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A comprehensive action determination model – towards a broader understanding of ecological behaviour using the example of travel mode choice

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A comprehensive action determination model– towards a broader understanding of ecological behaviour using the example of travel mode choice[1]

1. Introduction

Understanding, explaining, and changing human behaviour are the main objectives of psychology in general. One goal of environmental psychology is to understand what determines people's actions with regard to environmentally relevant domains. A number of different approaches have been proposed throughout the field's history. Many of them could be categorised under the generic term "action models" or "action determination models". The Theory of Planned Behaviour (TPB, see e.g. Ajzen, 1991) and the Norm-Activation Model (NAM, Schwartz, 1977; Schwartz & Howard, 1981) have proven especially useful in the domain of environmental actions (e.g. Bamberg & Schmidt, 1998; Boldero, 1995; Hunecke, Blöbaum, Matthies, & Höger, 2001; Nordlund & Garvill, 2003; Harland, Staats, & Wilke, 2007). Recent integrations of both theories (Bamberg & Möser, 2007; Bamberg, Hunecke, & Blöbaum, 2007) and extensions of both theories to include habits (Verplanken, Aarts, van Knippenberg & van Knippenberg, 1994; Klöckner, Matthies, & Hunecke, 2003) showed the promising potential for an integrative approach. In contrast to the other theories, the Ipsative Theory of Behaviour (Tanner, 1999; Tanner, Kaiser, & Wölfing Kast, 2004) offers an interesting and often neglected perspective on the situational determination of behaviour.

The authors of this paper suggest taking the integrative approach even a step further. None of the models and approaches named above adequately represents the multi-determination of environmental behaviour on its own. Each model seems to over- and underestimate the importance of characteristic aspects. The Theory of Planned Behaviour focuses on intentions, but neglects the role of objective situational constraints and facilitators as well as habits and personal norms. The Norm-Activation Model focuses on personal norms, but underestimates the role of habits, intentions, attitudes, and the situations themselves. The theoretical concept of habits describes the interaction of intentions and habits, but fails to sufficiently address non-automatic situational facilitation and constraints of behaviour as well as normative processes. Finally, the Ipsative Theory of Behaviour effectively describes the objective and subjective characteristics of situations as predictors of behaviour, but completely ignores intentional, habitual or normative processes. Despite initial attempts to combine selected models (e.g. the TPB and NAM: Bamberg et al., 2007), there is still no structured framework, which aims to be comprehensive. The need for a comprehensive theory becomes evident when the complexity of pro-environmental behaviour in real life is analysed. It is not taken into question that the existing theories (especially the TPB and NAM) have succeeded in explaining behaviour to a large extent in specific domains. All models, however, show limitations in other domains. Instead of looking for an integrated model, some authors suggest using models only in the domains where they perform best. They argue that the focus should be to identify the specific domain where a model is applicable (Lindenberg & Steg, 2007). The authors of this paper, however, agree with other authors (Wall, Devine-Wright, & Mill, 2007; Matthies, 2003) that combining existing theories is a more promising approach. It may result in *one* theoretical framework that might apply to *all* behavioural situations by describing all relevant factors influencing behaviour and their relative importance depending on the domain. An integrative model is also beneficial from an interventionist perspective: by integrating all potentially relevant predictors of behaviour into one model, it would be easier for planners to include all relevant aspects in their design of intervention strategies.

Before outlining the comprehensive model, it is important to introduce the theories and assumptions that provide its basis. The first is Ajzen's Theory of Planned Behaviour (TPB, see e.g. Ajzen, 1991). According to this theory, behaviour is determined by the

Intention (INT) to enact certain behaviour. According to the TPB, an intention is formed in a rational choice process by weighing three different aspects: the person's *Attitudes* (ATT) towards the behaviour, the person's perception of social pressure to act in a certain way (*Social Norms,* SN)[2] and the person's perception of behavioural control in the situation. *Perceived Behavioural Control* (PBC) refers to a person's experience of having total control of a situation or being, at least partly, controlled by other people or situational conditions. In the domain of ecological behaviour, TPB proved helpful in explaining travel mode choice (Bamberg & Schmidt, 1998), recycling behaviour (Boldero, 1995), water conservation (Lam, 1999) and ecological consumer behaviour (Sonnenmoser, 1999).

