Choice of Travel Mode in the Theory of Planned Behavior:

The Roles of Past Behavior, Habit, and Reasoned Action

Sebastian Bamberg

Department of Psychology

Universität Giessen

Giessen, Germany

Icek Ajzen

University of Massachusetts – Amherst

Peter Schmidt

Department of Sociology

Universität Giessen

Giessen, Germany

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Correspondence:

Professor Icek Ajzen
Department of Psychology
Tobin Hall - Box 37710
University of Massachusetts
Amherst, MA 01003-37710

Abstract

Relying on the theory of planned behavior (Ajzen, 1991), a longitudinal study investigated the effects of an intervention — introduction of a pre-paid bus ticket — on increased bus use among college students. In this context, the logic of the proposition that past behavior is the best predictor of later behavior was also examined. The intervention was found to influence attitudes toward bus use, subjective norms, and perceptions of behavioral control and, consistent with the theory, to affect intentions and behavior in the desired direction. Furthermore, the theory afforded accurate prediction of intention and behavior both before and after the intervention. In contrast, a measure of past behavior improved prediction of travel mode prior to the intervention but lost its predictive utility for behavior following the intervention. In a test of the proposition that the effect of prior on later behavior is due to habit formation, an independent measure of habit failed to mediate the effects of past on later behavior. It is concluded that choice of travel mode is largely a reasoned decision, that this decision can be affected by interventions that produce change in attitudes, subjective norms, and perceptions of behavioral control, and that past travel choice contributes to the prediction of later behavior only if circumstances remain relatively stable.

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Many environmental problems can be traced in part to the excessive use of private automobiles. In Germany and other European countries, it is widely recognized that especially in urban areas, increased use of public transportation could help to lower air pollution, reduce noise levels, ease traffic congestion, and alleviate parking problems (Apel, 1992; Monheim & Monheim-Dandorfer, 1990; OECD, 1988; Staehelin-Witt, 1991; Tolley, 1990; Topp, 1990). Consequently, authorities in many towns and cities make concerted efforts to induce citizens to forsake their automobiles in favor of public transportation (Apel, 1992; Enquete-Kommission, 1994; OECD, 1990; Sparman, 1991; Topp, & Rothengatter, 1992). As is true in other domains, the difficulties encountered in efforts to influence choice of travel mode are often attributed to ingrained habits that are difficult to change (Aarts, Verplanken, & van Knippenberg, (1997). The research reported in the present article applied the theory of planned behavior (Ajzen, 1991) to examine the effects of an intervention designed to increase bus use, and to explore in this context the influence of past behavior on choice of travel mode.

Briefly, according to the theory of planned behavior, human action is guided by three kinds of considerations: beliefs about the likely consequences of the behavior (behavioral beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may further or hinder performance of the behavior (control beliefs). In their respective aggregates, behavioral beliefs produce a favorable or unfavorable attitude toward the behavior; normative beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioral control, the perceived ease or difficulty of performing the behavior. In combination, attitude toward the behavior, subjective norm, and perception of behavioral control lead to the formation of a behavioral intention. As a general rule, the more favorable the attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question. Finally, given a sufficient degree of actual control over the behavior, people are expected to carry out their intentions when the opportunity arises. Intention is thus assumed to be the immediate antecedent of behavior. However, because many behaviors pose difficulties of execution that may limit volitional control, it is useful to consider perceived behavioral control in addition to intention. To the extent that people are realistic in their judgments of a behavior's difficulty, a measure of perceived behavioral control can serve as a proxy for actual control and contribute to the prediction of the behavior in question (see Ajzen, 1991).

The theory of planned behavior has received good empirical support in applications to a wide variety of different domains (for recent reviews, see Ajzen, 2001; Armitage & Conner, in press; Sutton, 1998). However, the study reported in the present article is one of the few attempts to use the theory as a conceptual framework for an intervention to effect change in behavior (see Bamberg & Schmidt, in press). According to the theory, it should be possible to influence intentions and behavior by designing an intervention that has significant effects on one or more of the antecedent factors, i.e., on attitudes toward the behavior, subjective norms, and perceptions of behavioral control.

The Role of Past Behavior

Clearly, according to the theory of planned behavior, human social behavior is reasoned in nature. Although people's beliefs may be unfounded or biased, their attitudes, subjective norms, and perceptions of behavioral control are assumed to follow reasonably from these beliefs, produce a corresponding behavioral intention, and ultimately result in behavior that is consistent with the overall tenor of the beliefs. This view has been challenged by theorists who argue that human behavior can be automatic or habitual (e.g., Aarts & Dijksterhuis, 2000; Aarts, Verplanken, & van Knippenberg, 1998; Bagozzi, 1981; Fazio, 1990; Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989; Triandis, 1977). Measures of past behavior have played an important role in attempts to test this conception. If social behavior is reasoned, then — it is argued — frequency of prior behavior should have only an indirect link to later behavior; its effect should be mediated by intention and perceived behavioral control. However, when added to the regression equation, past behavior is typically found to significantly improve the prediction of later behavior, over and above the effects of intentions and perceptions of behavioral control (Ajzen, 1991; Bagozzi, 1981; Bentler & Speckart, 1979; Fredricks & Dossett, 1983; see Ouellette & Wood, 1998 for a meta-analytic review). Findings of this kind are generally taken to mean that the behavior under consideration, rather than being completely reasoned, is at least in part under the direct control of the stimulus situation, i.e., that it habituates with repeated performance. According to this view, frequency of past behavior is an indicator of habit strength, and it can be used as an independent predictor of later action. Taking the bus to work on a regular basis eventually becomes a habit in the sense that little cognitive effort is required for continued execution of the behavior.

Past behavior as reasoned action. A second explanation for the predictive power of past behavior relies on the recognition that a strong relation between prior and later behavior only proves that the behavior in question is stable over time. It may be argued that observation of a behavior's temporal stability tells us very little about the factor or factors responsible for the stability. Clearly, "habit" is only one of many possible mediating factors and, indeed, may not be needed at all to account for behavioral stability. Under certain conditions, it is virtually assured that frequency of prior behavior will be a powerful predictor of later behavior. A measure of prior behavior reflects the operation of all factors, internal and external, that controlled performance (or nonperformance) of the behavior in the past. Thus, taking the bus to work on a regular basis may reflect a positive value placed on public transportation, the convenience of nearby bus stops, lack of alternative modes of transportation, a feeling of relative security on the bus, and so forth. So long as the configuration of controlling factors remains stable over time, there is no reason for the behavior to change. Later behavior, being under the control of an unchanging set of factors, will by necessity resemble previous behavior. In the context of the theory of planned behavior, we would attribute behavioral stability over time to the stability of intentions and of perceived behavioral control. These factors presumably determined the behavior in the past and, if they remain unchanged, will produce corresponding behavior in the future. There is thus no need to assume that the behavior has come under the control of habit.

