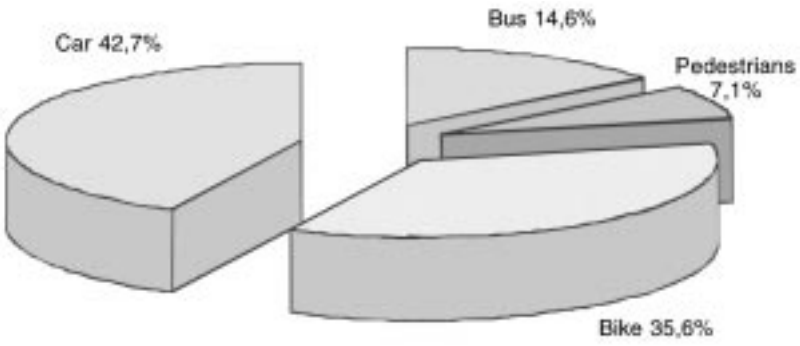

Figure 7. The model split in 1994 (baseline).

Tables I and II, Figure 7 shows that in 1994, the car was the most preferred mode of transportation (42.7%), followed by the bike (35.6%). The proportion of trips using public transport was rather low, 14.6%.

The Interventions: The "Semester Ticket" and the "Circular University Route"

The goal of the first intervention, the so-called "semester ticket," was to achieve a drastic reduction in the price of public transport. The semester ticket is an innovative concept for financing a collective good. It is based on a solidarity principle which requests all students to contribute with the consequence that the individual burden becomes small. In exchange, the possession of a valid student identity card entitles all students to make free use of public transport. In Giessen the semester ticket enables students to make free use of all forms of public transport (buses and trains) within a radius of approximately 30 miles. The ticket adds DM 38 (ca. US $21) to the normal half-year university fee, a drastic price reduction since the normal bus user has to pay the same amount of money for one ordinary monthly ticket (which is valid only for the buses in the community of Giessen). Furthermore, the use of public transport is facilitated because the purchase of an individual ticket is no longer necessary.

The goal of the second intervention, the circular university bus route, was to reduce the travel time for the transportation mode "bus." For this purpose a new bus route was planned and introduced, connecting the main university facilities with each other directly, with

the city centre, and with the train station. By this circular route the mean travel time spent on public transport was reduced by approximately 15 minutes for most university targets. To finance the new bus route, the semester ticket fee was increased from DM 38 to DM 44.

The semester ticket was introduced in May, 1994. Prior to that the student body was able to vote for or against its introduction. Sixty-five percent of those participating voted for the semester ticket. The circular university route was introduced in October, 1995.

Bridging Assumptions Concerning the Effects of the Two Interventions

A set of bridging assumptions (BA) will now be presented. These propositions refer to the relationship between the two interventions and the constructs of the TPB. In evaluation research these propositions are called "action hypotheses" (Chen, 1990). For the semester ticket, one can conclude that the attribute "cheap" was the central target of the intervention. So the first bridge assumption postulates:

BA1. The introduction of the semester ticket increases the reported likelihood with which students associate the attribute "cheap" with public transportation (behavioural belief).

We further assume that the drastic price reduction caused by the semester ticket motivated former non bus users to test public transport. Through this testing they will acquire information about the bus system (e.g., the time-table, bus routes, bus stops), which facilitates the use of public transport.

BA2. The introduction of the semester ticket increases students' beliefs that there will be a good bus connection and that they will be familiar with the time-table.

As stated above, the introduction of the semester ticket was accompanied by an intensive public discussion in university and local newspapers and an ensuing student vote. The third bridging assumption refers to the expected effects of this discussion and vote:

BA3. Because of the intensive public discussion and the ensuing vote the perceived expectations of significant others are supposed to be greater after the introduction of the semester ticket (subjective norm).

For the circular university circular route one can conclude that the attribute "quick" was the central target of this intervention. So the first bridging assumption concerning this intervention postulates:

BA4. The reduction of travel time caused by the circular route increases the reported likelihood with which students associate the attribute "quick" with the public transportation (behavioural belief).

Furthermore we expect that not having to change from one bus route to another could give rise to more frequent associations with the perceived probability of the attributes "comfortable" and "without stress":

BA5. The avoidance of changes caused by the circular route increases the reported likelihood with which students associate the attributes "comfortable" and "without stress" with public transportation (behavioural beliefs).

BA6. After the introduction of the circular route the perceived quality of the bus connections between the place of living and the university campus increases, especially for students living in the city of Giessen (control belief).

Empirical Evaluation of the Two Interventions

Effects of the semester ticket. Table III shows the cross-tabulated self-reported transportation mode before the introduction of the semester ticket (1994) and one year after (1995) for those students who participated in the first and second panel wave and recorded at least one university trip (N = 679) at both times.