The Norm-Activation Model (NAM, Schwartz, 1977; Schwartz & Howard, 1981), the second theory used in the comprehensive model, assumes that the driving force of behaviour is a feeling of moral obligation (*Personal Norm*, PN). This personal norm is not always active, but must be triggered during a preceding process of norm-activation. In other words, this process is only started if a person *perceives* someone or something in need (*Awareness of Need*, AN). A person only acts if he/she sees a causal relationship between his/her actions and the problematic outcome (*Awareness of Consequences*, AC).[3] Finally, the acting person must experience some amount of perceived behavioural control to activate the personal norm. According to the theory, personal norms are probably the most important predictor of norm-oriented behaviour, but not the only one. Social norms (as in the TPB) are also supposed to impact behaviour, both directly and mediated by personal norms. Attempts to empirically confirm the direct influence of social norms on behaviour, however, have not been successful in the domain of travel mode choice (e.g., Klöckner & Matthies, 2009; Bamberg & Möser, 2007; Bamberg et al., 2007). Non-moral aspects such as saving time or money are also considered, which would be reflected as behavioural or control beliefs in the TPB. Including non-moral aspects is a rather broad understanding of the NAM proposed by a research group working with Matthies (Matthies, 2003; Klöckner & Matthies, 2004; Matthies & Blöbaum, 2007; Matthies, Klöckner & Preißner, 2006), based on considerations in Schwartz and Howards' original model (1981). The more popular version of the NAM does not include these non-moral aspects. The NAM has been applied in different domains of conservationism, including waste paper recycling, joining environmentalist campaigns and choosing ecological modes of travel (e.g. Hunecke et al., 2001; Nordlund & Garvill, 2003; Stern, Dietz, Abel, Guagnano, & Kalof, 1999; van Liere & Dunlap, 1978; Hopper & Nielsen, 1991).

Both TPB and NAM have limitations in predicting repetitive behaviour , which was demonstrated by increasing explained behaviour variation substantially when habit was added to the model (e.g. Verplanken et al., 1994; Klöckner et al., 2003). Therefore the theoretical concept "habit" was also added to the comprehensive model proposed in this paper. Triandis (1980) pointed out the structural difference between frequent actions and actions which are exhibited rarely or for the first time. The more often decisions are made with a satisfying outcome in the same set of circumstances, the less influence the processes of deliberate decision making have in these situations. Behavioural patterns become more automated as a result. Support for this notion is found in studies like Ouellette and Wood's meta-analysis (1998). Verplanken et al. (1994) and Verplanken, Aarts, van Knippenberg, and Moonen (1998) integrated habits into the theory of planned behaviour to explain travel mode choice to show how this improved the TPB. Klöckner et al. (2003) and Klöckner and Matthies (2004) integrated habits into the NAM and demonstrated comparable effects in the context of this model.

Another limitation of both TPB and NAM is that they reduce the situational influence on people's behaviour to perceived behavioural control. Other theories, like the Ipsative Theory of Behaviour (Tanner, 1999; Tanner et al., 2004), have a more sophisticated approach: Situational determination explains behaviour (and, perhaps more significantly, nonbehaviour) by *objective* and *perceived* situational constraints. The Ipsative Theory of Behaviour is based on the economic theory proposed by Frey (1988). It assumes that in addition to the *objective possibility set* (OPS), which is determined by objective situational constraints and opportunities, there is an *ipsative possibility set* (IPS) of possibilities that individuals *consider* to be relevant to their behavioural decision. There is a difference between OPS and IPS (IPS is usually smaller than OPS, but can be larger under some conditions), but IPS is influenced by OPS. Tanner (1999) applied the Ipsative Theory of Behaviour to environmental behaviour (reducing the frequency of driving a car). In their study on ecological consumerism, Tanner et al. (2004) show that situational conditions (in both the household and the store) are powerful predictors of shopping behaviour. For our analysis, we used car access (CA) as a measure of “objective” situational constraints or facilitation, and PBC as a measure of subjective situational constraints. Limited access to a car is an important constraint of possible behavioural alternatives. On the other hand, having access to a car facilitates the decision to use it.

The models and additional constructs described above were selected because they already show some overlap in the variables and therefore pose a good possibility for integration. Some of the variables are identical in the models or are closely related on a theoretical level. For example, the NAM and TPB both assume perceived behavioural control to be important in enacting behaviour. Both models also consider social norms to be important predictors. Like the TPB, Triandis theory (1980), which includes habits, considers intentions to be a key component in behavioural determination. The IPS described in the Ipsative Theory of Behaviour is related to perceived behavioural control because a limited range of visible alternatives also reduces the perceived behavioural control. On the other hand, some constructs are exclusive to one theory if the theories are considered in their original form. Personal norms, awareness of need and awareness of consequences are only described in the NAM. Habits are only proposed by theorists like Triandis (1980) and were not included in the original versions of TPB and NAM. Only the Ipsative Theory of Behaviour differentiates between objective constraints to behaviour, the set of possibly accessible alternatives and the IPS activated in a situation of behavioural decision making.[4] The models also differ in the way they relate the variables to each other. The NAM assumes personal norms to be a direct predictor of behaviour, but the TPB ascribes this function to intentions. The Ipsative Theory of Behaviour predicts that the IPS determines the behavioural decision. In contrast, models that include habits consider a trade-off between habits and intentions to be the predictor of behaviour.