Of course, this analysis in terms of the stability of the determining factors cannot account for the residual effect of past on later behavior after intentions and perceptions of behavioral control are statistically held constant. However, the residual effect of prior on later behavior also does not constitute direct evidence for the role of habitual processes. Several alternative explanations can be offered for the residual effect of past behavior. First, it may be due to a methodological artifact: Measures of prior and later behavior may have common method variance not shared by measures of the other components in the theory of planned behavior. We are able to examine this possibility in the present study. Second, and of greater theoretical interest, perceptions of behavioral control may be unrealistic and may remain so even after considerable experience. People may wish to increase their use of the bus and may intend to do so, but reality has a tendency to intervene and prevent them from carrying out their intentions. To the extent that this was true in the past and continues to be an important factor at present, past behavior could contribute to the prediction of later behavior over and above intentions and perceptions of behavioral control. Because of the way the present study was designed, we have no way of testing this possibility. Finally, the residual predictive effect of prior behavior may indicate that factors in addition to intention and perceived behavioral control influence the behavior in question. The effects of these additional factors would be reflected in prior behavior, and if they too remain stable over time, a measure of past behavior will contain important determinants of later behavior not included in the theoretical model. To be sure, the missing determinant may in fact be habit, but there is no shortage of alternative candidates. Investigators have proposed adding to the theory of planned behavior such predictors as personal norms (e.g., Gorsuch & Ortberg, 1983), anticipated regret (e.g., Richard, van der Pligt, & de Vries, 1995), self-identity (Sparks & Guthrie, 1998), affect (Manstead & Parker, 1995), and a number of other factors (see Conner & Armitage, 1998, for a review). Of all these possible mediators, we only examine the role of habit in the present investigation.

To test the proposition that a frequently performed behavior habituates, we would ideally obtain a measure of habit that is divorced from prior behavior frequency and then test whether this measure makes an independent contribution to the prediction of later behavior, over and above the effects of intentions, perceptions of behavioral control, or any other postulated determinants. To the best of our knowledge, only one systematic attempt has been made to develop such an independent measure of habit, based on the idea that accessibility of a behavioral alternative increases with habit strength (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994), and some evidence in support of this approach has been summarized in a recent review (Aarts, Verplanken, & van Knippenberg, 1998). The measure confronts respondents with a set of alternative behavioral choices (e.g., different travel modes, such as car, bus, train, bicycle) and asks them to indicate, as quickly as possible, which option they would select in a number of hypothetical situations (e.g., when going to the beach, visiting friends, etc.). Frequency of choice across situations is assumed to indicate habit strength. One part of the study reported in this article examined the mediating effect of habit, as assessed by this fast-response index.

The Role of New Information

Another way to study the role of prior behavior as a predictor of later behavior is to examine the effects of new information. A reasoned action model, such as the theory of planned behavior, predicts that introduction of new information may change the cognitive foundation of intentions and behaviors. Even in the case of a behavior that has become routine with practice, the behavior is expected to be regulated at some level of awareness such that the relevance of new information can be noticed and taken into consideration. As a result, we would expect that frequency of past behavior will lose some of its predictive validity. In fact, with sufficient change in attitudes, subjective norms, or perceptions of behavioral control, the effect of prior on later behavior should become nonsignificant.

The present research examined these ideas in the context of a longitudinal study involving choice of travel mode among college students at the University of Giessen in Germany. The focus of the study was on a high-opportunity behavior, taking the car or bus to go to the campus, and it examined the effects of an intervention designed to increase the number of students who ride the bus instead of using their cars. The intervention consisted of the introduction of a pre-paid “semester ticket” that permitted unlimited rides on the local bus system by presentation of a valid student identification. Pre-payment was required as part of the university tuition. Based on the theory of planned behavior, we predicted that introduction of the semester ticket plan, if effective, could change students’ beliefs about using the bus to go to the campus; make attitudes, subjective norms, and perceptions of control with regard to riding the bus more favorable; and thus modify intentions and raise the rate of bus use (and lower the rate of car use). Frequency of past bus or car use, a high-opportunity behavior, is expected to predict behavior before introduction of the semester ticket. After introduction of the new plan, the ability of prior behavior to predict later behavior is expected to decline sharply. By way of comparison, the constructs in the theory of planned behavior are expected to reflect the changes produced by introduction of the semester ticket, and updated measures, obtained after the new plan was launched, are expected to predict later behavior as well as they did earlier.

Finally, we also examined the role of habituation by obtaining an independent measure of habit. To the extent that the link of prior to later behavior reflects operation of a habit, the independent measure should serve as a mediating factor that, when controlled, eliminates the path from prior to later behavior.

Method

Procedure and Participants

The study employed a two-wave panel design, with a one-year interval between waves. Introduction of the semester ticket plan was preceded by considerable discussion and publicity beginning about one year prior to the first wave of data collection. Articles concerning the proposed policy appeared in the student newspaper, and student representatives organized several informational meetings. About five months prior to the final decision to launch the new plan and actual introduction of the semester ticket, a vote was taken among the student population. The rate of participation in the vote was 27% which, although quite low, is higher than the 19% to 20% rate of participation in the general student parliamentary elections. Among the participating students, 65% voted in favor of the semester ticket plan, which required students to pay 39 German marks (about $23) each term as part of their tuition.

The first set of data was collected during the Spring semester registration period in February 1994, about two months prior to introduction of the new semester ticket plan. Over a period of eight working days, a non-systematic sample of students who came to the registration offices were approached and handed a questionnaire. They were asked to return the completed questionnaire via campus mail. Of the 3491 questionnaires distributed, 1874 (54%) were completed and returned.

The second phase of data collection consisted of a mailed survey that took place in February 1995, about eight months after introduction of the semester ticket and one year after the first wave. Due to a variety of factors, including graduation, drop-out, and address change, only 1316 of the 1874 students who had returned the original questionnaire could be located. Of these

1316 students, 1036 (79%) completed and returned the second questionnaire. Comparison of the original and final samples revealed very few statistically significant differences, and none involving components of the theory of planned behavior (see Bamberg & Schmidt, in press, for details). Thus, the original and final samples were equivalent in terms of their initial attitudes, subjective norms, perceptions of behavioral control, intentions, and reported travel-mode behavior.

Participants in the final sample were 42% male and ranged in age from 20 to 37 years, with a mean of 25 years. In terms of their major fields of study, they were broadly representative of the general student body.

Questionnaire

Most items contained in the questionnaire were designed to assess the constructs in the theory of planned behavior. The travel mode alternatives considered were driving a car, riding the bus, riding a bicycle, and walking. With respect to each alternative, respondents answered two questions designed to measure each of the predictors in the theory of planned behavior: attitude, subjective norm, perceived behavioral control, and intention. Responses were provided on 5-point graphic scales. The two items for each construct were separated by other items, but all items for a given travel mode were kept together.

Travel-mode attitudes were assessed by means of the following two items. "For me, to take the bus (use my car / bicycle / walk) to get to the campus next time would overall be "good–bad" (first attitude item) and "pleasant–unpleasant" (second attitude item).

The two subjective norm items were formulated as follows. (a) "Most people who are important to me would support my taking the bus (using my car / bicycle / walking) to get to the campus next time" and (b) "Most people who are important to me think that I should take the bus (use my car / bicycle / walk) to get to the campus next time." Each of these items was followed by a 5-point scale with endpoints labeled likely and unlikely.