TABLE III
Self-Reported Transportation Mode for Trips to the University Before the Introduction of the Semester Ticket (1994) and One Year After (1995). N = 679

1995 \ 1994	Car	Bike	Bus	Pedestrian	
Car	167	23	8	6	204 (30.0%)
Bike	24	168	12	14	218 (32.1%)
Bus	88	31	77	13	209 (30.8%)
Pedestrian	17	14	7	10	48 (7.1%)
	296 (43.6%)	236 (34.8%)	104 (15.3%)	43 (6.3%)	679 (100%)

As one can see, bus use increased significantly from 1994 (15.3%) to 1995 (30.8%). In the same time period car use decreased significantly from 43.6% to 30.0%, whereas bike use and the number of pedestrians remained relatively stable. This indicates that the semester ticket had a substantial effect on the travel mode choice of the students, and especially on former car users.

Now we want to analyse the changes that took place in greater detail, by comparing the means of the indicators of the TPB before and after the introduction of the semester ticket.

As one can see from Table IV, there is a drastic change in the reported likelihood with which the students associate the attribute "cheap" with the use of the bus (*BA1*). The intervention also seems to have changed the reported likelihood of the attribute "quick." No changes occurred in the attributes "comfortable" and "without stress."

TABLE IV
Means and Standard Deviations of the TPB Variables for Bus Use Before the Introduction of the Semester Ticket (1994) and One Year After (1995). Only Cases Without Missing Values. $N = 622$

	Before		After		
	M	*SD*	*M*	*SD*	*p*
Behavioural beliefs					
Bus quick	–1.19	1.01	–1.07	1.05	*
Bus comfortable	–0.10	1.28	–0.02	1.29	n.s.
Bus without stress	–0.26	1.22	–0.33	1.26	n.s.
Bus cheap (*BA1*)	–0.84	1.23	0.78	1.47	**
Control beliefs					
Good bus connection (*BA2*)	0.05	1.54	–0.66	1.42	**
Departure knowledge (*BA2*)	–0.36	1.61	0.14	1.65	**
Indicators of the latent constructs attitude, norm, perceived behavioral control (PBC), and intention					
Bus attitude 1	–0.65	1.10	–0.34	1.21	**
Bus attitude 2	–0.73	1.06	–0.51	1.12	**
Bus norm 1 (*BA3*)	–0.67	1.18	–0.39	1.27	**
Bus norm 2 (*BA3*)	–0.87	1.13	–0.76	1.20	*
Bus PBC 1	–0.49	1.49	–0.16	1.61	**
Bus PBC 2	–0.39	1.57	0.10	1.63	**
Bus intention 1	–1.39	1.14	–0.97	1.46	**
Bus intention 2	–1.38	1.15	–0.89	1.49	**

Note: All rating scales ranged from –2 to +2.
* $p < 0.05$; ** $p < 0.01$; n.s. = not significant.

Let us now look at the changes of the reported likelihood of the resources/obstacles associated with bus use (*BA2*). The perceived knowledge of the time-table increased significantly, whereas the perceived existence of good bus connections decreased significantly. One may conclude that through their direct experience with the bus system, more students came to be familiar with the departure times of the buses in 1995 than in 1994, but that this direct experience led to an even more critical evaluation of the actual bus service. The observable changes in the reported likelihood of some of the behavioural consequences and control beliefs correspond to drastic changes in the means of the indicators of the latent constructs "subjective norm" (as predicted in *BA3*), "attitude," "perceived behavioural control," and "intention."

From a substantive point of view, the huge increase in perceived behavioural control over the use of the bus is astonishing. Only one of the measured control beliefs (knowledge of time-tables) changed in a positive direction whereas the other (quality of bus connections) changed in a negative direction. It is hard to imagine that lack of knowledge about time-tables is a stronger determinant of behavioural control than bad bus connections. It might be that the measured control beliefs do not capture the most important determinants of the behavioural control construct. So the results reported above (Figures 3, 4, and 5: see also the discussion on p. 505) which imply that the perceived consequences of bus use have an effect on behavioural control, may mirror a real effect. Perceived consequences may not only determine the attitude but may also "colour" the perceived behavioural control. One can imagine that the degree to which a person thinks that he/she is able to do something is coloured by his/her desire to do/not do this very thing.[2]

Effects of the circular route. Table V shows the self-reported transportation mode use before the introduction of the circular university route (1995) and half a year after (1996) for those students who participated in the second and third panel wave and recorded at least one university trip (N = 408) at both times.