1.1. An integrated approach – the comprehensive action determination model

In this section, we will develop the first version of an overall theoretical framework of ecological behaviour we call the *Comprehensive Action Determination Model (CADM)* (see Figure 1). The first important assumption is that individual behaviour is directly determined by influences from three possible sources: intentional, situational, and habitual. This notion is clearly supported by the literature (Bamberg & Schmidt, 1998; Verplanken et al., 1994; Tanner et al., 2004; Klöckner et al, 2003). In contrast to the NAM, which assumes that personal norms are a direct predictor of behaviour, the influence of social or personal norms in the CADM is not direct, but rather mediated by intentional and habitual processes. Empirical studies have already shown that the influence of personal norms on behaviour is likely to be mediated by intentions (Bamberg et al., 2007). This is, however, also assumed theoretically because (social and personal) norms are constructs that are more general (over time and situations) and should be more distal to behaviour than intention. Together with attitudes and perceived behavioural control, personal and social norms are considered to be a reference used to generate intentions in a decision making situation. While attitudes reflect cognitive and affective beliefs about the behaviour in question and perceived behavioural control reflects beliefs about the degree of determination, personal norms provide the moral "colouring" of the decision-making process. The integrating stage, however, is the *intention*, which is generated immediately before a behavioural decision is made.[5]

All four sources (three direct and one indirect) do not exist independently of each other, but interact in a complex way over time. As described earlier, normative processes have an impact on how intentions are formed when making decisions. They also influence habits due to their high temporal stability as compared to an average level of attitude and perceived behavioural control. Although personal norms are not considered to be active at any given time, the norm itself which is routed in the value system usually exists for a long time. We consider personal norms to be stable references to the personal value system that can potentially activated in any situation, but are not always. If a situation activates a personal norm by generating an awareness of need, an awareness of consequences and the necessary perceived behavioural control in the first place which then impact personal norms, personal norms can become relevant in generating an intention to act in line with the personal norm. There is still the possibility to deny responsibility and deactivate a personal norm, which would change their impact on intentions, but usually not the personal norm itself. This means that personal norms themselves are considered rather stable, what may vary between situations is their impact on intentions. Habitual and situational processes interfere with intentional processes and moderate the impact of intentions on behaviour (Verplanken et al., 1994; Ajzen & Fishbein, 2005). Perceived behavioural control is necessary to activate normative and intentional processes. Therefore, situational influences impact normative and intentional processes (Ajzen, 1991; Harland, et al., 2007). It is assumed that personal norms adjust to situational conditions over the long term because norms to behave in a subjectively or objectively impossible way will change or be deactivated in the long run. Behaviour feeds back on the change or stabilisation of personal norms and habits. It is proposed that personal norms are inferred over time through social interactions as well as analysing the patterns of one's own past behaviour, a process parallel to the inference of attitudes by observing behaviour (Bem, 1965). Habits are generated by successfully performing stable behavioural patterns in stable situations, which means that past behaviour is a crucial variable in establishing a habit (Klöckner & Matthies, 2008). Some of these complex relations cannot be analysed with data from a single point in time, but require longitudinal data. The CADM proposed in this paper is, therefore, limited in scope to the processes active at a given point in time.

The importance of each source of behavioural determination varies over time, across situations and between people. This notion questions whether applying the proposed CADM to travel mode choice constitutes a valid test of the theory that different types of ecological behaviour (e.g. recycling, energy saving, use of public transportation) are predicted by a different set of psychological predictors (e.g. Gatersleben, Steg, & Vlek, 2002; Lévy-Leboyer, Bonnes, Chase, Ferreira-Marques, & Pawlik, 1996). We consider the comprehensive character of the CADM, however, to be an advantage. It includes a wide variety of possible predictors and explicitly assumes a variation of their relative importance within different situations. We chose the domain of travel mode choice as a first test for the CADM because it is a well-researched area in environmental psychology. This also made it possible to apply a strictly theory-based approach of model testing using already published results about the plausibility of the theoretical relations as a foundation. A second possible challenge to the need for the CADM is the fact that other authors have already achieved very high proportions of explained variation in ecological behaviour (e.g. Kaiser, 2006) without using such a high level of complexity. A closer look at these papers encourages us in our approach for two reasons. First, Kaiser (2006) achieves his high level of explained variation using an approach similar to the one we propose here (integrating established models, in his case normative aspects, into the TPB). The second argument, which we consider to be far more significant, is that Kaiser (2006) does this in an *aggregated* behaviour index (his General Ecological Behaviour Scale). This general behaviour scale should be far less influenced by specific situational constraints or facilitators and distinctive habitual behaviour patterns. On the other hand, it should be more closely related to general environmental attitudes and personal norms because the individual interferences of behaviour even out in specific situations. As a result, we expect that habits and objective situational constraints are needed as additional predictors to achieve a high proportion of explained variation not just in a general behaviour index, but in a certain type of ecological behaviour (like travel mode choice). They are strongly related to the specific situations and are underestimated when analysing aggregated behaviour indices on their own. From this perspective, the model analysed by Kaiser (2006) could be seen as a simplified version of the CADM for generalized behaviour.

