Extending the Theory of Planned Behavior: Predicting the Use of Public Transportation[1]

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An expanded version of the theory of planned behavior (TPB) was used to predict and explain public transportation use. A pre–post design was used to examine changes in university students' bus ridership after the implementation of a universal bus pass (U-pass) program. Bus ridership significantly increased after the U-pass was implemented, and associated changes in attitudes and beliefs about transportation modes were found. In both phases, students' public transportation use was well predicted by the original TPB. However, 2 additional constructs—a descriptive norm, and the interaction between intention and perceived behavioral control—significantly improved prediction in both phases of the study. These constructs might be useful additions to the original TPB, at least in this behavioral domain.

Among the many environmental problems we now face, global climate change (global warming) is one of the most serious. Human-caused greenhouse gas emissions are important contributors to global climate change (Oskamp, 2000). In British Columbia (B.C.), Canada, transportation is the largest source of greenhouse gases (B.C. Ministry of Energy, Mines, and Petroleum Resources; British Columbia Ministry of Environment, Lands, and Parks, 1999). Besides air pollution, heavy reliance on cars is causing other environmental problems (e.g., noise, congestion) in major cities worldwide. Many societies face the urgent challenge of reducing car use. However, reductions in car use are difficult to achieve (Steg, 1996; Tertoolen, Van Kreveld, & Verstraten, 1998; Vlek & Steg, 1996). For example, Steg and Sievers (2000) found that even those with high awareness of the risks and problems caused by car use evaluate the personal benefits of car use as more important than the environmental problems caused by car use.

An Intervention Program to Reduce Car Use

Structural interventions are one approach to discourage car use and encourage use of public transportation and high-occupancy vehicles. These interventions

[1]This study was supported by funding from British Columbia Transit. The authors acknowledge Linda Steg for her help in developing the questionnaire.

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Journal of Applied Social Psychology, 2002, **32**, 10, pp. 2154-2189.
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offer benefits for using alternatives, such as bus or carpool priority lanes or reduced bus fare. The universal bus pass (U-pass) program for university students is an example of the latter. In the United States, at least 23 universities (Brown, Hess, & Shoup, 1998), and in Canada, at least 5 universities (Drolet, 1999) have implemented U-pass programs.

The effectiveness of U-pass programs has been examined (e.g., Brown et al., 1998; Williams & Petrait, 1999), and reduced car use among university students is generally found. The focus of most studies, however, has been limited to determining the percentage of transportation mode change and the monetary costs and benefits of the program, but not the psychological aspects of U-pass programs. For example, which beliefs or norms contribute to the change of transportation mode choices? What impact do U-pass programs have on attitudes toward car use and public transportation use? Answers to such questions will provide crucial information for the design of successful future interventions to reduce car use. Thus, the present study aims to investigate the impact of a U-pass program not only on car-use reduction, but also on psychological factors associated with the change in transportation mode choices brought about by the U-pass program.

Predicting Public Transportation Use: The Theory of Planned Behavior

Identifying the determinants of public transportation use is also important in promoting increased ridership. Its prediction is often based on economics and land use, and often the only predictors considered are demographic variables (e.g., age, gender, income) and the costs of using specific transportation modes (e.g., Dargay & Pekkarinen, 1997; Reed, 1973). In psychology, transportation mode choice has been analyzed with such variables as social value orientation and trust in others (e.g., Van Lange, Van Vugt, Meertens, & Ruiter, 1998; Van Vugt, Meertens, & Van Lange, 1995), and environmental concern and awareness of the environmental problems caused by car use (Garvill, 1999; Steg & Vlek, 1997). However, these proposed influences on transportation use tend to be studied separately, without an integrating theoretical framework. Among the few exceptions, Bamberg (1995, 1996) and Bamberg and Schmidt (1993, 1998) have employed the theory of planned behavior (TPB; Ajzen, 1985; Schifter & Ajzen, 1985) as an integrating framework for psychological factors underlying public transportation use.

The TPB has been applied successfully to predict and explain diverse behaviors, such as voting choices, weight loss, smoking cessation, and committing traffic violations (see Ajzen, 1991, and Conner & Armitage, 1998, for reviews). It provides a relatively parsimonious theoretical framework for integrating various key constructs and a clear operational definition of each construct within the theory. The TPB proposes that intentions are the closest antecedents of behavior, and intentions are in turn predicted by attitude, subjective norm, and perceived

behavioral control (PBC). The TPB further assumes that these components are, in turn, determined by salient beliefs for each component and evaluations of those beliefs: behavioral beliefs for attitudes, normative beliefs for social norms, and control beliefs for the PBC. Behavioral beliefs are about attributes of a given behavior, or specific beliefs about outcomes of performing the behavior. Normative beliefs concern perceived approval or disapproval of certain behaviors by one's significant others. Control beliefs pertain to factors that will either facilitate or interfere with the performance of a behavior.

Ajzen (1988) claimed that these beliefs are the informational foundation of behavior and that the causes of behavior can be traced ultimately to these beliefs. Therefore, changes in these beliefs should lead to behavior change. Based on this rationale, some researchers (e.g., Fishbein et al., 1995; Parker, Stradling, & Manstead, 1996) have designed intervention programs to change underlying beliefs in order to determine whether they change behavior. Others (e.g., Bamberg & Schmidt, 1998; Middlestadt et al., 1995) have investigated the impact of intervention programs by examining changes in beliefs that occurred after the intervention. For example, Bamberg and Schmidt assessed the impact of a U-pass program in Germany and demonstrated that the increase in bus use and decrease in car use were brought about, at least in part, by the changes in underlying beliefs about bus use. In the present study, we examine changes in beliefs and other constructs in order to assess the psychological impact of a U-pass program.

Proposed Additions to the Theory of Planned Behavior

Since Ajzen (1991) suggested that the TPB is open to expansion, numerous researchers have proposed the addition of new predictors to improve the explanatory power of the original TPB (e.g., Conner & Armitage, 1998; Parker, Manstead, & Stradling, 1995). In the present study, we propose expanding the original model by adding the interaction effect between PBC and intention (Ajzen, 1985, 1991) and several other new and potentially useful variables: descriptive norms, moral (personal) norms, environmental values, and perceived responsibility for and awareness of the problems caused by car use. The main goals are to explain actual and intended public transportation use better than could the original constructs in the TPB and to help build a more powerful TPB in general.

The Intention ×PBC Interaction

Ajzen and Madden (1986) acknowledged that both PBC and behavioral intention might be necessary for the performance of a behavior, suggesting an interaction effect between them such that the effect of intention on behavior depends on PBC. That is, intention is expected to influence behavior to the extent that one has behavioral control. For instance, when one perceives little control over performing a certain behavior, the strength of intention to perform the behavior

should not affect the likelihood that the person will perform the behavior, thus weakening the intention–behavior relation. On the other hand, when one perceives strong control over performing a certain behavior, the control factor is not important any longer, and the likelihood of his or her performing the behavior depends more strongly on whether or not the person has the intention to do so, thus strengthening the intention–behavior relation.

Although Ajzen (1991) reported that only one out of seven studies he reviewed found a significant PBC × Intention interaction, more recent studies have reported significant interaction effects (e.g., Conner & McMillan, 1999; Reinecke, Schmidt, & Ajzen, 1996; Terry & O'Leary, 1995). For example, Reinecke et al. found that when PBC was stronger, the intention to use condoms was more strongly predictive of behavior than when PBC was weaker. Because of these promising results, the moderating effect of PBC on the relation between intention and behavior is investigated in the present study.