As can be seen from Table V, our expectation that the introduction of the new circular bus route would cause an increase in the use of public transport was not confirmed. On the contrary, the percentage of trips to the university conducted with public transport decreased slightly, whereas the private car use increased slightly.

TABLE V
Self-Reported Transportation Mode for Trips to the University Before the Introduction of the Circular University Route (1994) and One Year After (1995). N = 408

1996 \ 1995	Car	Bike	Bus	Pedestrian	
Car	88	9	27	2	126 (30.9%)
Bike	3	92	11	6	112 (27.5%)
Bus	14	23	90	7	134 (32.8%)
Pedestrian	4	7	13	12	36 (8.8%)
	109 (26.7%)	131 (32.1%)	141 (34.6%)	27 (6.6%)	408 (100%)

Note: The percentages for 1995 are different from Table III because of panel mortality.

Table VI presents the means of the TPB items. Between 1995 and 1996 there was a small, but statistically significant increase in the likelihood with which the students associated the attribute "quick" with the use of the bus for trips to the university (*BA4*).

The expected changes in the probability of the attributes "comfortable" and "without stress" (*BA5*) and the expected change in the perceived quality of bus connections between the place of living and the university campus (*BA6*) were not confirmed empirically. Taken together, as expected after the introduction of the circular bus route, there was an increase in the likelihood with which the students associated the attribute "quick" with bus use, but this increase had no substantial effect on actual behaviour. On the average, students still thought that going by bus was rather slow. That is probably why the change in the belief "quick" influenced neither attitude nor behaviour.

Testing the TPB model over the three waves. Finally we want to present the results of the longitudinal TPB test. The longitudinal test is based on the data of those students who participated in all three panel waves, reported at least one trip to the university at all three points in time, and for whom there were no missing values in the variables of the model (N = 294). Because a longitudinal test of the entire TPB model (as represented in Figures 4 to 6 for the data of the first wave) would result in a very complex model, we have restricted the longitudinal test to the core TPB model.

The specification of longitudinal model for bus use is depicted in

TABLE VI
Means and Standard Deviations of the TPB Variables for Bus Use Before the Introduction of the Circular University Route (1995) and One Year After (1996). Only Cases Without Missing Values. $N = 353$

	Before		After		
	M	*SD*	*M*	*SD*	*p*
Behavioural beliefs					
Bus quick (*BA4*)	–0.99	1.10	–0.84	1.18	**
Bus comfortable (*BA5*)	0.06	1.29	0.01	1.31	n.s.
Bus without stress (*BA5*)	–0.23	1.22	–0.21	1.25	n.s.
Bus cheap	0.74	1.52	0.83	1.37	n.s.
Subjective likelihood of control beliefs					
Good bus connection (*BA6*)	–0.49	1.45	–0.35	1.49	n.s.
Departure knowledge	0.21	1.68	0.31	1.67	n.s.
Indicators of the latent constructs attitude, norm, perceived behavioral control (PBC), and intention					
Bus attitude 1	–0.24	1.19	–0.18	1.24	n.s.
Bus attitude 2	–0.39	1.16	–0.38	1.20	n.s.
Bus norm 1	–0.33	1.26	–0.33	1.27	n.s.
Bus norm 2	–0.67	1.25	–0.69	1.26	n.s.
Bus PBC 1	–0.01	1.66	0.10	1.60	n.s.
Bus PBC 2	0.17	1.67	0.22	1.59	n.s.
Bus intention 1	–0.82	1.54	–0.75	1.54	n.s.
Bus intention 2	–0.76	1.54	–0.62	1.56	n.s.

Note: All rating scales ranged from –2 to +2.
** $p < 0.01$; n.s. = not significant.

Figure 8. (To simplify the figure, the measurement models are not shown in the figure.)

For each wave we have specified the core model. The three cross-sectional models are connected longitudinally through stability coefficients. The TPB does not lead one to expect cross-lagged effects: At each point in time, bus use should be directly influenced only by the intention and the intention only by the attitude, subjective norm, and perceived behavioural control measured at the same point in time. As can be seen from Figure 8, this expectation was confirmed with one exception: The subjective norm measured at point 2 exerts a cross-lagged direct effect on the attitude measured at point 3. This effect can be interpreted as the result of an internalization process. The perceived expectations of important others are internalized, and thus