The broad overview of the interplay of the four sources discussed so far constitutes a relatively abstract level of the model. A more detailed description of the processes within each of the four sectors uses variables from the integrated models. Figure 2 depicts an adaptation of the CADM to the domain of travel mode choice. The adapted model is not a complete version of the general CADM because it was tested on a given data set. The TPB predicts that the travel mode choice is directly influenced by the intention (not) to use a car and perceived behavioural control (Bamberg & Schmidt, 1998). Furthermore, the TPB states that the intention is generated from perceived behavioural control, social norms and attitudes (which were not measured in this study because the analysis was conducted on an existing data set which did not include attitudes). Extensions of the TPB which include the construct of habit (e.g. Verplanken et al., 1994) show the car choice habits directly influence travel mode choice and moderate the relationship between intention and behaviour. According to Bamberg et al. (2007), we presume that personal norms are an additional predictor of intentions, but not a direct predictor of behaviour. Referring to the NAM, we assume that personal norms should be influenced by the awareness of need, awareness of consequences and perceived behavioural control as these are necessary to activate the feelings of moral obligation (Hunecke et al., 2001). Furthermore, social norms should impact personal norms because personal norms are formed by internalising social norms and adapting them to the personal value system. We do not expect a direct influence of social norms on behaviour because this was not established in previous research on of travel mode choice when personal norms were included in the model (Klöckner & Matthies, 2009; Bamberg & Möser, 2007; Bamberg et al., 2007). Finally, the Ipsative Theory of Behaviour states that both subjective and objective constraints influence the performance of behaviour, which is also supported by more recent versions of the TPB (Ajzen & Fishbein, 2005). Therefore, the objective situational conditions (in this case car access) should influence behaviour directly and when mediated by cognitive representations (perceived control). Habits should relate to constructs which demonstrate long-term stability. Habits can only develop if situational influences remain stable. This means that car choice habits should be influenced by both objective and subjective situational constraints and facilitators. Unlike intentions, which are generated in the decision making situation, a personal norm, although not permanently activated, is a relatively stable psychological construct related to one's own value system. As a result, we also expect personal norms to predict car choice habits. Both of these influences should be mediated (from a theoretical point of view) by previous behaviour (see Klöckner & Matthies, 2008). The influence of social norms on habits should be mediated by personal norms, as is the major part of their influence on actual behaviour. We also expect a larger variation in social norms due to changing social networks, especially in the population of students analysed in the study at hand. Therefore, we do not expect social norms to have a significant direct influence on habits.

1.2. The present study

By establishing a preliminary theoretical framework, this paper aims to add to the discussion regarding a more comprehensive understanding of human behaviour in the domain of ecological behaviour and to define a research strategy toward a more comprehensive conception of behaviour determination. It uses a structural equation approach to test the proposed model against established, less complex models in the domain of travel mode choice. To face the problem of equivalent models,[6] which is especially evident for complex models like those suggested here (see e.g. MacCallum, Wegener, Uchino & Fabrigar, 1993), a strictly theory-driven, step-by-step test of established models and the integrated model was conducted on a sample of 389 students. First, the TPB (applied to travel mode choice by Bamberg & Schmidt, 1998) and the NAM (applied to travel mode choice by Hunecke et al., 2001) were tested individually. They were then integrated in the next step as suggested by Bamberg, et al. (2007). Finally, habit and objective situational constraints were added as shown in Figure 2. The aim of the study was to confirm that a comprehensive model based on the theoretical assumptions described above predicts empirical data better than less complex theories. In particular, the variation in behaviour is explained to a larger extent than in the TPB and the NAM (to confirm the comprehensive character of the model). Finally, we anticipated that adding norm-activation processes to the model would increase the explained variation of intention. In the last step, we tested the moderation hypotheses of habit, car access and PBC on the relationship between intention and behaviour. We expected that intentions would have a stronger relationship with behaviour when habits are weak (Verplanken et al., 1994) and that the intention-behaviour link is stronger when perceived behavioural control is high (Ajzen & Fishbein, 2005). Finally, intention should be a more important predictor of car choice when car access is easy. Limited car access is a situational restraint that makes car use virtually impossible, regardless of the intention. Intentions to use the car may eventually not develop at all in such a case.