Social Norms

The original concept of subjective norms in the TPB concerns approval or disapproval of a behavior by significant others. However, several researchers (e.g., Ajzen, 1991; Conner & Armitage, 1998; Godin & Kok, 1996; Trafimow & Finlay, 1996) have pointed out that subjective norms are only weakly related to intentions, especially compared to that of attitude. Sheeran and Orbell (1999) described some approaches that have been used in attempts to improve this weak relation.

One approach is to pay more attention to the moderating influence of individual differences and specific situations on the social-norm/behavioral-intention relation. For example, Terry and Hogg (1996) argued that social norms should be reconceptualized using the theories of social identity and self-categorization. They demonstrated that social identity moderates the norm–intention relation. That is, the perceived norms of a behaviorally relevant reference group influence behavioral intentions only for those who identified strongly with the reference group. For those who did not identify strongly with the behaviorally relevant reference group, the effects of personal determinants of behavioral choice were stronger than the perceived norms of the group.

A second approach is to include a broader notion of norm. Cialdini, Reno, and Kallgren (1990) argued that there are two types of norms: injunctive and descriptive. *Injunctive norms* refer to rules about what is morally approved or disapproved of—that is, what ought to be done—which is equivalent to Ajzen's subjective norm. In contrast, *descriptive norms* describe what is typical or normal—what most individuals do in a given situation. Cialdini et al. pointed out that the perception of what most people do (i.e., descriptive norms) motivates individuals to do the same because it provides "evidence as to what will likely be effective and adaptive action" (p. 1015), as well as an information-processing shortcut in choosing how to behave in a given situation.

A few studies (Conner & McMillan, 1999; Nucifora, Gallois & Kashima, 1993; Sheeran & Orbell, 1999; White, Terry, & Hogg, 1994) have investigated the effect of descriptive norms on behavioral intention in a TPB context. Both Nucifora et al. and White et al. investigated the intention to have safer sex among students and found that descriptive norms uniquely contributed to the variance in intention after attitude and subjective norms were controlled for. Sheeran and Orbell also demonstrated that descriptive norms explained a significant portion of the variance in intention to buy lottery tickets over and above attitudes, subjective norms, and PBC.

Moral Norms

Some researchers have argued that not only external social norms (e.g., descriptive or injunctive norms), but also personal (internalized) feelings of obligation or moral responsibility must be added in order to fully explain behavior (e.g., Gorsuch & Ortberg, 1983; Schwartz & Tessler, 1972). The concept of moral or personal norms has been discussed in detail in Schwartz's works (Schwartz, 1968, 1977; Schwartz & Howard, 1984). His norm-activation model of altruism (Schwartz, 1977) emphasizes the role of personal feelings of moral obligation to perform prosocial behavior and has been applied successfully to pro-environmental behaviors (e.g., Black, Stern, & Elworth, 1985; Hopper & Nielsen, 1991; Van Liere & Dunlap, 1978).

The effect of moral norms has been investigated in the TPB context as well (see Manstead, 2000, for a review). For example, Parker et al. (1995) showed that the addition of a moral norm substantially improved prediction of the intention not to commit driving violations over that accounted for by the original TPB constructs. Harland, Staats, and Wilke (1999) demonstrated that moral norms helped to explain four environmentally relevant behaviors, including the use of public transportation instead of cars, beyond that of the original TPB variables.

To date, we have found only one study (Conner & McMillan, 1999) that used the three different types of norms discussed earlier in the context of TPB; namely, injunctive norms, descriptive norms, and moral norms. Conner and McMillan investigated the role of the three norms in a study of cannabis use and found that injunctive norms were significant predictors of cannabis use but, when descriptive and moral norms were entered together, injunctive norms were no longer significant predictors. Both descriptive norms and (the lack of) moral norms uniquely explained the variance in intention to use cannabis. Our study explores the relative importance of these three forms of norms in a different behavioral domain: the use of public transportation.

Environmental Concerns and Values

The present study also examines variables that have been found to be associated with public transportation use or car use in previous studies. For instance,

Steg and Vlek (1997) investigated the roles of awareness of and perceived responsibility for the problems caused by car use in a study of car use in the Netherlands. Car users with greater awareness of the problems felt more responsible for the problems caused by car use, and they used their cars less. Steg, Geurs, and Ras (in press) also showed that awareness of the problems caused by car use explained variance in actual car use beyond that accounted for by demographic variables (age, gender, educational level, and income). A study of the determinants of transportation mode choice in Sweden (Garvill, 1999) also found that environmental concern and a perceived causal link between car use and environmental problems predicted the intention to reduce car use. The present study explores the generalizability of these findings.

Values have also been reported as associated with pro-environmental behaviors. For example, Stern, Dietz, Kalof, and Guagnano (1995) investigated the relation between pro-environmental behavior and measures of underlying values derived in studies by Rokeach (1973) and Schwartz (1992). Using 34 values selected to represent Schwartz's list, Stern et al. found that two of Schwartz's values (self-transcendence and self-enhancement) explained beliefs about environmental conditions and willingness to take pro-environmental actions and that these values had both direct and indirect effects on related behavioral intentions.

Schultz and Zelezny (1998) further supported the importance of values by demonstrating, in a five-country survey, that nature-related self-transcendence items (a world of beauty, unity with nature, and environmental protection) were positively associated with self-reported measures of pro-environmental actions. Our study explores the role of environmental values in relation to other values as a predictor of public transportation use.

Hypotheses

The purpose of the present study is twofold: (a) to predict and explain university students' intended and actual public transportation use with an extended version of the TPB; and (b) to assess the psychological impact of a U-pass program. Accordingly, we hypothesize the following:

> *Hypothesis 1.* The original constructs of the TPB will significantly explain university students' intended and actual public transportation use.
>
> *Hypothesis 2.* Additional constructs (the Intention × PBC interaction, descriptive and moral norms, awareness of and perceived responsibility for the problems caused by car use, and environmental values) will explain intended and actual public transportation use beyond that predicted by the original constructs of the TPB.

Hypothesis 3. There will be changes in the model's constructs and beliefs before and after the U-pass implementation.

Method

Site and Circumstances

The study took place at a medium-sized university in western Canada. The U-pass program was implemented in September 1999, at the beginning of the fall semester, as a result of a successful student referendum in February 1999. The U-pass program entitles all students with current student identification cards to use the bus system anywhere in the region at any time. Fee payment of $11 (Canadian) per month ($44 per semester) is mandatory, regardless of students' preferred transportation mode choice. Compared to the usual price of $36 for a monthly student pass, U-pass offers a considerable price reduction.

Design and Procedure

This study employed a longitudinal approach to measure possible changes associated with the U-pass implementation. Two surveys took place: one during summer 1999, prior to the U-pass implementation; and one afterward, in late October 1999. In the first data collection (Phase 1), questionnaires were distributed to students in a variety of undergraduate classes in many departments (Psychology, English, History, Anthropology, Geography, Sociology, Education, Business, Economics, Mathematics, Physics, and Astronomy) who said they also planned to be on campus in the fall term. The students were asked to complete the questionnaires at home and to bring them to their next class. All participation was voluntary. On the questionnaire, students were asked to provide contact information so that the researcher could contact them in October for the second phase of the data collection.