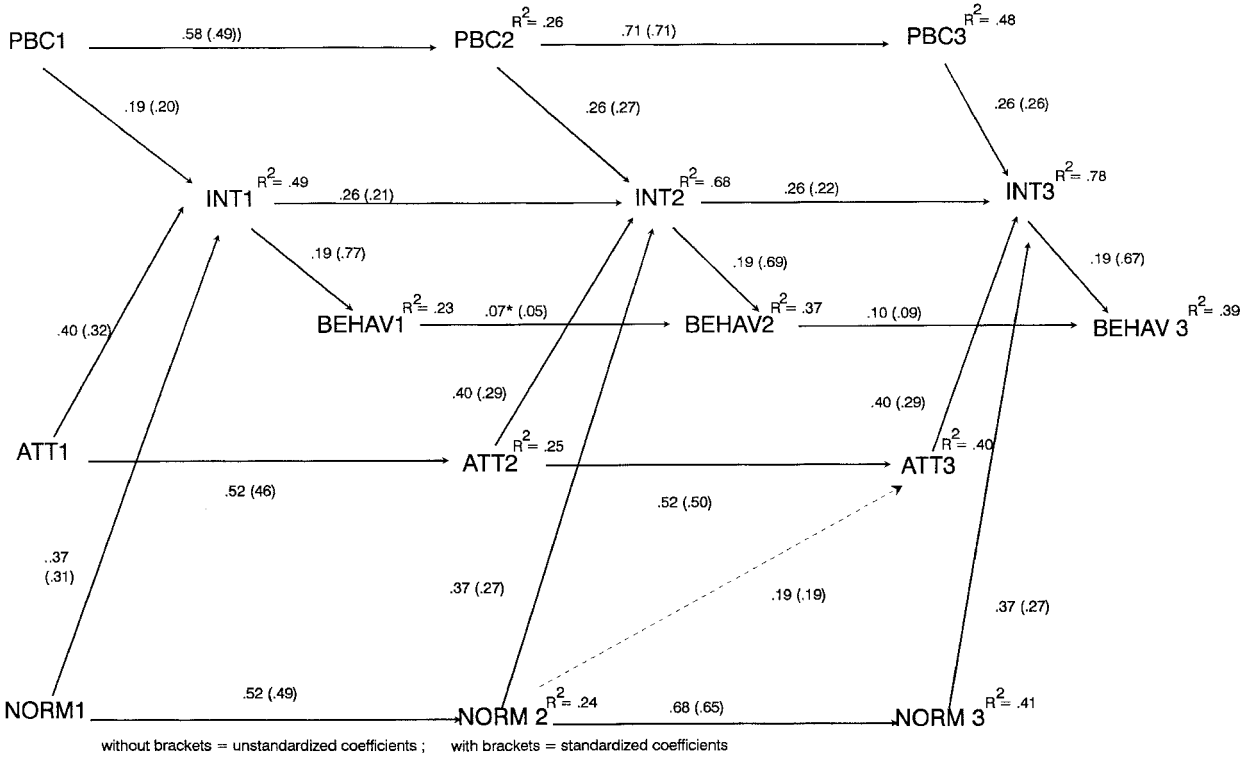

Figure 8. Results of the three-wave test of the TPB (bus use).

later influence the attitude toward the behaviour (see Kelman, 1958). After adding the cross-lagged effect, the core TPB model estimated simultaneously over the three waves fits the data well (χ^2 = 295.73; *df* = 259; *p* = 0.06, GFI = 0.94).

In a second step we have tested how stable the measurement models and the causal structure proposed by the TPB are over the whole period of the investigation. To secure construct validity the measurement models of the latent constructs should be equal at all three points in time. Empirically this can be tested by setting the corresponding factor loadings equal at all three points. Additionally, we will assume that the causal relationship between the TPB constructs is invariant over time. There is no theory-driven reason why, for example, the effect of intention on actual bus use should differ over time. These assumptions can be tested with the help of χ^2 difference tests: One can compare the fit (χ^2) of the model with equality constraints with that without equality constraints (Bollen, 1989, pp. 355–364). If the two χ^2 values do not differ statistically, the equality assumptions are confirmed. Our tests confirm that the factor loadings of the TPB constructs are invariant for all points in time, implying that the measurement models are the same throughout the period. The effects of intention on behaviour and the effects of subjective norm and attitude on intention are invariant over time, too. For attitude, the relationship between Wave 1 and Wave 2 is of identical size to that between Wave 2 and Wave 3 (0.52). The same invariance holds for the relationship between intention measured at different times (0.26). The fit of the model with equality constraints, depicted in Figure 8, is good (χ^2 = 311.72; *df* = 275; *p* = 0.06, GFI = 0.94).