2. Method

2.1. Sample

The study is based on a re-analysis of existing data which was collected in an online study conducted from the end of June to the end of July 2007 with students at the University of Duisburg-Essen. This university was chosen because of its location in the densely populated Ruhr region, which has a comparably good public transportation network. A random sample of 5,590 students was selected from all departments. Each student received a letter from the research team explaining the aim of the study. They were informed that all participants who finished the online questionnaire *and* completed the travel log would be included in a lottery to win one of eight vouchers for an online bookstore (value: 25 Euros). The letter also included the URL for the questionnaire, a personalised user name and password for access. In the end, 389 students participated in the study. The response rate of 7% was very low, but can be explained by several factors. First, the research team was not allowed to send a reminder letter to the students for data privacy reasons. As a result, there was no way of motivating students who did not register on the project homepage. The study was also started at a time of the year in which students are usually busy with exams, which proved to be a problem. Some irritated students contacted the project hotline to complain about having a research team from another university conduct a survey at their school, which may have reduced the willingness to participate. The low response rate, however, has serious implications for possible sampling errors and thus the generalizability of the results: if the lack of response was not at random (e.g. students more interested in environmental issues had a higher response rate), then the results are not representative for the student population at this university. Actually, analyses of socio-demographic data indicate a systematic bias of the sample: 60.7% of the sample was female, 39.3% male (48% of all university students are female). Students from all departments participated, but the educational sciences were overrepresented and economics underrepresented in the sample as compared to the numbers from the different departments. The obvious process of self-selection only makes the model test more conservative. The sample should have more homogeneous opinions than the student population, thus reducing variation in the sample group. It was not possible to test whether the following socio-demographic statistics of the sample deviated from the population because the university administration only provided limited information about the population. However, a deviation is likely given the high level of self-selection. The mean age was 24.7 years, ranging from 19 to 52 years of age (median: 24 years). The students were enrolled at the university for 0 to 16 years (mean: 3.4 years; median: 3 years). 43% of the participants were single, 34.8% were in a relationship but living separately, 21.6% were living together with their partner and 0.5% were either divorced or widowed. Just over two-thirds of the sample (67.3%) had a part-time job in addition to their studies.

2.2. Procedure

Once the students received the letter, they could log on to the online survey system programmed specifically to collect the data. After logging onto the system, the students were presented with a list of tasks they had to complete. The first was to fill out a short introductory questionnaire which primarily consisted of socio-demographic information, similar to that presented in the sample description, and provide an e-mail address under which they could be contacted during the study. The students were also asked if they had a part-time job and, if so, where it was located, where they most frequently went shopping and where their most frequent leisure activity took place. Finally, the students were asked how often they had access to a car.

After finishing the introductory questionnaire, the students answered a second online questionnaire which included all cognitive variables of the analyzed models. The items listed in the Appendix were presented in random order and had to be answered on a seven-point agreement scale. The negative end of the scale was labelled “totally disagree” (coded as “1”) and positive as “totally agree” (coded as “7”). The Response Frequency Measure of habit and the Self Report Habit Index (see below) were also included as two independent measures of habit in the second questionnaire.

On the day *after* answering the second questionnaire, an online logbook was started for up to four frequent trips (university, most frequent shopping location, most frequent leisure activity, work). The logbook was activated day by day to keep students from “inventing” trips in advance. It was possible, however, to complete elapsed days in the travel log after the fact. In addition to other information about the trips, the students indicated the travel mode they used for each one.

All questionnaires consisted of several pages, but it was not possible to go back to earlier pages and change the answers to already answered questions. The survey system did not require the students to answer every question, but prompted them if they did not answer and asked if this was done intentionally. Once a questionnaire or travel log day was completed, the task was marked “solved” in the task list and the questionnaire could no longer be activated. Students who were overdue with one or more tasks received an e-mail reminder to participate in the study. Missing values (5.6% of all values) in single items were imputed by ML estimates following a procedure proposed by Schafer and Graham (2002).

2.3. Measures

All cognitive variables of the tested model were included in the second online questionnaire. Each latent variable was measured by two or three indicators (see Appendix for a complete list of the used items). Some of the items used to measure the Awareness of Need

(AN), Awareness of Consequences (AC), Personal Ecological Norms (PN), Social Norms (SN), Perceived Behavioural Control (PBC) and Intention to Use Alternative Travel Modes (INT) were also applied in previous studies (e.g. Klöckner & Matthies, 2009). However, these were improved by testing them against newly developed items in a pre-test (*N*=45) involving students at the Ruhr-University Bochum, conducted in spring 2007. In an item analysis consisting of internal consistency tests (Cronbach's alpha), the best two or three items per latent variable were selected based on the pre-test data. The internal consistency coefficients were confirmed in the final data set (see Appendix) and indicate a very high consistency of the resulting scales. No item selection procedures were conducted for the final data set, but the proposed structure of the items was confirmed by a confirmatory factor analysis (see the measurement model test indices in the Results section). No changes to the measurement model were applied in the final data set.

Only one indicator of actual situational conditions was used in this study. Car access (CA) was operationalised by the answer to the question *how often* the student has access to a car (1=never; 5=always). We admit that this self-reporting of car access is not an *objective* measure of car access, but it comes much closer to measuring an external situational influence than PBC. It entered the structural test of the CADM as a single indicator. Thus, the measurement error of this indicator could not be estimated.