To assess perceived behavioral control, respondents answered two items of the following form. (a) "For me to take the bus (use my car / bicycle / walk) to get to the campus next time" would be easy–difficult" and (b) "My freedom to take the bus (use my car / bicycle / walk) to get to the campus next time is high–low".

Participants also responded to the following two intention items. (a) "My intention to take the bus (use my car / bicycle / walk) to get to the campus next time is strong–weak" and (b) "I intend to take the bus (use my car / bicycle / walk) to get to the campus next time: likely–unlikely".

In addition to assessing the predictors in the theory of planned behavior, the questionnaire also inquired into the respondents' past behavior by asking them to indicate how often they had used each alternative mode of transportation to get to the campus in the preceding semester. Five modes of transportation were listed: bicycle, car, bus, train, and walking. The response alternatives were: always, often, occasionally, seldom, never.

Finally, self-reports of actual behavior were obtained by asking respondents which of the five modes of transportation (bicycle, car, bus, train, and walking) they had used to get to the campus on the day that they completed the questionnaire. A person who checked the bus option was given a score of 1 for bus use, whereas a person who checked one of the other options was given a score of 0 for bus use. In a comparable fashion, binary scores were assigned to each of the other modes of transportation. Although the list of travel mode options included the train, it was known that very few students were actually using the train to get to the campus. For this reason, the constructs of the theory of planned behavior were not assessed with regard to train use.

It is worth noting that the self-report measure of behavior was obtained at the same time as the measure of intentions. Strictly speaking, therefore, measurement of intention and performance of the reported behavior did not follow the logically required temporal sequence. This procedure was necessitated by limitations on our ability to recontact the students to ascertain their travel-mode choices a few days after administration of the questionnaire. However, travel mode choice is quite stable over a short period of time (see Bamberg & Lüdemann, 1996), and there is no reason to expect that a slightly delayed measure of behavior would have produced substantially different findings.

The second wave of the survey used the same questionnaire, with the addition of the fast-response measure of habit proposed by Verplanken, Aarts, van Knippenberg and van Knippenberg (1994). Because this measure of habit became available only after the data of the first wave had already been collected, it was obtained only in the second wave. Respondents were given the following instructions: “Listed below are a few leisure-time activities that you may often perform. Assume that you would like spontaneously to engage in one of these activities. Which mode of transportation would you be most likely to use? Please respond quickly without much deliberation.” The travel mode choices offered were car, bus, bicycle, train, and walking. Participants were asked to indicate which of these modes they would choose for the following 10 destinations or purposes:

Summer excursion with friends to a lake	Evening visit to a bar
Visit a friend	A trip on a nice day
Visit your parents	Routine grocery shopping
Engage in sports	Eat in the dining commons
Stroll through the city	Go to the movies

To create two indicators of the latent construct “habit,” the 10 situations were divided at random into two groups of five, and within each group, we counted the number of times respondents chose each travel mode. The two frequencies served as indicators of habit for that mode.

Results

The questionnaires returned by the students were found to contain missing data. To avoid contamination by careless responding, and for ease of analysis, listwise deletion of missing data was employed. In addition, participants were excluded if they indicated that they had not gone to the campus on the day that they completed the questionnaire. These procedures resulted in reduced sample sizes that ranged, depending on the variables included in a given analysis, from 578 to 592.

Effectiveness of the Intervention

To assess the overall impact of the intervention, we compared attitudes, subjective norms, perceived behavioral control, intentions, past behavioral tendency, and reported behavior on the day of questionnaire completion before and after introduction of the semester ticket plan. In making these comparisons we must note that, because all students were eligible to take advantage of the new plan, it was impossible to secure a non-intervention control group. This limitation is not uncommon in field studies, but it raises the possibility that events other than introduction of the pre-paid semester ticket may have produced the observed effects (Campbell & Stanley, 1963). However, we are not aware of any alternative possible explanations for the changes observed in the present investigation. There were no other intervening events that would have had an obvious effect on bus ridership in the local community, nor did any other communities report marked changes in travel mode choices over the same period.

Because the semester ticket was designed to increase bus ridership to the campus, we expected the strongest direct effects on measures regarding this mode of transportation. To be effective, however, the intervention would have to draw increased bus ridership from the population of students who prior to introduction of the bus ticket drove their cars to the campus. A secondary focus, therefore, was the effect of the intervention on measures related to car use. We did not expect introduction of the semester bus ticket to have a strong impact on use of a bicycle or on walking as campus travel modes.

Table 1 shows the means and standard deviations of the different measures in the two waves of data collection. Very few participants (less than 3% in the first wave and close to 0% in the second wave) reported walking to the campus. In the interest of saving space, therefore, results regarding this travel mode are not shown. In Table 1, attitude, subjective norm, perceived behavioral control, intention, and past behavior can range from 1 to 5, with high scores indicating favorable dispositions or actions. The behavior is the proportion of participants who indicated that they used the bus, car, or bicycle to get to the campus on the day they completed the questionnaire.

(Insert Table 1 about here)

It is of interest to note, first, that dispositions to ride the bus to the campus, and actual bus use, were relatively low at the time of the first wave. Respondents generally did not like taking the bus to the campus, they did not think that people important in their lives expected them to take the bus, they held relatively low perceptions of control regarding this behavior, they generally did not intend to take the bus, they reported taking the bus infrequently in the past, and only 15% actually took the bus to the campus on the day they completed the questionnaire. Dispositions regarding car and bicycle use were generally more favorable; participants reported using these modes of transportation more frequently than the bus, and greater proportions of students actually used their cars (46%) or their bicycles (36%) on the day they filled out the questionnaire.

Inspection of Table 1 suggests that introduction of the semester ticket — accompanied by an extensive informational campaign — had, as expected, a considerable impact on dispositions toward bus use and on reported bus ridership. Attitudes, subjective norms, perceptions of control, and intentions all became more favorable, respondents reported using the bus more frequently, and the proportion of respondents who used the bus to get to the campus on the day they completed the questionnaire more than doubled, from 15% to 36%. All of these changes were statistically significant at $p < .01$.

Also as expected, there were few significant effects of the intervention on dispositions with respect to using the car or bicycle to get to the campus. These modes of transportation were not directly addressed by introduction of the semester ticket, which was designed to increase readiness to take the bus to the campus.[1] However, increased bus ridership must come at the expense of other travel modes. It can be seen that the increase in bus ridership came largely from drivers of automobiles. Although bicycle use on the day of questionnaire completion declined slightly, from 36% to 33%, this decrease was not statistically significant. In contrast, the proportion of students who drove their cars to the campus declined considerably, from 46% before introduction of the semester ticket to 31% afterwards ($p < .01$).

In short, introduction of a pre-paid semester bus ticket, accompanied by publicity about the new plan, appears to have made people more favorably inclined toward using the bus to get to the campus, and it induced many students to abandon their cars in favor of taking the bus. However, implementation of an intervention can change not only the mean values of affected variables, but also the temporal stabilities of these variables. When changes are relatively constant across individuals, the observed changes in mean values will have little effect on test-retest correlations. However, if participants are affected by the intervention to varying degrees, we would observe a decline in temporal stability. Lacking a no-intervention control group, it is difficult to determine with any degree of certainty whether introduction of the pre-paid semester ticket did or did not affect the temporal stabilities of the theory of planned behavior components. Nevertheless, it is instructive to examine the degree to which the measures obtained in the first wave predict those obtained in the second wave and, more importantly, to compare the temporal stabilities of measures regarding the different modes of transportation. Because the intervention was directed primarily at bus use, we would again expect more change, and hence less temporal stability, in measures related to this mode of transportation than in measures related to car or bicycle use.