In one case, however, the assumption of stability cannot be upheld. From 1994 to 1995 (the year of the introduction of the semester ticket) the effect of behavioural control on intention gets stronger (from 1995 to 1996, it remains stable, however). One can come up with different post-hoc explanations of the fact that the effect of PBC is stronger at the second time of measurement than at the first. The perceived behavioural control may become more authentic because more students have now actually used the bus, or the non bus users now see a stronger need to legitimize their continued car-driving by pointing out that the bus is difficult to use.[2]

Figure 8 also indicates that the correlations between the same construct measured on different occasions vary considerably over time. Attitude remains relatively stable over time. The stability of perceived

behavioural control as well as of norms is high, too, but is significantly higher between the second and the third time of measurement. The variables intention and, in particular, behaviour show low stability, however. This indicates that for these variables, the relative position of the individual respondent has changed drastically over time, something that can be interpreted as a hint that there are subgroup-specific effects of the interventions (see Tables III and V).

Subgroup-specific effects of the two interventions. Until now all the reported analyses have been based on the whole sample. However, already during the development of the two interventions it was believed that specific subgroups could react differently to the interventions. Such heterogeneity could lead to a misinterpretation of the effects obtained.

The Theory of Planned Behaviour has not dealt with the question of theory-driven subgroup detection; so far it is mainly a model of proximal behavioural determinants (Eagly & Chaiken, 1993). Our analyses are therefore restricted to the potential differences in reaction to the interventions caused by differences in some, objective frame-conditions on the reactions of the students to the introduced interventions. Because better public transport was introduced, we expected students living in the city of Giessen to react more strongly to the introduction of the semester ticket than students living on the outskirts of Giessen. And because students perceived the use of a private car as a relatively expensive travel mode, the drastic price reduction provided by the semester ticket should be a greater incentive for car users than for bike users to change to public transport. Hence, the group of students living in the city of Giessen and owning a car was the central target group for the semester ticket intervention. For the group of students living outside the city, the bad bus connections are probably the greatest barriers to the use of public transport. Because the price reduction caused by the semester ticket did not improve the poor quality of the regional bus connections, we expected only a weak reaction to the semester ticket in this subgroup.

Table VII presents the absolute numbers and percentages of students who changed from other travel modes to public transport after the introduction of the semester ticket, in the total sample and in the four subgroups "living in the city and owning a car," "living outside the city and owning a car," "living in the city and not owning a car," and "living outside the city and not owning a car."

TABLE VII
Gains for Public Transport After the Introduction of the Semester Ticket

	Whole sample (N = 679)	Living in city; with car (N = 119)	Living outside city; with car (N = 275)	Living in city; no car (N = 180)	Living outside city; no car (N = 105)
Gain					
Total	132	18	70	28	16
% changing to bus	19.4	15.1	25.5	15.5	15.2
Gain coming from (in %)					
Car users	66.7	27.8	94.3	14.3	81.3
Bike users	23.5	55.6	2.9	60.7	12.5
Pedestrians	9.8	16.7	2.9	25.0	6.3

As can be seen from Table VII, our expectations as to the subgroups that would react more strongly to the semester ticket are not confirmed empirically. We expected that the students owning a car and living outside Giessen would be most resistant to change. However, their reactions were the strongest. Of the 275 students in this group, 70 (25.5%) changed, whereas in the subgroup "living in the city and owning a car" only 15.1% changed. Table VII also shows the original travel modes of those students who changed. Whereas in the two subgroups "outside Giessen, with and without ownership of a car" the students mainly changed from the car, the students in the two inner-city subgroups mainly changed from the bike to public transport.

One possible explanation for the non-confirmation of our original expectation is the following.[2] Students differ in their sensitivity to the price of transportation. Price sensitivity is hardly dependent on where students live, but on the existence of realistic alternatives. For those living in the city of Giessen and caring strongly about price, the bicycle was a realistic alternative even before the semester ticket was introduced. Hence, it can be assumed that only the least price sensitive students living in the city of Giessen were car drivers before the introduction of the semester ticket. Not so for students living outside Giessen where the bicycle is no realistic alternative, and since, in addition, the longer distances travelled, the more money is saved with the semester ticket, it becomes a bigger incentive.

The same subgroup analyses were conducted for the effects of the circular university route. Because the circular route objectively improves the use of public transport mainly for students living in the city (the poor quality of the regional bus routes remains), we expected a stronger reaction from the two inner-city subgroups. As one can see from Table VIII, this hypothesis is confirmed empirically. The subgroup "city without ownership of car" reacts the most strongly, followed by the subgroup "city with ownership of a car." In both subgroups most changers are former bike users, however.