The strength of car choice habit (HAB) was recorded using two independent indices developed by Verplanken and colleagues as two indicators of a latent construct "habit". The first was the Response Frequency Measure (RFM) introduced by Verplanken et al. (1994) and later validated by Klöckner et al. (2003). This script-based measure of habit strength is a general index of car use in five imagined situations (see Appendix for details). The respondents were confronted with five imaginary travel goals (e.g. visiting a friend in a nearby town) and asked to name the first mode of travel to make this trip which came to mind. Due to the limited amount of information provided, it was not possible to make a deliberate choice on the mode of transportation. Verplanken et al. (1994) assume that travel mode choice scripts are activated to choose a type of transportation. If a person consistently selects the same means of transportation, it is assumed that he/she can activate a general script to choose travel modes relatively independently of the destination. Therefore, the number of times a particular mode of travel ("car" in this case) is chosen equals the strength of the general car choice habit. The travel goals were presented in random order. The second indicator used was an adapted version of the Self Report Habit Index (SRHI) developed by Verplanken and Orbell (2003). The basic idea of this second habit measure is to record self descriptions of feelings related to different dimensions of habitual behaviour (history of repetition, automaticity, and expressing identity) without recording the behaviour itself. A selection of six out of the 12 items of the SRHI was adapted to travel mode choice for this study.

Car choice behaviour (BEH) was recorded in an online travel log. For one week starting the day after the online questionnaires were answered, the students were asked to log up to two trips to each of the four possible destinations (university, favourite shop, favourite leisure activity, work). They were to report the time and place they started the trip, the time they arrived at their destination, the chosen (main) mode of transportation and the weather conditions at the time the trip took place. The logbook was limited to four destinations and asked only about the trips *to* these destinations, not about the *return* trips. This was done to make the process as simple as possible for the students and to minimise dropouts during the logbook period. Although this is still a self-reported measure of behaviour, the logbook procedure made sure that comparatively few distortions or biases occurred as research shows that travel logs enhance the quality of reporting (Bricka & Bhat, 2006). Precise logbook instructions were provided to ensure the accuracy and consistency of the data within and between subjects. The car choice index entered as a single behavioural indicator in the structural equation model and was computed as the number of reported trips by car divided by the total number of reported trips. A comparable measure was used by Klöckner and Matthies (2009).

3. Results

All analyses reported in this paper were conducted using Mplus (Muthén & Muthén, 1998-2007). We followed a strictly theory-driven, confirmatory approach as suggested by MacCallum et al. (1993) to face the problem of equivalent models. Furthermore, no data-driven post hoc model modifications were conducted to improve model fit. As MacCallum, Roznowski and Nekowitz (1992) pointed out, a much larger sample size is necessary to obtain reliable results even if an exploratory modification strategy could be justified in some cases (e.g. developing new theories). For this reason, all tested structural paths of the models are grounded in theory *and* already published empirical studies to ensure that the theoretically assumed relations were not falsified empirically. No measurement error covariations were allowed. Following suggestions from McDonald and Ho (2002), decomposable fit indices (Chi^2, the noncentrality parameter *d*, and RMSEA) are reported separately for the measurement model, path model, and overall model fit. This was done to ensure that a very well-fitting measurement model (combined with much higher degrees of freedom than the path model) would not compensate for the potentially poor fit of the theoretically derived path model.

3.1. Testing the Theory of Planned Behaviour

First, the TPB was tested on the data set. Since attitudes towards car use were not recorded in the data set, the following incomplete TPB model was tested: car choice behaviour was regressed on intentions and perceived behavioural control, while intentions were regressed on social norms and perceived behavioural control. The measurement model for intention, perceived behavioural control, social norms and behaviour was specified as described in the Method section. Table 1 shows the results of the model test and Table 2 indicates the model fit indices for all tested models. The results show that the TPB structure performs well with the data. 59% of the variation in car use is explained by the variation in intention and perceived behavioural control. Although attitudes were not included as a predictor of intention in this study, they explain 54% of the variation in intention. All proposed model paths are statistically significant and the model fit is good (for the total, measurement and path models). Intention to use alternative travel modes is a highly significant negative predictor of car use, while perceived behavioural control of car use is a highly significant positive predictor. The intention to use alternative modes of transportation is highly significant, predicted by the corresponding social norms to do so and, to a much larger degree, negatively predicted by perceived behavioural control. It must be noted, however, that including attitudes in the model might have changed the model estimates, especially for the predictors of intention. The model fit might have also changed.

3.2. Testing the Norm-Activation Model

The NAM was tested on the data set in the second step. Car choice behaviour was regressed on personal norms and perceived behavioural control, while personal norms were regressed on the awareness of need, awareness of consequences, social norms and perceived behavioural control. The measurement model for personal norms, the awareness of need, awareness of consequences, perceived behavioural control, social norms and behaviour was specified as described in the Method section. Table 3 reveals the results of the model test and Table 2 displays the model fit indices. The results show that the NAM structure is also excellent for the data. However, the 54% of variation in car use (5% less than in the TPB) is explained by the variation in personal norms and perceived behavioural control. The proposed predictors explain 55% of the variation in personal norms. All but one of the model paths are statistically significant and the model fit is once again good (for the total, measurement, and path models). Car use is significantly predicted by perceived behavioural control and negatively by personal norms to use other modes, although this relationship is weak. Personal norms are predicted positively by social norms and the awareness of consequences, and negatively by perceived behavioural control. All weights were weak to medium size. The predicted influence of the awareness of need on personal norms is not significant, which can be explained by the strong correlation between the awareness of need and awareness of consequences.