(Insert Table 2 about here)

Table 2 displays the relevant between-wave path coefficients for the latent constructs of attitude, subjective norm, perceived behavioral control, and intention, based on the two indicators of each variable. These coefficients were computed by means of the two-wave structural equation analysis described later, and are thus adjusted for unreliability within waves. It can be seen first that the stability coefficients were generally quite high, given that a whole year and introduction of the semester bus ticket intervened between the two waves. This suggests that introduction of the pre-paid bus ticket produced similar changes across participants. More importantly, it can also be seen that measures of the different variables were less stable for bus use, with correlations ranging from .35 to .61, than for use of car (r = .49 to r = .84) or bicycle (r = .60 to r = .77). The mean stability coefficients, using Fisher's r-to-z transformation, were .49, .73, and .72 for the bus, car, and bicycle, respectively. Significance tests for these differences will be reported after presentation of the two-wave structural models.

To summarize, we can conclude that introduction of the pre-paid semester ticket had a considerable impact on students' attitudes and behavior, especially in relation to taking the bus to the campus. Attitudes, subjective norms, perceptions of behavioral control, and intentions with respect to bus use became, on average, significantly more favorable, and reported bus ridership to the campus increased at the expense of car use. However, there also appeared to be appreciable individual differences in reactions to the new bus ticket plan, as reflected in the relatively low temporal stabilities of dispositions regarding bus use.

Prediction of Travel Mode Intentions and Behavior

We now turn to the central aspect of our study, the prediction of travel mode choice in the framework of the theory of planned behavior, with special attention to the role of past behavior. Because the intervention had virtually no effects on dispositions toward riding the bicycle or on actual bicycle use, and to save space, the remainder of this article focuses on the bus and the car, with particular emphasis on taking the bus to the campus as the advocated mode of transportation. Table 3 presents the means, standard deviations, and correlations among the theory of planned behavior indicators regarding bus use assessed in the first wave (above the diagonal) and in the second wave (below the diagonal).

(Insert Table 3 about here)

The data for bus and car use were submitted to structural equation analyses, using the LISREL 8 computer program (Jöreskog & Sörbom, 1993).[2] In these analyses, attitudes, subjective norms, and perceptions of behavioral control were allowed to covary; the correlations ranged from .49 to .72, but are not shown for the sake of simplicity. All other modeled relations are shown in Figures 1 and 2. Figure 1 displays the structural model parameters for riding the bus to the campus, as well as the amount of explained variance in intentions and behavior, before (Wave 1) and after (Wave 2) introduction of the pre-paid bus ticket. The fit between structural model and data was evaluated by means of three standard indices: goodness-of-fit (GFI), adjusted goodness-of-fit (AGFI), and root mean square error of approximation (RMSEA). The GFI estimates the amount of variance explained by the model, and the AGFI adjusts this estimate by taking into account the degrees of freedom. Both of these estimates can vary from 0 to 1, and a good fit is indicated by values above .95. The RMSEA index additionally compensates for sample size, with low values indicating good fit. Usually, a RMSEA value of .05 or less is considered acceptable. The fit for the two-wave bus model was found to be very good in light of these criteria. Although, as is often the case for large samples, there was a significant discrepancy between predicted and obtained covariance structures (χ^2 [108, $\underline{N}$ = 578] = 144.19, p < .01), the three goodness-of-fit indices reached satisfactory levels (GFI = 97, AGFI = .96, RMSEA = .02).

(Insert Figure 1 about here)

A preliminary analysis, which excluded the measure of past behavior (B_0), showed that the theory of planned behavior accounted for 47% of the variance in bus choice to get to the campus at the time of the first wave, prior to introduction of the semester ticket, and for the same amount of variance in reported bus use in the second wave. As can be seen in Figure 1, addition of reported bus use in the past increased the amount of explained variance in the first wave to 64% and, consistent with the results of previous studies, the direct path from past to later behavior ($B_0 – B_1$) was strong (0.24) and significant. However, frequency of past bus use to go to the campus did nothing to improve the prediction of bus choice following introduction of the semester ticket, although the path from prior to later behavior ($B_0 – B_2$), albeit weak (0.10), was statistically significant. The amount of explained variance in reported behavior remained about the same (46%) as without past behavior. In other words, the changes produced by the intervention were sufficient to disrupt the relation between frequency of past bus use and later behavior.

By way of contrast, the components of the theory of planned behavior afforded quite accurate prediction of bus use intentions and behavior in both waves. Attitudes, subjective norms, and perceptions of behavioral control accounted for 49% of the variance in intentions in the first wave and for 64% in the second wave; and in both waves, intentions had strong and significant paths to reported bus choice. These results are consistent with our major hypothesis, demonstrating that the predictors in the theory of planned behavior are sensitive to new information even in the case of a routine behavior such as taking the bus to the campus. The fact that the model accounted for a greater proportion of variance in the second wave may indicate that, as a result of the intervention, participants had given more thought to their travel mode options and had developed more clearly formulated attitudes and intentions.

Figure 1 also displays the stability coefficients of the different measures within the context of the structural equation analysis for the model as a whole. It can be seen that, with the addition of past behavior, the stability coefficient for bus use behavior was reduced to .05 and not significant. This finding again suggests that introduction of the pre-paid bus ticket disrupted the relation between prior and later bus use, in this case each measured on a single occasion.

Similar results were obtained with respect to driving a car to the campus. The path coefficients and proportions of explained variance are displayed in Figure 2. Model fit was found to be adequate (χ^2 [106, N = 592] = 125.33, p < .10; GFI = .98; AGFI = .96; RMSEA = .02). The path from past to later behavior was strong and significant, and addition of past behavior increased the proportions of explained variance in reported car use from 71% to 77%. After introduction of the semester ticket, however, the path from prior to later behavior was no longer significant, and past behavior did not account for any additional variance.

(Insert Figure 2 about here)

The structural equation analyses also permitted us to test the possibility, discussed in the introduction, that the residual empirical relation between past and later behavior is caused at least in part by common method variance (Ajzen, 1991). In the analyses reported previously, the residual correlations between the errors of the latent variables "past behavior" (B_0) and "later behavior" (B_1) were allowed to vary freely. To test for the possible effect of shared method variance, we recomputed the analyses, setting the residual correlations between the errors of B_0 and B_1 to zero. If the direct path from prior to later behavior is in part attributable to common method variance, this should cause a significant decrease in model fit. The results provided no support for the method variance explanation. For each of the two travel modes, the χ^2 difference between the models with and without constraints on the residual correlations between the errors of B_0 and B_1 were found to be non-significant ($\Delta\chi^2 = 2.95$, $\underline{df} = 1$ for bus use; $\Delta\chi^2 = 0.46$, $\underline{df} = 1$ for car use).