As reported above, after the introduction of the circular university route, the total number of users of public transport did not increase as expected. Instead there was a slight decrease, whereas car use increased somewhat. In Table VIII we can see that this result was mainly caused by the reaction of one subgroup, that is the subgroup "living outside Giessen and owning a car." Comparing 1995 with 1996, for this subgroup, public transport lost nearly twice as many

TABLE VIII
Gains and Losses for Public Transport After the Introduction of the Circular University Route

	Whole sample (N = 408)	Living in city; with car (N = 77)	Living outside city; with car (N = 164)	Living in city; no car (N = 104)	Living outside city; no car (N = 63)
Gain					
Total	44	8	14	18	4
% changing to bus	10.8	10.4	8.5	17.3	6.3
% of gain coming from					
Car users	31.8	37.5	64.3	11.1	0.0
Bike users	52.3	50.0	21.4	72.2	75.0
Pedestrians	15.9	12.5	14.3	16.7	25.0
Loss					
Total	51	6	25	14	6
% changing from bus	12.5	7.8	15.2	13.5	9.5
% of loss coming from					
Car users	52.9	50.0	72.0	21.4	50.0
Bike users	21.6	16.7	12.0	42.9	16.6
Pedestrians	25.5	33.3	16.0	35.7	33.3

customers as it had gained (25 vs. 14). More detailed analyses which cannot be presented here because of lack of space, showed that it was especially former car users, who had changed to public transport after the introduction of the semester ticket in 1994, who in 1996 returned to the car. Regression analyses show that for this group, the main determinant for the return to one's own car was the perceived low comfort of the regional bus connections. The price reduction of the semester ticket was obviously sufficient to motivate this subgroup to start using the now less costly public transport instead of the expensive private car. But the low quality standards of public transport that they then experienced made them return to their own car.

Contrary to those living outside Giessen, the students living in the city of Giessen have the alternative of the cheap and quicker bike. In this subgroup, therefore, even a drastic reduction of the price of public transport was not such a large incentive, especially since the semester ticket did not result in a reduction in time spent on inner-city travel. For these students, the reduction of travel time caused by the new circular bus route seems to have been a greater incentive, especially for those without a car. From these results one can conclude that price reductions can obviously function as a motivational cue to re-evaluate one's own travel mode decision. In the long term, however, even drastic price reductions cannot compensate for poor quality standards of public transportation services.

DISCUSSION

The starting-point for the present paper was the view that at the moment the direct political relevance of social science environmental research is relatively low because of the following four central deficits: Lack of theory-driven links between macro or meso level interventions and the individual reactions at the micro level; lacking policy relevance of behavioural models developed in the social sciences; lack of dynamics in the theoretical models and the corresponding empirical tests; and insufficient theory-driven identification of target groups with different behavioural reactions.

Thus, the first goal of the paper was to present a theoretical framework which can help to overcome these deficits. The first deficit should be tackled by the systematic development and empirical test of bridging assumptions, which connect changes of the objective

framing conditions, which are intended by policy interventions at the macro and meso levels, with the situational perception of the individual actors. At the second step we need behavioural models which are able to describe the causal relationship between these situational perceptions and the observable behaviour. The Theory of Planned Behaviour, used as a general actor theory, is a good example of how this problem can be solved. As a way of dealing with the third deficit, lacking dynamics, we showed how a panel design can be used to evaluate intervention effects. This allows us to test assumed causal relationships over time and to detect possible long-term side effects. Dealing with the last deficit, we showed how bridging assumptions, connecting objective framing conditions to the individual perception of the decision situation, can be used to detect specific subgroups with different behavioural reactions to the interventions.

In the second section of our paper, the proposed conceptual framework was applied to a concrete research project, the empirical evaluation of two transport policy interventions at a meso level, so that we can conduct a first critical examination of the framework's usefulness.

From a theoretical point of view the present study raises the question whether the causal structure postulated by the Theory of Planned Behaviour is sufficient. The empirical results can be interpreted as indicating that the relationship between people's normative, behavioural, and control beliefs and their overall attitude, norm, and perceived behavioural control is more complex than postulated by the TPB. In the present study all three types of beliefs seem to "colour" a student's attitude, norm, and perceived control towards bus use, all at the same time. One may also wonder whether there are other determinants of intention and behaviour apart from those postulated by the TPB. In the literature, many proposals for extensions of the TPB can be found, as for example the inclusion of moral beliefs, self-identity, regret, affect, or habit (see, e.g., Conner & Armitage, 1998). Another theoretical deficit of the TPB is the above-mentioned inability of the TPB to guide a theory-driven detection of subgroups. One possible solution for making up for this deficit may be to include more situation-invariant personal variables in the TPB, such as general attitudes or value orientations. Our own research (Bamberg, Kühnel, & Schmidt, 1999) shows that value-attitude patterns can be used in a more theory-driven detection of subgroups which differ strongly in the perceptions of the same decision situation.