3.3. Testing the integrated Theory of Planned Behaviour and Norm-Activation Model

In the third step, the TPB and NAM were integrated as suggested by Bamberg et al. (2007) and Kaiser (2006). Car choice behaviour was regressed on intention and perceived behavioural control while intentions were regressed on social norms, personal norms and perceived behavioural control. Personal norms were regressed on the awareness of need, awareness of consequences, social norms and perceived behavioural control. The measurement model for intention, personal norms, the awareness of need, awareness of consequences, perceived behavioural control, social norms and behaviour was specified as described in the Method section. Table 4 contains the results of the model test and Table 2 displays the model fit indices. According to the results, the integrated TPB-NAM structure was once again fit the data. Like in the TPB, 59% of the variation in car use is explained by the variation in intention and perceived behavioural control (which was expected because this part of the model structure is identical to the TPB). 57% of the variation in intention is due to social norms, perceived behavioural control and additional personal norms. This constitutes an increase of 3%. The proposed predictors explain 56% of the variation in personal norms,. All but one of the model paths are statistically significant and the model fit is once again good (for the total, measurement and path models). Car use is negatively predicted by intentions to use alternative modes with a medium beta weight while the influence of perceived behavioural control is positive and a little stronger. Intention is significantly predicted in a negative direction by perceived behavioural control. This effect is strong. Social and personal norms have weak yet significant positive effects on intention. Including personal norms reduces the influence of social norms, which makes a partial mediation of the effect of social norms plausible. Since the structure of the predictors of personal norms is identical to the NAM test, it is not surprising that the resulting patterns of beta weights were similar. Once again, the predicted influence of the awareness of need on personal norms failed to be significant.

3.4. Testing the Comprehensive Action Determination Model

The CADM proposed by the authors was tested in the fourth phase. Car choice behaviour was regressed on intention, perceived behavioural control, car access and car choice habit. Intentions were regressed on social norms, personal norms and perceived behavioural control. Personal norms were regressed on the awareness of need, awareness of consequences, social norms and perceived behavioural control. Habit was regressed on personal norms, perceived behavioural control and car access. Perceived behavioural control was regressed on car access which represents one aspect of objective behavioural control in this study. The measurement model for intention, personal norms, the awareness of need, awareness of consequences, perceived behavioural control, social norms, habits and behaviour was specified as described in the Method section. Table 5 displays the results of the model test and Table 2 shows the model fit indices. Figure 3 represents the standardised regression weights of the path model and the R^2 of dependent variables. The results show that the CADM structure performs well on the data. 65% of the variation in car use is explained by the variation in intention, perceived behavioural control, habits and car access. This constitutes an increase of 6% in explained variation by the additional predictors. An F-test for

R^2 differences shows that this increase is highly significant: $F(2,283)=30.09$, $p<.001$. 60% of the variation in intention is explained by social norms, perceived behavioural control and personal norms. 54% of the variation in personal norms is demonstrated by the proposed predictors. 44% of the variation in PBC is explained when variation in car access is integrated. 78% of the variation in car choice habits is represented by the variation in perceived behavioural control, car access and personal norms. However, the model fit is not as good as with the previously tested models due to the higher complexity of the CADM.[7] The Chi^2/df ratio indicates a significant deviation between the predicted and observed data for the total, measurement, and path models. The *RMSEA* for the path model is reasonable (Browne & Cudeck, 1993). *CFI* and *SRMR* indicate a good fit for the total model. All but one of the model paths are statistically significant. Car choice behaviour is positively related to car choice habits, car access and perceived behavioural control. A negative relation was found between intentions to use alternative modes of travel and car use. All relations have a medium beta weight. Intentions to use other means of transportation were negatively predicted by perceived behavioural control, which have a strong impact. A medium positive effect is found for personal norms. Social norms have a weak but significant positive effect on intentions. The patterns of predictors of personal norms are similar to the ones described earlier. Once again, the expected influence of the awareness of need on personal norms failed to be significant. There is a positive and strong relationship between perceived behavioural control and car access. Habits are positively predicted by perceived behavioural control, which have a strong effect, as well as car access (medium effect). The habits are negatively predicted by personal norms to use alternative modes of travel (medium effect).