The Phase 2 data collection took place in late October, 3 months after the Phase 1 data collection, and took approximately 1 month. The same questionnaire as in Phase 1 (exclusive of unchanging demographic information, such as age and gender) was placed on a web page established for this purpose, and those who left e-mail addresses were notified by e-mail to complete the Phase 2 questionnaire online. The same questionnaires were mailed to 26 participants of Phase 1 who left only mailing addresses as contact information.

Questionnaire

The same questionnaire (Appendix) was used in both phases. Most questions had a 5-point bipolar scale response format ranging from -2 (*strongly disagree*) to +2 (*strongly agree*). The dependent variable, bus use, was the percentage of occasions that students took the bus to and from the university, compared to other

modes of transportation, during the previous 10 school days that each student came to school.[3]

Intention. One item on the questionnaire directly asked students about their intentions to use the bus, on the 5-point scale (ranging from -2 to +2) described in the previous paragraph.

Attitudes. Attitude toward bus use was measured using a direct question about the student's general preference for riding the bus.

Norms. Three kinds of norms were examined: subjective (injunctive), descriptive, and moral. Subjective norm was measured by two items that asked respondents to rate the extent to which most people who are important to them think that they should take the bus to and from school. The descriptive norm was measured by asking respondents to estimate what percentage of their friends use public transit for commuting to school. The moral norm was measured using two items directly asking whether or not respondents would have any sense of guilt driving to school.

Perceived behavioral control. A direct measure of PBC was assessed using one item that asked respondents to rate how difficult it was for them to take the bus to commute to and from school.

Behavioral beliefs and control beliefs. Behavioral beliefs and control beliefs were measured mainly to investigate the changes in them between Phase 1 and 2.[4] Behavioral beliefs about transportation mode (costs, convenience, travel time, comfort, and flexible schedule) were selected from previous studies (e.g., Fenwick, Heeler, & Simie, 1983; Hartgen, 1974). As well, a question about having control over one's time was added. Behavioral beliefs about car use were also assessed, for comparison with those concerning bus use. Two control beliefs—living near a good bus route and knowing the bus schedule well—were measured, as in Bamberg and Schmidt's (1998) study. Both evaluations and subjective probabilities of the beliefs were requested, using the bipolar scales described earlier in this section.

Value orientation. Schwartz's (1992) values were used to measure value orientations. The rank order that participants assigned to the value of protecting the environment, among six other values (true friendship, equality, family security, social power, wealth, and authority), was used as a measure of the importance of environmental values.

[3]Although asked retrospectively, it was assumed that this measure represented an accurate indication of the present transportation mode choice of students because it covered a very recent time period and because it is relatively easy to remember compared to other events that vary greatly on a daily basis.

[4]Belief-based measures of subjective norm as an explanatory device have been controversial. Forward (1997) reported that the two components of belief-based measure of subjective norms—normative beliefs and the motivation to comply—were not significantly related and that the effect on intention was a result of normative belief alone. This is consistent with other studies, and researchers often omit motivation to comply from their studies (Ajzen & Driver, 1991; Beck & Ajzen, 1991; Doll & Orth, 1993). Therefore, we used only a global measure of subjective norms.

Awareness of and responsibility for the problems caused by car use. Awareness of problems caused by car use was measured with eight items that asked respondents to rate, in a bipolar scale response format, the extent to which they agreed with the statement of various environmental problems resulting from car use. The average of these eight items was used as a problem awareness measure. Perceived personal responsibility for the problems was queried by one item that directly asked respondents how responsible they feel for solving the problems caused by car use.

Analyses

First, in order to analyze the convergent and discriminant validity among the original TPB variables and the added variables, we performed two principal component analyses: one on the items designed to measure the injunctive, descriptive, and moral norms; and the other on items for the moral norm, awareness of, and responsibility for the problems caused by car use.

Second, hierarchical multiple regression analyses were performed on both Phase 1 and Phase 2 data in order to test the hypotheses. These regressions were also performed to determine which TPB variables and proposed additional variables were most useful.

In addition, we performed paired-sample t tests in order to examine whether or not changes had occurred in the beliefs and other variables from Phase 1 to Phase 2. Finally, in order to examine the possible causal direction of changes, we performed a regression analysis of change in behavior on changes in the predictors used in the hierarchical multiple regression analyses.

Results

Participants

Approximately 1,020 questionnaires were distributed during Phase 1 in a variety of undergraduate classes, as described earlier. The total number of completed questionnaires collected was 431, for a return rate of 42.3%. Of the 431 students who returned the questionnaires, those who either lived on campus or very close to school and therefore did not have to choose any transportation mode (those who always walked to school) were excluded, as were disabled students. This resulted in 387 valid completed questionnaires (56.8% females, 41.8% males, and 1.4% unidentified; M age = 24.5 years). Among them, 309 questionnaires (79.8%) included some form of contact information (mailing address, e-mail address, or both) for the Phase 2 survey.

These 309 participants were contacted either by mail or by e-mail during the Phase 2 survey. Of the 26 Phase 1 participants who received the Phase 2 questionnaire by mail, 15 returned their completed questionnaire by mail (return rate = 57.7%). Among the 246 participants who received the e-mail notice, 160

Table 1

Means and Standard Deviations of the Variables

	Phase 1			Phase 2		
	M	*SD*	α	*M*	*SD*	α
Percentage of bus use	31.58	42.49		42.64	43.82	
Intention to take the bus	0.15	1.41		0.37	1.56	
Attitude toward bus use	0.04	1.23		0.13	1.07	
Subjective norm	0.24	0.62	.67	0.26	0.87	.66
Descriptive norm	1.87	1.03		2.09	0.99	
Car-use moral norm	-0.30	1.14	.82	-0.19	1.09	.85
PBC over bus use	0.46	1.53		0.53	1.24	
Environmental values	4.12	0.66		3.80	1.64	
Car-use problem awareness	0.50	12.66	.81	0.44	0.62	.82
Car-use felt responsibility	0.02	1.12		0.05	1.03	

Note. $n = 175$. PBC = perceived behavioral control. Most variables were measured on a 5-point bipolar scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*). Descriptive norm was measured on a 4-point scale ranging from 1 to 4, with larger values indicating a stronger perceived descriptive norm. The value measure was assessed by the rank participants assigned the value of "protecting the environment" among other six values on a 7-point scale ranging from 1 (*highest*) to 7 (*lowest*). Internal consistencies (α) are given for composite variables.

returned their answers online (return rate = 65.0%). Participants were contacted up to four times for a reply. This resulted in a total of 175 participants among the 272 who received e-mail or letter notices. The overall return rate was 64.3% (40.2% males, 59.8% females; *M* age = 24.4 years). All of the analyses were based on these 175 participants who participated in both phases.[5]

Descriptive Statistics

Table 1 lists the means and standard deviations for the variables in Phase 1 and Phase 2. Internal consistency is also listed for the composite variables. The car-use moral norm mean was negative for both phases, indicating that, on average, participants did not feel guilty about driving to school.

[5]In order to test for selection effects among the returned surveys, we performed a logistic regression of participation mortality (participated or not) on all of the other predictor variables, plus age and gender. None were reliable predictors of participation mortality. Thus, we concluded that the full Phase 1 sample ($n = 387$) and Phase 2 samples did not differ in any important way.