As was shown in Table 2 and can again be seen in Figures 1 and 2, the temporal stability coefficients of the theory of planned behavior constructs were generally lower for use of the bus to go to the campus than for car use. To test for the significance of these difference between bus and car use, a new model was formulated that included both behaviors simultaneously, with no constraints on the stability coefficients. This analysis resulted in a χ^2 value of 245.93 ($\underline{df} = 200$, $\underline{p} < .05$). Next, all five stability coefficients of the variables related to car use were constrained to be equal to those related to bus use. In this model, a χ^2 of 299.60 was obtained ($\underline{df} = 205$, $\underline{p} < .01$). The χ^2 difference between the two models (54.67, $\underline{df} = 5$) was significant ($\underline{p} < .01$), indicating that the stability coefficients of variables related to bus use were significantly lower than those for car use.

The relatively low stabilities for use of the bus to go to the campus, combined with the great impact of the intervention on the mean values of measures related to this behavior (see Table 1), indicate that introduction of the semester ticket had a strong effect, changing students' perception of the situation as well as their reported behavior. These changes appear to have made past behavior largely irrelevant for the prediction of later behavior.

Mediation by Habit: The Fast-Response Measure

From a habit perspective, the findings presented above suggest that introduction of the semester bus ticket may have necessitated development of a new habit. The original measure of past behavior — which referred to behavior in the semester prior to the intervention — would then not have reflected the habit that existed a year hence when later behavior was observed. In fact, the past behavior means displayed in Table 1 provide some support for this line of reasoning. Frequency of bus, car, and bicycle use were reported for the periods prior to each questionnaire administration, separated by one year. Reported use of the bus to go to the campus increased significantly while reported car use declined significantly. If these measures of past behavior frequency are taken to reflect habit strength, then the results suggest that habits did indeed change.

However, this approach to the question of habitual behavior is less than persuasive. What it implies is that every time we observe change in a behavioral tendency, we can simply assume that habit has changed. This line of reasoning is circular and cannot be empirically disconfirmed. As noted in the introduction, what is needed instead is an independent measure of habit divorced from any measure of behavior it is designed to predict and explain. With such a measure, it would be possible to examine whether habit did or did not change following introduction of the semester ticket. An independent measure of habit would, in this regard, be comparable to the measures of attitude, subjective norm, perceived behavioral control, and intention.

Our fast-response measure of choice intentions, which relied on the procedures developed by Verplanken, Aarts, van Knippenberg, and van Knippenberg (1994), was designed to provide such an independent index of habit strength. Because this measure could only be obtained in the second wave of data collection, we have no direct evidence concerning changes in habit strength that may have occurred. However, we can inspect the extent to which habit mediates the effect of prior on later behavior. If, at the time of the second wave, choice of travel mode has again habituated, then our measure of habit should reflect frequency of past behavior. Consequently, when introduced into the model as a mediating variable, the effect of past on later behavior should disappear.

Looking first at bus use, we initially examined the residual effect of past behavior after controlling for the mediation of intentions and perceived behavioral control, but without the habit measure. Using LISREL on the data of the second wave only, we found that reported frequency of bus use in the course of the present semester (i.e., past behavior) added significantly to the prediction of bus use reported on the day participants completed the questionnaire (i.e., later behavior), over and above the prediction afforded by intentions and perceived behavioral control. The path coefficient for past behavior was .31 ($p < .01$). This finding replicates the results obtained in the first wave, showing a significant residual effect of past on later behavior. However, as can be seen in Figure 3, introduction of habit (indexed by the fast-response measure of intention) as a mediator did nothing to eliminate the residual effect. The overall test of the model resulted in an excellent fit (χ^2 [14, N = 578] = 19.97, p = .13; GFI = .99; AGFI = .96; RMSEA = .02). Although the path from past behavior to habit was strong (.64) and highly significant ($p < .01$), habit had no significant effect on later behavior and the path coefficient from prior to later behavior remained .31.

(Insert Figures 3 and 4 about here)

Similar results emerged for use of the car as a mode of transportation. Without the measure of habit, frequency of past behavior had a significant direct path to later behavior (path coefficient = .28; $p < .01$). As can be seen in Figure 4, the model retained a significant, although weakened, path coefficient (.13; $p < .01$) from prior to later behavior even after introduction of the habit measure. The overall fit of the model was again satisfactory (χ^2 [13, N = 592] = 15.82, $p = .26$; GFI = .99; AGFI = .98; RMSEA = .02). The attenuation of the path coefficient may be attributable to the fact that the intervention was directed at use of the bus to get to the campus and only indirectly at car use, and that there was therefore much less change in the antecedents of car use (see Table 1).

Discussion and Conclusions

The results of the present investigation demonstrate the utility of the theory of planned behavior as a conceptual framework for the prediction of travel mode choice and for understanding the effects of an intervention on this behavior. Attitude, subjective norm, and perceived behavioral control were found to influence students' intentions to take the bus to the campus, and these intentions in turn permitted quite accurate prediction of reported behavior. Introduction of a pre-paid semester bus ticket proved to be an effective intervention, more than doubling the proportion of students who rode the bus to the campus, rather than drive their cars. The effects of the intervention on behavior could be traced to its effects on the antecedent determinants: It raised attitudes, subjective norms, and perceptions of behavioral control with respect to using the bus to go to the campus, thus strengthening intentions to do so and ultimately affecting reported behavior.

As in previous investigations, past commuting behavior was found to retain a significant impact on later behavior when added to the other predictors in the theory — at least within-waves. Across waves, following the intervention, earlier behavior lost its predictive ability. What, then, is the role of prior behavior in the prediction of later behavior? To attribute the link between prior and later behavior to habit is problematic. According to Hull's learning theory (Hull, 1943), habits are conditioned responses controlled by environmental stimuli. Although the stimulus-response association can be mediated by internal, implicit goal responses, the whole process is considered automatic, bypassing cognitive mediation. A moment's reflection, however, reveals the difficulties inherent in applying this stimulus-response theory, which was developed to account for simple conditioned responses, to complex human social behavior. Consider, for example, such a mundane behavior as going to see a movie with friends. Even if we have performed this behavior numerous times in the past, we never engage in it without some conscious cognitive mediation. We have to make a conscious decision to go to the movies on a particular night, choose the film we want to see, make arrangements to meet our friends, go to the movie theater, buy tickets, etc. To be sure, some aspects of this complex series of acts may be performed habitually without much cognitive effort, as when we drive to the theater while conducting a conversation with passengers, but clearly, much conscious regulation is required to perform most other aspects of the act we call "going to the movies". This view of routinized behavior is similar to the description of semiautomatic response patterns that involve controlled processes as well as interspersed autonomous phases (Bargh, 1989; Logan & Cowan, 1984; Posner & Rothbart, 1989; Wegner & Bargh, 1998).