Apart from proposing a more convincing conceptual framework for policy-relevant social science environmental research, what are the concrete implications of the present case study for the development and introduction of transport policy interventions?

Firstly, individual travel mode choice can be strongly influenced at the local level, even by single actors such as a university or a company. A sustainable transport policy is not a task only for national policy-makers, rather it needs a lot of concrete action at the regional and local levels.

Secondly, people are willing to support transport policies which aim at reducing car use, even when they have to pay for it. Our study shows that habitual bike users (who did not use public transport after the interventions although paying for it) holds a particularly positive attitude toward the introduced interventions. Agreement with such policies seems to be a question of the perceived fairness of the measures and the possibility of participating in the decision process. The perceived fairness of a measure seems to be greater when it contains clear incentives for the desired behavioural changes.

Thirdly, in the case of the Giessen semester ticket, the drastic price reduction seems to have had the primary effect of raising the motivation especially of car-using students to re-evaluate their travel mode choice consciously. The semester ticket seems to have stimulated them to give more attention to the question, whether the now "free" public transport might not be a better alternative for their daily travel to and from the university. To answer this question they sought information about the new alternative and often seemed to try it. The motivational impact of the price reduction seems to vary, however, with the perceived quality of other available "free" means of transportation (in our case the bike). The results of the subgroup analyses in particular underline the close interrelationship between the impact of the price reduction and the time and comfort oriented attributes of a means of transportation. For the students living in the city of Giessen and owning a car, the perceived costs of time associated with the use of public transport seem to outweigh the motivational impact of the price reduction. In the long term, the same holds true for students living outside Giessen. Saving money cannot compensate for the drawbacks caused by the poor quality of the regional bus system.

Fourthly, the present study shows that the same underlying motivational mechanisms caused different effects of the interventions for

students subjected to different objective settings. Generalizing these results, one can conclude that the introduction of a measure such as the semester ticket in a different context (e.g., a different town) may yield different results. These results again underline the importance of the careful and systematic development of the bridging assumptions. Only a detailed analysis of the objective setting informs the researcher about the "logic of the situation" and enables her/him to formulate hypotheses about the outcome of an intervention. However, the formulation of situation-specific bridging assumption can be guided by taking account of the motivational mechanisms found in our study.

APPENDIX

Operational Definitions of Variables

Behavioural beliefs. "Using the bus (car/bicycle) next time I want to go to the campus, would be (1) cheap; (2) quick; (3) comfortable; (4) without stress; (5) flexible." The response scale was a five-step bipolar scale from +2 (very likely) to –2 (very unlikely).

Control beliefs. "Next time I want to go to the campus, there will be a good bus connection between my apartment and the university campus." "Next time I want to go to the campus, I will know when the next bus departs." "Next time I want to go to the campus, a car will be available to me." "Next time I want to go to the campus, the distance between my apartment and the campus will not prevent me from using my bike." The response scale was a five-step bipolar scale from +2 (very likely) to –2 (very unlikely).

Attitude. "For me, next time to take the bus (use my car/bicycle) to go the campus would overall be good/bad" (first attitude item) and "pleasant/unpleasant" (second attitude item).

Subjective norm. (1) "Most people who are important to me would support that next time I take the bus (use my car/bicycle) to go to the campus"; (2) "Most people who are important to me think that next time I should take the bus (my car/bicycle) to go to the campus." Both of these items were followed by a five-point scale with endpoints labelled "likely" and "unlikely."

Perceived behavioural control. (1) "For me next time to take the bus (use my car/bicycle) to go to the campus would be easy – difficult"; (2) "My freedom to take the bus (my car/bicycle) to go to the campus next time is high – low." Both of these items were assessed by means of a five-point scale with endpoints labelled "easy" to "difficult" and "not at all facilitating" to "very facilitating."

Intention. (1) "My intention next time to take the bus (car/bicycle) to go to the campus is strong – weak"; (2) "I intend next time to take the bus (car/bicycle) to go to the campus next time: likely – unlikely." The response range was a five-step bipolar scale from +2 to –2, labelled "strong" to "weak" and "likely" to "unlikely."

Actual behaviour. The travel mode behaviour was measured by the use of a standardized protocol of all routes a person had travelled during the day in chronological order (Social-Data, 1993). From these protocols we selected the first trip starting at the apartment and ending at the campus. The travel modes used for this trip were saved in the data file. Notice that this is a dichotomous variable. Use of a single dichotomous indicator of behaviour does not make it possible to correct the latent variable for unreliability and may violate the multi-normality assumption underlying LISREL (Bollen, 1989). However the use of alternative estimation procedures will not generally produce better results with the sample size available here. Weighted least squares estimation gives less biased and more efficient estimates only when one has samples of at least 2000 persons (see Hoogland, 1998; Hoogland & Boomsma, 1998).