Table 2 lists the correlations between the variables for Phases 1 and 2. Some patterns of correlations were very similar in both phases. For example, in both phases, greater car-use problem awareness was associated with a stronger moral norm for not using car ($r = .51, p < .01$; and $r = .55, p < .01$, for Phases 1 and 2, respectively) and more felt car-use responsibility ($r = .52, p < .01$; and $r = .52, p < .01$, for Phases 1 and 2, respectively). Also, percentage of bus use was most highly correlated with intention to take the bus ($r = .72, p < .01$; and $r = .79, p < .01$, for Phases 1 and 2, respectively), followed by perceived behavioral control ($r = .50$, $p < .01$; and $r = .64, p < .01$, for Phases 1 and 2, respectively), in both phases.

Table 3 shows the changes in transportation mode choices between Phases 1 and 2. On average, in Phase 2, driving alone significantly decreased (by 6.7%), $t(174) = 2.89, p < .01$; and taking the bus significantly increased (by 11.1%), $t(174) = -4.37, p < .001$, compared to Phase 1. Biking also significantly decreased (by 5.7%), $t(174) = 2.81, p < .01$, probably because of the seasonal weather change, while carpooling and walking were almost unchanged.

Principal Components Analyses of the Items

In order to examine the convergent and discriminant validity among the TPB and added variables, a principal components analysis with varimax rotation was performed on items designed to measure the three different types of norms: injunctive, descriptive, and moral (Table 4). For both phases of the study, items that measure the different constructs clearly loaded on different factors, which provides evidence for the convergent and discriminant validity of the items designed to measure the three types of norms.

The same analysis was performed on items designed to measure moral norms, awareness of, and responsibility for problems caused by car use (Table 5). For both phases, two moral norm items loaded on the same factor, and one item for felt responsibility for problems caused by car use loaded on a separate factor. The eight items designed to measure awareness of problems caused by car use resulted in two factors in both phases.[6] It is common to produce two factors when there are eight items[7] (Tabachnick & Fidell, 1996), and the eight items achieved a reasonable internal reliability for both phases (.81 and .82, respectively). Thus, we used the average of eight items as one measure of problem awareness. In general, the results of the principal components analyses provide good evidence for the convergent and discriminant validity of these constructs.

[6]For both phases, the first dimension reflected world or general environmental problems caused by car use, and the second dimension represented more local problems associated with car use.

[7]According to Tabachnick and Fidell (1996), the number of factors produced by factor analysis of which the eigenvalue is greater than 1 is usually somewhere between the number of variables divided by 3 and the number of variables divided by 5. The two-factor solution for eight items follows this rule of thumb.

Table 2

Correlations Among Variables

Phase 2	Phase 1									
	1	2	3	4	5	6	7	8	9	10
1. Percentage of bus use	—	.72*	.43*	.44*	.14	.39*	.50*	-.12	.28*	.15
2. Intention to take the bus	.79*	—	.69*	.68*	.33*	.29*	.60*	-.26*	.41*	.27*
3. Attitude toward bus use	.42*	.52*	—	.59*	.40*	.31*	.48*	-.28*	.29*	.36*
4. Subjective norm for bus use	.48*	.56*	.54*	—	.41*	.29*	.43*	-.28*	.37*	.36*
5. Car-use moral norm	.27*	.36*	.41*	.48*	—	.23*	.29*	-.28*	.51*	.52*
6. Descriptive norm	.57*	.47*	.41*	.38*	.33*	—	.19	-.03	.05	.18
7. PBC over bus use	.64*	.66*	.42*	.47*	.30*	.37*	—	-.17	.31*	.18
8. Environmental values	.10	.08	-.15	-.05	-.25*	.06	.03	—	-.42	-.41*
9. Car-use problem awareness	.30*	.36*	.31*	.49*	.55*	.28*	.27*	-.15	—	.49*
10. Car-use felt responsibility	.10	.12	.23*	.27*	.52*	.27*	.07	-.37*	.40*	—
Between study[a]	.70*	.74*	.66*	.64*	.75*	.59*	.67*	.45*	.81*	.65*

Note. Numbers above the diagonal are correlations among Phase 1 variables, and below the diagonal are correlations among Phase 2 variables. PBC = perceived behavioral control.

[a]The values in this row are the correlations of the same variables between Phases 1 and 2.

*$p < .01$.

Table 3

Comparison of Traffic Mode Choices Percentages Between Phase 1 and Phase 2

	Phase 1		Phase 2		
	M	*SD*	*M*	*SD*	*p*
Car	33.08	42.61	26.43	39.48	.01
Bus	31.58	42.49	42.64	43.82	.001
Bicycle	19.69	35.71	13.99	29.70	.01
Carpool	9.90	22.68	11.17	22.53	*ns*
Walk	5.76	17.27	5.77	19.22	*ns*

Table 4

Principal Components Analysis of Norm Items

	Phase 1			Phase 2		
Variable	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Moral 1	.90			.90		
Moral 2 (reverse scored)	-.89			-.89		
Subjective Norm 1		.85			.93	
Subjective Norm 2		.82			.70	
Descriptive Norm 1			.87			.96
Variance explained (%)	28.70	26.20	23.80	35.90	28.40	21.20

Note. For the sake of brevity, only the loadings larger than .40 are listed. Full items are listed in the Appendix.

Predicting Intention to Use the Bus and Actual Bus Use in Phase 1

First, hierarchical multiple regression analyses with intention to use the bus as the dependent variable were performed to investigate the increases in variance (if any) when the new variables (descriptive norm, car-use moral norm, environmental value, car-use problem awareness, and car-use felt responsibility) were added to the three original TPB constructs (i.e., attitude toward bus use, subjective norm, and PBC). Table 6 lists the predictors added in each step, corresponding multiple correlation squared changes, and the betas for each variable, with t and p values. In the first step, the three original TPB constructs were entered. In the second step, the new variables (descriptive norm and car-use moral norm) that were expected to extend one of the original TPB constructs (social norms) were

Table 5

Principal Components Analysis of Moral Norm, Problem Awareness, and Felt Responsibility Variables

Variable	Phase 1				Phase 2			
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4
World Environment 1	.77					.81		
World Environment 2	.66					.78		
General Environment	.67					.59		
Local Environment 1	.70	.44			.56			
Local Economic Problem 1		.78			.80			
Local Economic Problem 2		.76			.76			
Local Urban Problem	.42	.62			.51			
Local Environment 2	.41	.42			.55	.54		
Moral Norm 1			.89				.88	
Moral Norm 2 (reverse scored)			-.86				-.89	
Felt responsibility				.94				.89
Variance explained (%)	22.40	19.60	17.20	10.50	20.70	20.00	17.70	10.30

Note. For the sake of brevity, only the loadings larger than .40 are listed. Full items are listed in the Appendix.