The theory of planned behavior also recognizes elements of automaticity. Beliefs are accessed, and attitudes and intentions are consciously formulated, only in the early stages when a behavior is newly enacted. Once the behavior has been performed many times, it is usually no longer necessary to go through a consideration of accessible beliefs. Attitudes and intentions are stored in memory and they can be retrieved directly without much cognitive effort (see Ajzen & Sexton, 1999; Ajzen & Fishbein, 2000). Thus, when we awake in the morning, we don't usually consider the advantages and disadvantages of going to work and then formulate a conscious intention to do so. Instead, preparations for departure proceed with little conscious monitoring.

However, we would argue that a complex sequence of behaviors always involves some degree of conscious cognitive regulation. If we awake with an upset stomach, the sequence of actions leading to departure for work is likely to be disrupted and a conscious decision is made to go, or not to go, to work on that particular day. Cognitive regulation of routine behaviors is evident even in relatively simple action sequences. When we are introduced to another person at a party, we automatically extend a hand in greeting without giving it a second thought. However, if we have just spilled our drink and our hands are wet, this automatic response is suppressed and we apologize for not being able to shake the other person's hand.

In short, even when routine, human social behavior is always regulated at some, even if low, level of cognitive effort. As a result, relatively minor events of relevance can be noticed, they can disrupt automatic execution of the behavior and initiate reasoned action. The results of the present study support this point of view. For most students, traveling to the campus involved a routine sequence of behaviors that, by and large, did not require much deliberation. Students who had been using their cars regularly to get to the campus did not have to make their travel mode decisions anew every day. However, they did reconsider their options as soon as a pre-paid semester bus ticket was introduced. Clearly, the students were monitoring the situation sufficiently to become aware of the new bus plan and to recognize its relevance to their own behavior. Consequently, a considerable proportion of students began riding the bus to the campus.

To be sure, the residual (within-wave) effects of past behavior may reflect the operation of important psychological processes, but it does not provide direct evidence for the mediating role of habituation. To investigate the role of habit requires a measure that is independent of past behavior. The fast-response measure of intention (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994) was designed to provide such an independent indicator. Its application offered little support for the mediating role of habit. Introduction of this measure into the structural equation models of the second wave data had only a small effect on the direct link between prior and later use of the car, and no mediating effect at all on prediction of the behavior that was the focus of the intervention, i.e., riding the bus to the campus.

It would be premature to conclude, however, that there is no role for habit in human action. Like frequency of past behavior, the fast-response index may not be a very good indicator of habit. Although this procedure results in highly reliable scores that tend to correlate well with frequency of past behavior (Aarts, Verplanken, & van Knippenberg, 1997), questions can be raised about its validity. The procedure asks respondents to indicate their intentions to perform a particular behavior in different hypothetical situations. The resulting measure may therefore best be interpreted as a generalized intention to perform the behavior in question. The justification for assuming that it may represent something other than a generalized intention is the instruction to participants to respond as quickly as possible. It is an empirical question whether time pressure has any effect on responses and, if so, whether the measure obtained under time pressure is in fact an indicator of habit strength. In addition, it may be necessary to develop a measure of habit that focuses on the specific behavior to be predicted, such as taking the bus to campus.

In any event, past behavior is clearly not always a good predictor of future behavior. Only when circumstances remain relatively stable does prior behavior make a significant contribution to the prediction of later action. Complex human behavior is cognitively regulated and, even after numerous enactments, appears to be subject to at least some degree of monitoring. As a result, new information, if relevant and persuasive, can change behavioral, normative, and control beliefs, can affect intentions and perceptions of behavioral control, and influence later behavior. We thus conclude that human social behavior, although it may well contain automatic elements, is reasoned in nature.

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Author Note

Correspondence concerning this article should be addressed to Dr. Sebastian Bamberg, Fachbereich Psychologie, Universität Giessen, Otto-Behaghel-Straße 10F, 35394 Giessen, Germany. Electronic mail may be sent to sebastian.bamberg@sowi.uni-giessen.de.

Footnotes

1. In a choice situation, preference for one option over another is best explained by the differences in dispositions regarding the available options (Ajzen & Fishbein, 1969). Actual car use can thus decline without a corresponding decline in attitudes or intentions if dispositions toward using the bus become more favorable relative to dispositions toward using the car.

2. Use of a single binary indicator of behavior prevents correction of the latent variable for unreliability and may violate the multi-normality assumption underlying LISREL (Bollen, 1989).

Table 1
Means and Standard Deviations Before (Wave 1) and After (Wave 2) Introduction of Semester Ticket

	Wave 1		Wave 2			
	M	SD	M	SD	t	η^2
Bus (N = 578)						
Attitude	2.31	0.99	2.60	1.11	6.78*	.07
Subjective norm	2.24	1.12	2.46	1.17	4.46*	.03
Perceived behavioral control	2.57	1.39	2.99	1.47	7.16*	.08
Intention	1.65	1.16	2.11	1.47	8.00*	.11
Past behavior	1.58	1.09	2.14	1.29	11.33*	.18
Behavior	0.15	0.36	0.30	0.46	7.29*	.08
Car (N = 592)						
Attitude	3.23	1.21	3.16	1.26	– 1.86	.01
Subjective norm	2.29	1.34	2.21	1.34	– 1.80	.01
Perceived behavioral control	3.37	1.56	3.55	1.54	1.80	.01
Intention	2.63	1.76	2.36	1.66	– 4.83*	.04
Past behavior	2.93	1.60	2.56	1.45	– 7.28*	.08
Behavior	0.46	0.50	0.31	0.46	– 7.93*	.10
Bicycle (N = 587)						
Attitude	3.37	1.37	3.33	1.37	– 0.74	.00
Subjective norm	3.29	1.50	3.21	1.44	– 1.50	.00
Perceived behavioral control	3.51	1.64	3.59	1.55	1.52	.00
Intention	3.19	1.78	3.03	1.76	– 2.87*	.01
Past behavior	2.93	1.61	2.87	1.56	– 1.42	.00
Behavior	0.36	0.48	0.33	0.47	– 1.77	.01

Note. Attitude, subjective norm, perceived behavioral control, intention and past behavior can range from 1 to 5. Behavior is the proportion of respondents who used a given mode of transportation. t = paired t-test, η^2 = proportion of explained variance (effect size).
*$p < .01$.

Table 2
Between-Wave Correlations Among Latent Constructs

	A	SN	PBC	I	B_0	B_1	Mean
Bus	.54	.45	.61	.46	.50	.35	.49
Car	.84	.75	.78	.70	.72	.49	.73
Bicycle	.77	.66	.76	.72	.76	.60	.72

Note. A = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; I = intention; B_0 = past behavior; B_1 = later behavior. All correlations are significant at $p < .001$.