NOTES

[1] From the point of view of statistical modelling, there are certainly more deficits. They include the lack of tests of assumptions such as multivariate normality and linearity, the decomposition of effects, the computation of latent means, and multiple imputation for panel mortality (see Jöreskog, 1993).

[2] We thank the issue editors for this suggestion.

REFERENCES

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In: J. Kuhl & J. Beckstein (Eds.), *Action-control. From cognition to behavior*, pp. 11–39. Berlin: Springer.

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

Bamberg, S., & Schmidt, P. (1997). Theoriegeleitete Evaluation einer umweltpolitischen Maßnahme. *Zeitschrift für Sozialpsychologie, 28*, 280–297.

Bamberg, S., & Schmidt, P. (1998a). Changing travel-mode choice as rational choice: Results from a longitudinal intervention study. *Rationality and Society, 10*, 223–252.

Bamberg, S., & Schmidt, P. (1998b). Modeling the dynamics of micro-social change: Results of a three-wave intervention study of travel-mode choice in a region. In: H. P. Blossfeld & G. Prein (Eds.), *Rational choice theory and large-scale data analyses*, pp. 258–278. Boulder, CO: Westview Press.

Bamberg, S., Kuehnel, S., & Schmidt, P. (1999). The impact of general attitude on decisions: A framing approach. *Rationality and Society, 11*, 5–26.

Bamberg, S., Schmidt, P., Ajzen, I., Glöckner-Rist, A. (1999). Verkehrsmittelnutzungsverhalten. In: A. Glöckner-Rist & P. Schmidt (Eds.), *Zuma-Informations-System. Elektronisches Handbuch sozialwissenschaftlicher Erhebungsinstrumente*. Mannheim: ZUMA.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York: Wiley.

Chen, H. T. (1990). *Theory driven evaluations*. London: Sage.

Coleman, J. (1990). *Foundations of social theory*. Cambridge, MA: Harvard University Press.

Conner, M., & Armitage, J. C. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology, 28*, 1429–1464.

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

Esser, H. (1993). *Soziologie*. Frankfurt: Campus.

Goodwin, P. B. (1992). A review of new demand elasticities with special reference to short and long run effects of prices changes. *Journal of Transport Economics and Policy*, *26*, 155–169.

Hoogland, J. J. (1998). Robustness of estimators in covariance structure analysis: A Monte Carlo study with a large model. In: J. Hoox & E. de Leeuw (Eds.), *Assumptions, robustness, and estimation methods in multivariate modeling*, pp. 67–87. Amsterdam: TT Publikaties.

Hoogland, J. J., & Boomsma, A. (1998). Robustness studies in covariance structure modeling: An overview and a metaanalysis. *Sociological Methods and Research*, *26*, 329–367.

Jöreskog, K. C. (1993). Testing structural equation models. In: K. Bollen & J. S. Long (Eds.), *Testing structural equation models*, pp. 294–316. Newbury: Sage.

Jöreskog, K. C., & Sörbom, D. (1993). *New features in LISREL 8*. Chicago: Scientific Software International.

Kelman, H. C. (1958). Compliance, identification and internalization: Three processes of attitude change. *Journal of Conflict Revolution*, *2*, 51–60.

Kutter, E. (1985). Notwendigkeiten, Möglichkeiten und Grenzen der Realwelterfassung im Verkehrsbereich. In: S. Klatt (Ed.), *Festschrift für Fritz Voigt*, pp. 45–80. Berlin: Technische Universität Berlin.

Manstead, A. S. R. (1996). Attitudes and behavior. In: G. R. Semin & K. Fiedler (Eds.), *Applied social psychology*, pp. 3–29. London: Sage.

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

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.

Verron, H. (1986). *Verkehrsplanung als Reaktion auf ein Angebot*. Berlin: Technische Universität Berlin. Schriftenreihe des Instituts für Verkehrsplanung und Verkehrswegebau, Nr. 20, D 83.

THE AUTHORS

Sebastian Bamberg is a research associate and Peter Schmidt is the program director for societal monitoring at ZUMA Mannheim, Postbox 12 21 55, D-68072, Mannheim, Germany.

Fax: +49 612 1246 100. E-mail: Bamberg: sebastian.bamberg@sowi.uni.giessen.de; Schmidt: schmidt@zuma-mannheim.de. Homepage: http://www.zuma-mannheim.de.

This study was conducted within the research programme "Social Science Dimensions of Global Environmental Change," supported by the German Science Foundation (Grant Schm 658/6-2).

The ZUMA Information System (ZIS) can be downloaded from the above-mentioned homepage.