Table 6

Hierarchical Regression of Intention to Take the Bus for Phase 1

Step	Variable	R^2	ΔR^2	β	*t*
1	Attitude toward bus use	.70	.70***	.34	5.57***
	Subjective norm			.66	6.12***
	PBC over bus use			.43	6.41***
2	Attitude toward bus use	.71	.012	.35	5.60***
	Subjective norm			.38	6.44***
	PBC over bus use			.36	6.67***
	Car-use moral norm			-.11	-2.06*
	Descriptive norm			.06	
3	Attitude toward bus use	.73	.02*	.39	6.15***
	Subjective norm			.36	6.22***
	PBC over bus use			.32	5.94***
	Car-use moral norm			-.14	-2.40*
	Descriptive norm			.06	
	Environmental values			.02	
	Car-use problem awareness			.17	2.92**
	Car-use felt responsibility			-.10	

Note. Only significant *t* values are shown. PBC = perceived behavioral control.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

added. In the third step, the other new variables, those not directly related to the original TPB constructs (environmental value, car-use problem awareness, and car-use felt responsibility) were added, resulting in the full proposed model.

The three original TPB variables explained most of the variance in intention to use the bus in the first step ($R^2 = .70$), $F(3, 138) = 107.82$, $p < .001$. The second step variables added a marginally significant amount of variance ($\Delta R^2 = .01$), $F(2, 136) = 2.88$, $p = .059$. In the third step, adding other new variables improved the prediction of intention by 2% ($\Delta R^2 = .02$), $F(3, 133) = 3.23$, $p < .05$. The total multiple correlation squared (R^2) explained was .73, $F(8, 133) = 26.49$, $p = .001$.

In the final model, in which all eight variables were included, five variables were significant: bus-use attitude ($p < .001$), subjective norm ($p < .001$), PBC ($p < .001$), car-use problem awareness ($p < .01$), and car-use moral norm ($p < .05$), although the beta for car-use moral norm was negative. Given that the zero-order correlation between car-use moral norm and intention was positive ($r = .33$, $p < .01$), this appears to be a case of suppression. When the three

original TPB variables were removed from the regression model, the beta for car-use moral norm was positive but nonsignificant.

Next, actual behavior (bus use) was regressed on the same predictors plus intention to use the bus (Table 7), again using hierarchical regression.[8] First, intention to use the bus was entered, followed by bus-use attitude, social norm, and PBC. In the third and fourth steps, new variables were added in two steps, as described earlier. In the fifth and last step, the Intention × PBC interaction was added. The full model, with 10 predictors, explained 64% of the variance in bus use, $F(10, 131) = 23.27, p < .001$.

Intention to use the bus, added in the first step, explained most of the variance in bus use ($R^2 = .51$), $F(1, 140) = 144.94, p < .001$. The two new norms (descriptive and moral), added in the third step, explained significantly more variance in bus use ($\Delta R^2 = .06$), $F(2, 135) = 9.64, p < .001$. The interaction term, added in the final (fifth) step, explained a further 4.6% of the variance in bus use, $F(1, 131) = 16.91, p < .001$. The second and fourth steps did not add a significant amount of variance: $\Delta R^2 = .02$, $F(3, 137) = 2.34, p = .07$; and $\Delta R^2 = .00$, $F(3, 132) = 0.24$, $p = .87$, respectively. In the final model, intention to take the bus ($p < .001$), PBC ($p < .01$), descriptive norms ($p < .001$), and the Intention × PBC interaction ($p < .001$) were significant.

In order to probe the nature of the significant interaction, we performed simple slope analysis (Aiken & West, 1991).[9] Figure 1 depicts how the simple relation between intention and behavior (bus use) varies depending on different levels of PBC. When PBC is strong, intention is more strongly positively related to behavior, whereas when PBC is weak, intention is less positively related to behavior.

Predicting Intention to Use the Bus and Actual Bus Use in Phase 2

Hierarchical multiple regression analyses on the intention to use the bus were performed again in Phase 2 to investigate whether or not the new variables explained variance beyond that of the original TPB variables (Table 8). For the full model, $R^2 = .58$, $F(8, 163) = 30.13, p < .001$. The entry order of the variable sets was the same as in Phase 1.

The three TPB variables, entered in the first step, explained 53.5% of the variance in intention to use the bus, $F(3, 168) = 64.41, p < .001$. Descriptive and moral norms, entered in the second step, added a further 2.2% of the variance, $F(2, 166) = 4.10, p < .05$. Other new variables added in the last step did not significantly add variance in intention to use the bus ($\Delta R^2 = .02$), $F(3, 163) = 2.41, p = .069$. In the final model with all eight variables, attitude toward bus use ($p < .01$),

[8]The results with regard to predicting behavior should be interpreted with caution, as behavior was not measured prospectively.

[9]He followed the procedure suggested by Aiken and West (1991) to obtain standardized coefficients for the interaction terms.

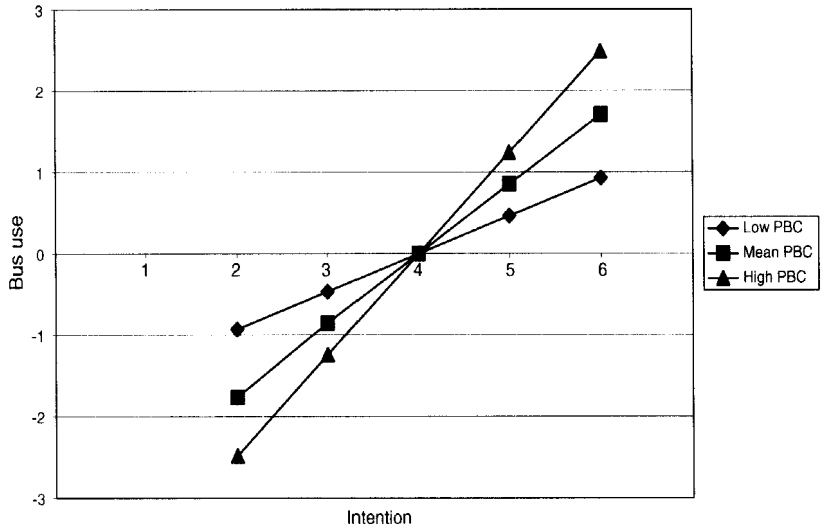

Figure 1. Simple regression slopes for the interaction between perceived behavioral control (PBC) and intention in Phase 1. The regression of intention (to take the bus) on bus use is shown for high PBC (1 *SD* above the mean), mean PBC (mean), and low PBC (1 *SD* below the mean) participants. All of the measures are standardized.

subjective norm ($p < .05$), PBC ($p < .001$), and descriptive norm ($p < .05$) were significant predictors.

Next, actual bus use was regressed using the same hierarchical regression procedure as in Phase 1 (Table 9), total $R^2 = .72$, $F(10, 161) = 40.57$, $p < .001$. As in Phase 1, intention to use the bus explained most of the variance in actual bus use (63% out of 72%), $F(1, 170) = 291.53$, $p < .001$; and the other three original TPB variables added a further 2.6% of the variance, $F(3, 167) = 4.24$, $p < .01$. In the third step, descriptive and moral norms significantly explained additional variance in bus use ($\Delta R^2 = .05$), $F(2, 165) = 14.36$, $p < .001$; but the other new variables added in the last step did not ($\Delta R^2 = .00$), $F(3, 162) = 0.13$, $p = .94$. The Intention × PBC interaction entered in the final step explained marginally significant additional variance in bus use ($\Delta R^2 = .01$), $F(1, 161) = 3.80$, $p = .053$. In the final model, intention to take the bus ($p < .001$), PBC ($p < .01$), descriptive norms ($p < .001$), and the Intention × PBC interaction ($p = .053$) were significant, or marginally so.