Table 3
Means, Standard Deviations, and Correlations Among Indicators for Bus Use in Wave 1 (Above Diagonal) and Wave 2 (Below Diagonal)

	M	SD	A_1	A_2	SN_1	SN_2	PBC_1	PBC_2	I_1	I_2	B_0	B_1	M	SD
A_1	2.70	1.21	1.00	.72	.54	.52	.56	.46	.55	.56	.39	.39	2.36	1.09
A_2	2.51	1.13	.79	1.00	.44	.40	.50	.38	.42	.41	.32	.30	2.26	1.06
SN_1	2.65	1.28	.60	.52	1.00	.86	.49	.45	.51	.52	.37	.33	2.34	1.18
SN_2	2.27	1.22	.58	.50	.77	1.00	.45	.38	.56	.56	.40	.34	2.14	1.14
PBC_1	2.85	1.60	.67	.62	.56	.59	1.00	.62	.54	.53	.45	.42	2.52	1.49
PBC_2	3.14	1.62	.58	.50	.49	.47	.67	1.00	.43	.41	.30	.32	2.62	1.59
I_1	2.07	1.48	.70	.64	.58	.68	.69	.51	1.00	.94	.69	.69	1.64	1.17
I_2	2.15	1.50	.71	.65	.58	.67	.69	.52	.95	1.00	.69	.66	1.66	1.19
B_0	1.58	1.09	.35	.33	.26	.32	.35	.26	.45	.44	1.00	.70	1.58	1.09
B_1	.30	.46	.49	.45	.37	.49	.48	.39	.71	.68	.40	1.00	.15	.36

Note. A = attitude toward taking the bus, SN = subjective norm, PBC = perceived behavioral control, I = intention, B_0 = past behavior, B_1 = later behavior.

Figure Captions

Figure 1. Bus use: Structural model with standardized path coefficients and explained variance in intentions and behavior. The subscripts 0, 1, and 2 refer to past behavior, Wave 1, and Wave 2, respectively. A = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; I = intention; B = behavior.

*not significant.

Figure 2. Car use: Structural model with standardized path coefficients and explained variance in intentions and behavior. The subscripts 0, 1, and 2 refer to past behavior, Wave 1, and Wave 2, respectively. A = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; I = intention; B = behavior.

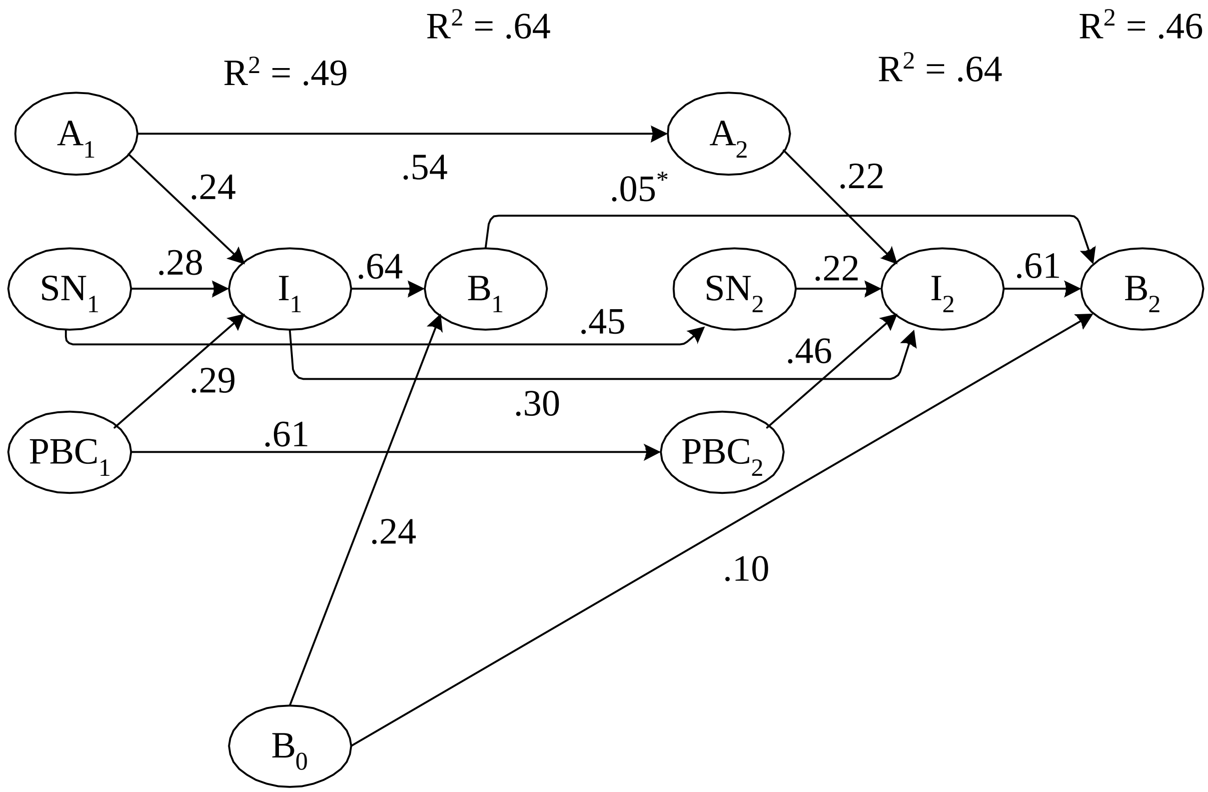
*not significant.

Figure 3. Bus use in Wave 2: Structural model with standardized path coefficients and explained variance in intentions and behavior. A = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; I = intention; B_0 = past behavior; B = later behavior; H = habit.

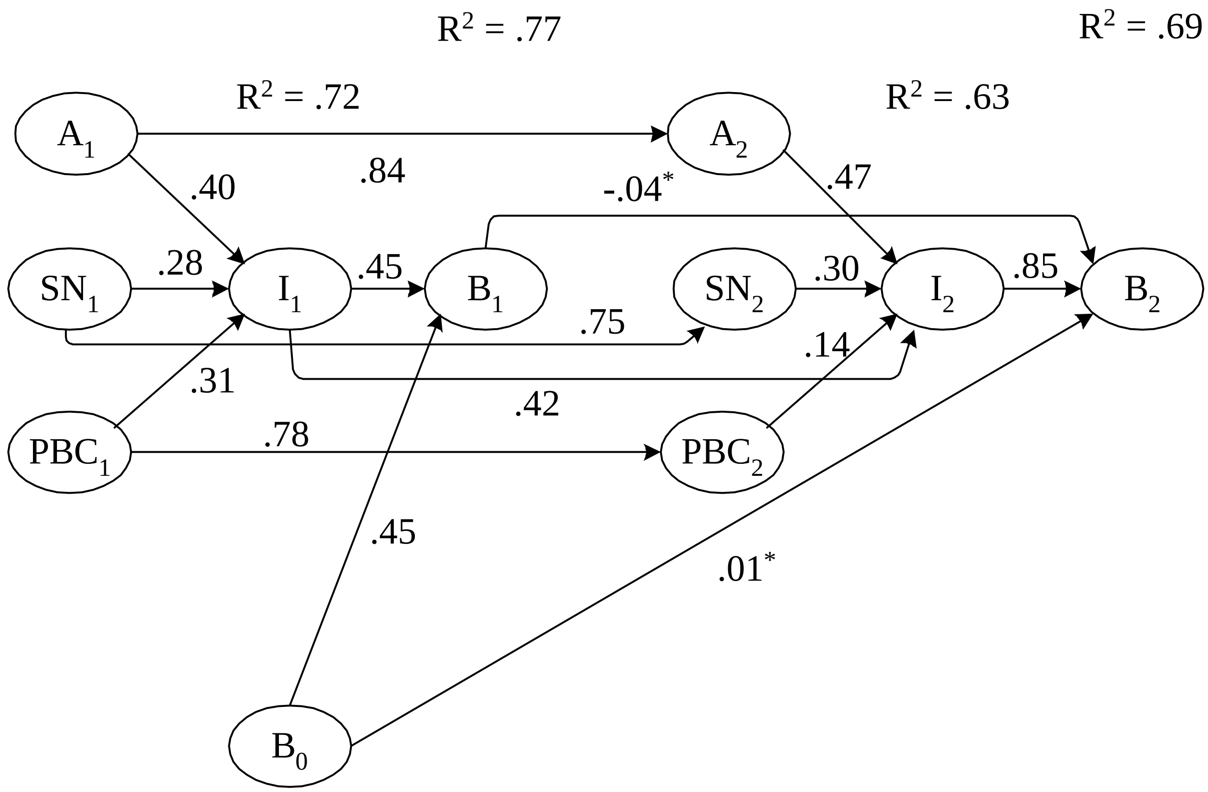
*not significant.