Again, we performed the simple slope analysis to probe the nature of the interaction between intention and PBC. As in Phase 1, intention is more strongly positively related to behavior when PBC is high than when PBC is low, although to a lesser extent than in Phase 1.

Table 7

Hierarchical Regression of Bus Use for Phase 1

Step	Variable	R^2	ΔR^2	β	*t*
1	Intention to take the bus	.51	.51***	.71	12.04***
2	Intention to take the bus	.53	.02	.79	7.38***
	Attitude toward bus use			-.10	
	Subjective norm			-.12	
	PBC over bus use			.12	
3	Intention to take the bus	.59	.06***	.72	7.00***
	Attitude toward bus use			-.12	
	Subjective norm			-.10	
	PBC over bus use			.15	2.09*
	Car-use moral norm			-.09	
	Descriptive norm			.25	4.23***
4	Intention to take the bus	.59	.00	.73	6.83***
	Attitude toward bus use			-.13	
	Subjective norm			-.11	
	PBC over bus use			.16	2.09*
	Car-use moral norm			-.10	
	Descriptive norm			.25	4.18***
	Environmental values			.03	
	Car-use problem awareness			-.02	
	Car-use felt responsibility			.06	
5	Intention to take the bus	.64	.046***	.74	7.39***
	Attitude toward bus use			.22	
	Subjective norm			-.15	
	PBC over bus use			-.14	3.16**
	Car-use moral norm			.21	
	Descriptive norm			-.11	3.65***
	Environmental values			.02	
	Car-use problem awareness			.09	
	Car-use responsibility			.04	
	Intention × PBC			.254	4.11***

Note. Only significant *t* values are shown. PBC = perceived behavioral control.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 8

Hierarchical Regression of Intention to Take the Bus for Phase 2

Step	Variable	R^2	ΔR^2	β	*t*
1	Attitude toward bus use	.54	.54***	.20	3.14**
	Subjective norm			.24	3.61***
	PBC over bus use			.45	7.33***
2	Attitude toward bus use	.56	.02*	.16	2.42*
	Subjective norm			.21	2.99**
	PBC over bus use			.42	6.80***
	Car-use moral norm			.22	
	Descriptive norm			.17	2.79**
3	Attitude toward bus use	.58	.02	.19	2.82**
	Subjective norm			.17	2.43*
	PBC over bus use			.40	6.52***
	Car-use moral norm			.04	
	Descriptive norm			.15	2.48*
	Environmental values			.10	
	Car-use problem awareness			.10	
	Car-use felt responsibility			-.06	

Note. Only significant *t* values are shown. PBC = perceived behavioral control.
$*p < .05$. $**p < .01$. $***p < .001$.

Changes in Beliefs and Psychological Constructs from Phase 1 to Phase 2

Paired-sample *t* tests were performed in order to investigate changes between Phase 1 and Phase 2 (Table 10). Significance was tested using an alpha level of .01 because of the relatively large number of univariate tests. First, none of the evaluations of behavioral beliefs changed. In contrast, there were several changes in the subjective probabilities for various behavioral beliefs. In terms of car use, the subjective probability of being comfortable when driving decreased significantly, $t(174) = -5.54$, $p < .001$. In terms of bus use, the subjective probabilities for the beliefs that it would be convenient, cheap, and would mean having control over one's time increased, $t(174) = 2.39$, $p = .018$ (marginally significant); $t(174) = 5.29$, $p < .001$; and $t(174) = 3.25$, $p < .001$, respectively.

Unlike the behavioral beliefs, none of the subjective probabilities for the control beliefs changed, whereas the evaluation of one control belief, knowing the bus schedule well, increased, $t(174) = 2.40$, $p = .017$ (marginally significant).

Table 9

Hierarchical Regression of Bus Use for Phase 2

Step	Variable	R^2	ΔR^2	β	*t*
1	Intention to take the bus	.63	.63***	.79	17.07***
2	Intention to take the bus	.66	.03**	.66	9.87***
	Attitude toward bus use			-.04	
	Subjective norm			.05	
	PBC over bus use			.20	3.30**
3	Intention to take the bus	.71	.05***	.59	9.32***
	Attitude toward bus use			-.07	
	Subjective norm			.06	
	PBC over bus use			.19	3.27**
	Car-use moral norm			-.09	
	Descriptive norm			.26	5.24***
4	Intention to take the bus	.71	.00	.59	9.10***
	Attitude toward bus use			-.08	
	Subjective norm			.06	
	PBC over bus use			.18	3.20**
	Car-use moral norm			-.08	
	Descriptive norm			.27	5.18***
	Environmental values			-.03	
	Car-use problem awareness			.00	
	Car-use felt responsibility			-.02	
5	Intention to take the bus	.72	.007*	.60	9.31***
	Attitude toward bus use			-.08	
	Subjective norm			.06	
	PBC over bus use			.22	3.67***
	Car-use moral norm			-.07	
	Descriptive norm			.23	4.31***
	Environmental values			-.02	
	Car-use problem awareness			.03	
	Car-use felt responsibility			-.07	
	Intention × PBC			.10	1.94*

Note. Only significant *t* values are shown. PBC = perceived behavioral control.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 10

Comparison of the Means Between Phase 1 and Phase 2

Variable	Phase 1		Phase 2		
	M	*SD*	*M*	*SD*	*p*
Behavioral belief					
Evaluation					
Schedule	1.36	0.80	1.44	0.64	
Convenience	1.55	0.66	1.53	0.54	
Quick	1.39	0.79	1.29	0.77	
Comfortable	0.86	0.96	0.78	0.95	
Cheap	1.15	0.94	1.04	0.87	
Weather	0.71	1.02	0.73	0.99	
Control	1.42	0.70	1.44	0.67	
Subjective probability for car					
Schedule	1.56	0.72	1.62	0.64	
Convenience	1.50	0.77	1.46	0.78	
Quick	1.63	0.63	1.50	0.70	
Comfortable	1.55	0.79	1.13	0.95	.001
Cheap	-0.20	1.34	-0.36	1.28	
Weather	1.17	1.02	1.09	0.99	
Control	1.53	0.74	1.54	0.66	
Subjective probability for bus					
Schedule	-0.01	1.17	0.17	1.00	
Convenience	-0.01	1.19	0.17	1.03	.018
Quick	0.06	1.23	0.07	1.14	
Comfortable	0.45	1.01	0.31	0.94	
Cheap	0.82	1.10	1.35	0.82	.001
Weather	0.18	1.09	0.05	1.11	
Control	-0.39	1.20	-0.12	1.09	.001
Content belief					
Evaluation					
On bus route	1.45	0.86	1.58	0.69	
Know schedule	0.89	0.96	1.07	0.85	.017

(*table continues*)

Table 10 (Continued)

Variable	Phase 1		Phase 2		
	M	*SD*	*M*	*SD*	*p*
Subjective probability					
On bus route	0.89	1.33	0.86	1.34	
Know schedule	0.56	1.24	0.47	1.22	
Attitude toward bus use	0.04	1.22	0.13	1.07	
Subjective norm for bus use	0.24	0.92	0.26	0.87	
Descriptive norm for bus use	1.87	1.03	2.08	0.99	.004
PBC over bus use	0.46	1.39	0.53	1.24	
Intention to take the bus	0.15	1.41	0.37	1.56	.006

Note. Only significant *p* values are shown. PBC = perceived behavioral control.

There were also changes in other variables. Intention to take the bus, $t(173) = 2.79, p < .01$, and the descriptive norm, $t(173) = 2.88, p < .01$, both increased significantly in Phase 2.

Predicting Changes Since Phase 1

In order to examine a possible causal direction of the changes described, we performed a regression analysis of behavior change using difference scores between Phase 1 and Phase 2 for each predictor as predictor variables. The dependent variable was the difference between Phases 1 and 2 in the percentage of times respondents took the bus to and from the university.

The result (Table 11) shows that the difference scores significantly explained 25.8% (adjusted $R^2 = 21\%$) of the variance in the behavior change, $F(9, 130) = 5.01, p < .001$, which suggests the direction of causal changes in behavior. In the model, difference scores for behavioral intention, $\beta = .47, p < .001$; and descriptive norm, $\beta = .18, p < .05$, were significant predictors. Difference score for behavioral intention in the model uniquely explained 17.6% of the variance in behavior change.

Discussion

This study demonstrates the predictive validity of the TPB in explaining university students' public transportation use. Moreover, it shows that certain new variables, added in order to expand the original model, explain bus use beyond that accounted for by the original TPB constructs. This study is one of the few that have employed the TPB in assessing the impact of an intervention program

Table 11

Prediction of Behavior Change by Difference Scores

Difference scores for:	β
Intention to take the bus	.46**
General attitude toward bus	-.01
Subjective norm for bus use	-.10
Descriptive norm for bus use	.16*
Moral norm for bus use	-.01
General control over bus use	.10
Value ranking of environmental concern	.01
Awareness of environmental problems	.02
Responsibility for environmental problems	-.03

Note. All of the variables listed are the difference scores for each variable between Phase 1 and Phase 2.
$*p < .05$. $**p < .01$.

(U-pass) on psychological variables. It demonstrates the effect of a U-pass program in two ways: the change in the percentage of bus use, and the change in psychological variables related to bus use.

Predictive Validity of the TPB

The original TPB variables (attitude toward the bus, subjective norm, PBC, and intention to take the bus) predicted university students' public transportation use very well. Attitude, subjective norm, and PBC alone accounted for 70.1% of the variance in intention to use the bus in Phase 1 and 53.5% of the variance in Phase 2. In predicting actual behavior (bus use), intention to take the bus and PBC accounted for 53.3% of the variance in behavior in Phase 1 and 65.8% of the variance in Phase 2. These values are relatively high compared to the reported values in the reviews of studies that have employed the TPB (Ajzen, 1991; Godin & Kok, 1996).

Our results also support Kaiser, Wolfing, and Fuhrer's (1999) proposition that the TPB is considered especially useful in predicting pro-environmental behavior because it includes the measure of constraints beyond one's control. Pro-environmental behavior is often characterized by the fact that it is susceptible to a wide range of nonpsychological (situational) constraints that often are not controllable by individuals. The attitude–behavior inconsistency often found in the prediction of pro-environmental behavior might be partly due to this difficulty associated with performing the behavior. Thus, a framework to predict

pro-environmental behavior should include a measure of difficulties in performing behavior, such as TPB.

The Intention × PBC Interaction

The intention by PBC interaction, entered last in predicting behavior, explained further variance in behavior over and above all other variables (including the new variables) in both phases. This adds further support to the claim that the Intention × PBC interaction should be added to the original TPB (e.g., Conner & McMillan, 1999). The nature of the interaction found in this study was as predicted by Ajzen (1991); that is, when one perceives higher level of control over the behavior, intention is more strongly positively related to the behavior. Other studies (e.g., Reinecke et al., 1996; Terry & O'Leary, 1995) have reported significant interactions of a similar nature.

However, Conner and McMillan (1999) reported a significant interaction of a different nature in their study of cannabis use. When PBC over cannabis use was low, intention to use cannabis was more strongly related to actual cannabis use, compared to when PBC was high. The type of behavior in question might explain this inconsistency in the nature of the interaction. As Conner and McMillan suggested, when behavior is socially desirable, the relation that Ajzen (1991) proposed might hold, whereas for socially undesirable behavior (e.g., cannabis use), the opposite might be true (probably because it requires stronger intention to perform a socially undesirable behavior). Further studies are needed to clarify this point.

Predictive Ability of the New Variables

Descriptive norms were significant predictors over and above the original TPB constructs in all the regression analyses except for the regression of intention in Phase 1. Our results add further support to the findings of previous studies that have reported the predictive utility of descriptive norms (e.g., Conner, Martin, Silveradale, & Grogan, 1996; Conner & McMillan, 1999; De Vries, Backbier, Kod, & Dijkstra, 1995). That descriptive norms are significant predictors of bus use (behavior) when subjective norms are not seems to indicate that descriptive norms indeed tap into a different aspect of social norms than do subjective norms. The direct impact of descriptive norms on behavior might have strong implications for behavioral intervention in that simply registering what most others are doing might influence an individual to do the same. For example, emphasizing descriptive norms (i.e., that most other people are doing the specific behavior) might be successfully used in a campaign aimed at behavior change.

On the other hand, neither holding an environmental value in higher esteem nor perceiving responsibility for the problems caused by car use significantly predicted the intention to take the bus or actual bus use. These concepts have

been reported to contribute to the prediction of pro-environmental behaviors, such as recycling (Guagnano, Stern, & Dietz, 1995; Hopper & Nielsen, 1991) and willingness to take political action for environmental protection (Stern, Dietz, & Kalof, 1993). Compared to these behaviors, public transportation use might not be perceived as a pro-environmental behavior, at least in this particular sample. Also, studies (e.g., Joireman, Van Lange, Kuhlman, Van Vugt, & Shelley, 1997; Van Vugt et al., 1995) that have reported the influence of value on public transportation use utilized a pro-social versus pro-self value orientation, rather than Schwartz's (1992) value system. Possibly, the former approach is more useful in predicting public transportation use.

Moral norms and awareness of the problems caused by car use contributed significantly to the prediction of intention to take the bus in Phase 1, over and above the original constructs of the TPB, but not in Phase 2. Phase 1 took place before the U-pass program implementation, and without the U-pass program present, the intention to take the bus was influenced by these factors. However, in Phase 2, with the U-pass program that greatly facilitated bus use in place, the intention to take the bus was no longer affected by these factors; instead, it was influenced by descriptive norm, the perception that many of one's friends were taking the bus.

This result appears to be consistent with Schultz and Oskamp's (1996) finding that the effort to perform a specific behavior moderates the relation between environmental concern and pro-environmental behavior. They found that environmental concern was positively related to recycling behavior only when recycling required more effort. When recycling was an effortful task, those who recycled nonetheless were likely to have greater environmental concern. However, when recycling became relatively effortless, or when monetary incentives were given, people recycled regardless of the degree of their environmental concern.

Schultz and Oskamp (1996) also suggested that the increase in recycling behavior as a result of effort-reducing or rewards-giving programs is attributable largely to increases in recycling by those who are less environmentally concerned. In this study, the increase in bus use might have been brought about mainly by those who were less concerned about the problems caused by car use or who felt less morally obligated for not using the car. This might have contributed to the fact that intention to take the bus was no longer explained by those factors in Phase 2. That descriptive norms explained intention instead in Phase 2 seems supportive of this reasoning.