Figure 4. Car use in Wave 2: Structural model with standardized path coefficients and explained variance in intentions and behavior. A = attitude toward the behavior; SN = subjective norm; PBC = perceived behavioral control; I = intention; B_0 = past behavior; B = later behavior; H = habit.

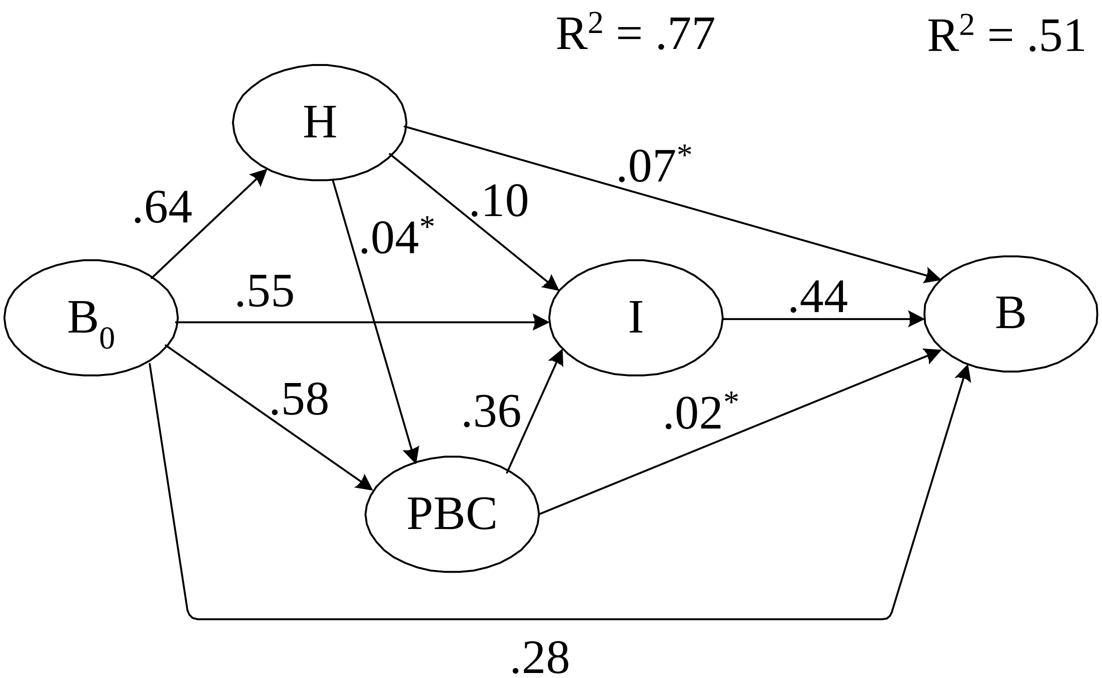
*not significant.

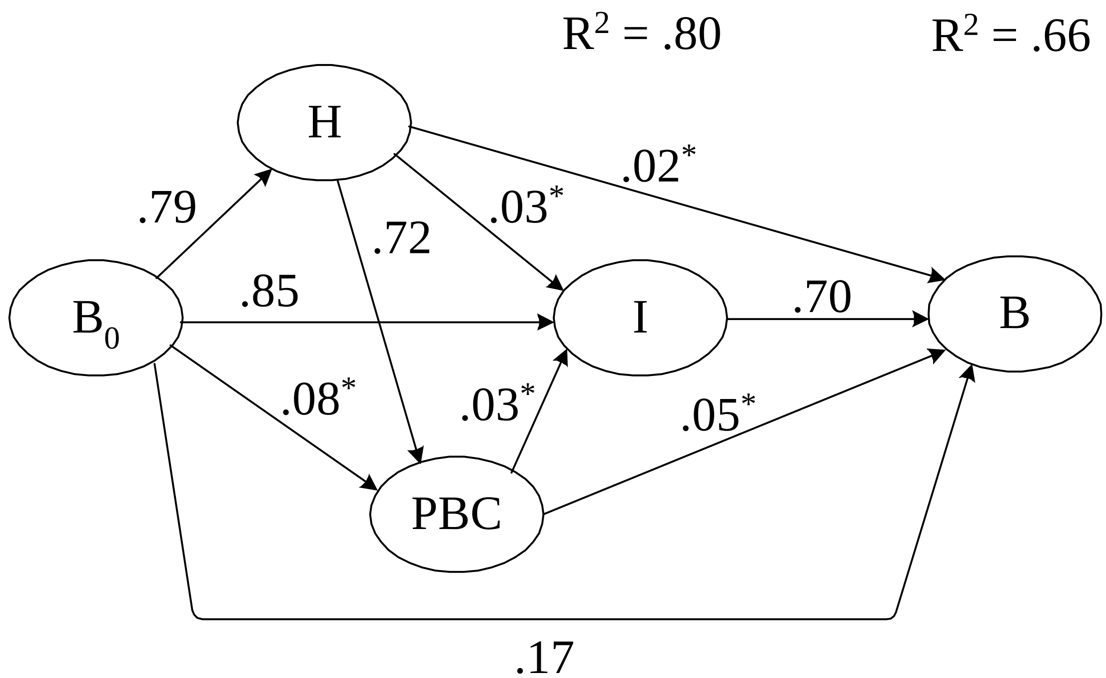


R² = .64
R² = .49
R² = .64
R² = .46
A1
A2
.54
.24
.05*
.22
SN1
.28
I1
.64
B1
SN2
.22
I2
.61
B2
.45
.46
.29
.30
PBC1
.61
PBC2
.24
.10
B0



R2 = .77
R2 = .69
R2 = .72
R2 = .63
A1
A2
.84
.40
-.04*
.47
SN1
.28
I1
.45
B1
SN2
.30
I2
.85
B2
.75
.14
.31
.42
PBC1
.78
PBC2
.45
.01*
B0


R2 = .77
R2 = .51
H
.07*
.64
.10
.04*
.55
.44
B0
I
B
.58
.36
.02*
PBC
.28



R2 = .80
R2 = .66
H
.02*
.79
.03*
.72
B0
.85
I
.70
B
.08*
.03*
.05*
PBC
.17