Changes From Phase 1 to Phase 2

Our study showed that there were changes in beliefs and other constructs after U-pass implementation. Overall, positive beliefs about car use decreased,

whereas those about bus use increased. It is noteworthy that the evaluation of behavioral beliefs did not change, whereas the subjective probability for them did. This suggests that participants evaluated the same factors as important in choosing a transportation mode at the time of Phase 2, but their perception of bus use had become more positive. As a result, they believed that bus use was more desirable than they did in Phase 1.

In addition, participants evaluated the control belief "knowing the bus schedule well" as more important in Phase 2 than they did in Phase 1. This could imply two things: First, because they started to take the bus more often, participants more strongly realized that this factor is of greater relative importance; and second, by then, participants evaluated the factor as more important because other barriers such as price had become relatively insignificant.

This result supports Bamberg's (1995) findings that once participants begin to use the bus more often as a result of a U-pass program, they develop less biased, more realistic perceptions of public transportation, and that beliefs about the outcome of using public transportation become more positive. This point is also documented in a study of condom use among adolescents (Reinecke et al., 1996) in which condom use was predicted at two points in time (1 year apart) using the TPB. Wave 1 predictors underwent substantial changes in the course of 1 year, at least partly as a result of having experience with condom use; attitudes toward condom use became more favorable and participants perceived more behavioral control over condom use.

These findings have strong implications for intervention programs. It might be suggested that facilitating the performance of a target behavior (e.g., by removing barriers) should precede attempts to change underlying psychological factors because once the behavior is performed, it is likely to influence the psychological factors. Van Vugt, Van Lange, Meertens, and Joireman (1996) pointed out, in their study of carpool priority lanes in the Netherlands, that removing personal barriers to increase one's opportunity to cooperate is one of the key factors for the success of structural interventions.

There were also changes in behavior (increases in bus use) after the U-pass program was implemented. The direction of causality as to how this change was brought about is arguable. However, the regression analysis of behavior change score on difference scores of predictors between Phases 1 and 2 provides some evidence for the direction. The difference scores accounted for 26% of the variance in behavioral change between Phase 1 and Phase 2, and difference scores of behavioral intention and descriptive norm were significant predictors. This indicates that the change in behavior was at least in part because of the changes in psychological variables.

Bamberg and Schmidt (1998) emphasized the reciprocal nature of psychological factors and behavior; psychological factors influence behavior, and then performing the behavior will influence psychological factors. Although clear causal

inferences cannot be made, at least at the correlational level this study demonstrated that the changes in psychological factors occurred after U-pass program implementation and that these changes, in turn, contributed to explain behavioral changes brought about by the U-pass program.

Limitations of the Study

Two limitations of this study must be mentioned. First, this study used university students as a sample, thus the extent to which the results can be generalized to other populations is not certain. In fact, the TPB might be more appropriate for the study of university students than for older adults because students tend still to be in the process of planning their transportation choices, compared to older adults who have established a certain pattern of transportation behavior in their lives. In such cases, more habitual patterns of behavior might exert stronger influences on behavior (cf. Verplanken, Aarts, van Knippenberg, & Moonen, 1998). However, because U-pass programs, which are targeted to university students, are gaining popularity, the results of this study will be useful for universities that are considering the introduction of such programs. Second, the validity of the modified version of the TPB tested in this study cannot always be assured for other behavioral domains. For other domains, different variables might be useful for expanding the original TPB theory.

This study demonstrated the ability of the TPB to predict university students' public transportation use. Furthermore, certain added variables improved the prediction of public transportation use. A descriptive norm was an especially reliable predictor of both behavioral intention and behavior. Also, the Intention × PBC interaction improved the prediction of behavior in both phases.

This study also examined the behavioral and psychological impact of a U-pass program. The U-pass program appears to have been successful in bringing about an increase in bus use, as well as positive changes in beliefs about bus use. The results confirm the positive influence of performing a behavior on psychological factors and the reciprocal nature of the influence between psychological factors and the performance of a behavior.

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Appendix

Sample Questionnaire Items

Evaluation of Behavioral Beliefs

"How important is each of the following aspects to you when commuting to and from school?"

This question was asked about the following seven factors:

That the schedule is flexible
That it is convenient to use
That it is quick to come to school
That I feel comfortable
That it is cheap to come to school
That I am protected from weather
That I can have a good control over my time

Responses were scored on a 5-point scale ranging -2 (*completely unimportant*) to +2 (*extremely important*).

Subjective Probability of the Behavioral Beliefs

"If I were to take the bus to school . . ."

I can have a flexible schedule.
It is very convenient.
It is relatively quick.
It is comfortable.
It is relatively cheap.
Bad weather doesn't matter.
I can have a good control over my time.

Responses were scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*). A set of the same questions was also asked for car use.

Evaluation of Control Beliefs

"How much would the following factors facilitate your decision to take the bus to come to school?"

To be on a good bus route
To know the bus schedule well

Responses were scored on a 5-point scale ranging from -2 (*not at all facilitating*) to +2 (*very facilitating*).

Subjective Probability of the Control Beliefs

"The next time you take the bus to school, how likely will it be that the following are true for you?"

I will be on a good bus route.
I will know the bus schedule well.

Responses were scored on a 5-point scale ranging from -2 (*very unlikely*) to +2 (*very likely*).

Bus-Use Perceived Behavioral Control

"How difficult would it be for you to take the bus to school?"

Response was scored on a 5-point scale ranging from -2 (*very difficult*) to +2 (*very easy*).

Descriptive Norm

"About what percentage of your friends take the bus to commute to and from school?"

Response was scored on a 4-point scale ranging from 1 (*0% to 24%*) to 4 (*75% to 100%*).

Environmental Value Rank

"Which of the following values are most and least important to you?"

Social power
True friendship
Equality
Wealth
Protecting the environment
Authority
Family security

Responses were scored on a 7-point scale ranging from 1 (*most important*) to 7 (*least important*).

Intention to Use the Bus

"I intend to use transit to commute to and from school."

Response was scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).

Attitude Toward Bus Use/Car Use

"I like the idea of taking the bus (driving) to school."

Response was scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).

Subjective Norm

"Most people who are important to me would support me in using the bus to commute to and from school."

"Most people who are important to me think that I should take the bus to and from school."

Responses were scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).

Car-Use Moral Norm

"I feel guilty about it when I drive to school."

"I do not feel bad about it when I drive to school."

Responses were scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).

Car-Use Problem Awareness

"Car use causes serious air pollution in the world" (World Environment 1).

"Car use is a major source of noise problems in the world" (World Environment 2).

"Car use contributes to the depletion of energy sources" (General Environment).

"In Victoria, air pollution caused by car use is getting serious" (Local Environment 1).

"In Victoria, car use is a major source of noise problems" (Local Environment 2).

"Traffic jams are a problem in Victoria" (Local Economic Problem 1).

"Finding a parking spot is a problem in Victoria" (Local Economic Problem 2).

"Many neighborhoods in Victoria are unsafe because there is too much traffic" (Local Urban Problem).

Responses were scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).

Car-Use Felt Responsibility

"I feel personally responsible for the problems resulting from car use when I drive."

Responses were scored on a 5-point scale ranging from -2 (*strongly disagree*) to +2 (*strongly agree*).