The next step in the analysis was conducted to determine the main contributors to this very specific pro-environmental behaviour. Which proximal or distal predictors have the greatest overall impact on travel mode choice, regardless of whether they impact behaviour directly or mediated by other variables? Furthermore, what are the major contributors to intentions and habits? The combination of direct and mediated effects was calculated for all modelled variables to analyse the impact different components of the CADM model have on the key variables of behaviour, intention, and habits. Table 6 displays these total effects. Car access and perceived behavioural control show by far the largest overall impact on behaviour. Intentions and habits are other important factors which influence behaviour and norms have a weaker yet significant impact. The awareness of consequences only had marginal total effects on behaviour. Once again, perceived behavioural control and car access are the most important predictors of intention, but personal and social norms and, to a far lesser degree, the awareness of consequences also contribute. The same pattern emerges for habits.

The final analysis was conducted to determine whether or not the proposed interactions between habit and intention, between perceived behavioural control and intention, or respectively between car access and intention, could be shown empirically. Thus, the CADM tested in the last step was extended by the three interaction terms “intention x habit”, “intention x PBC”, and “intention x car access.” Since these interaction terms were included on the latent variable level, the type of analysis had to be changed (Klein & Moosbrugger, 2000). Thus, standardised regression weights and absolute model fit indices are not available. Table 7 displays the results of the analysis. When the interaction terms were entered, the unstandardised regression weights and standard errors did not change significantly with very few exceptions. After entering the significant interaction between habit and intention, the main effects of both habit and intention on behaviour are no longer significant. The significant interaction between intention and car access also contributes to prediction of car choice. The interaction between PBC and intention, on the other hand is not significant. Comparing the relative fit indices of the models with and without interaction terms shows that the model *with* interaction terms fits the data better (lower AIC and BIC): AIC=25422.03 and

BIC=25727.23 for the model without interactions and AIC= 23949.22 and BIC= 24254.41 for the model including interactions. Individual factor scores were extracted for the relevant latent constructs for each participant to examine the direction of the interactions. Intention, habit and car access were dichotomised and the mean percentage of car use was plotted depending on strength of intention to use alternative travel modes, car habit strength and car access. These interactions are displayed in figures 4 and 5. The habit-intention interaction is counterintuitive: there is a stronger relationship between car use and intentions to use alternative modes of travel when car use habits are strong (Pearson correlation: r=-.64; n=194; p<.001) as compared to the situation when habits are weak (Pearson correlation: r=-.27; n=195; p<.001). The car access-intention interaction shows the expected direction: the relationship between intentions to use other means of transportation is stronger when the participants have easy access to a car (Pearson correlation: r=-.71; n=157; p<.001) as compared to when they have limited access (Pearson correlation: r=-.51; n=232; p<.001).

4. Discussion

The aim of this study was to propose a first version of a comprehensive model of ecological behaviour which utilises the Theory of Planned Behaviour, the Norm-Activation Model, habits, objective situational facilitators and constraints in order to explain ecological behaviour. Its predictive power is compared to already established models like the TPB and NAM, and both theories are integrated. The model structure analysis clearly demonstrates the promising potential of this approach of integrating intentional, normative, situational and habitual influences on ecological behaviour, and of further differentiating the model within and between these main determination categories (using well-established action models like the TPB, NAM, and Habits). Model fit indices indicate a satisfactory fit of the model and empirical data, and all but one proposed influences in the comprehensive model were significant. Compared to less complex models, the explained variation in travel mode choice behaviour was substantially higher. As expected, predictors from all four main determination categories contributed to explain car choice behaviour either directly or mediated. This reinforces the claim of the model to be a *comprehensive* approach. The results show that in addition to the expected strong determination of people's ecological behaviour by situational constraints (either influencing behaviour directly or mediated by PBC), intentional, habitual and normative processes still play an important role. This implies that, from an interventionist perspective, changing situational conditions is a promising way of modifying behaviour. At the same time, normative, intentional and habitual processes have the power to counteract this and must be considered. An examination of the total effects shows that the major players in determining students' behaviours when it comes to car choice were situational constraints, intentions and habits.

One of the three expected interaction effects (in this case car access moderating the intention-behaviour relation) could be confirmed, whereas the habit-intention interaction was significant but in an unexpected direction. The interaction between car access and intention confirmed our expectations: while students with limited access to a car were more or less forced to use other transportation options, students with easy access to a car actually had a choice between the car and alternative modes of travel. Thus, the intentions of students without car access can be considered irrelevant because the situation "forces" them to not use the car. The non-significant interaction between perceived behavioural control and intention could be explained by the general way that perceived behavioural control was measured. An interaction would have been more likely if the perceived behavioural control had been measured specifically for a certain trip and immediately prior to the planned performance of the behaviour. In this case, for example, an unexpected obstacle which caused a loss of perceived control and deactivated intentions could have been detected. To our surprise, intention and behaviour were more closely related when car choice habits were strong than when habits were weak. A closer look at the segment of the participants with strong car habits shows that they were also the ones with easy access to a car (Pearson correlation of the two latent variables: r=.74; N=389; p<.001). This is not surprising as having easy access to a car is a necessary prerequisite to develop a car choice habit in the first place. This means that students with a strong car choice habit were more likely to have access to a car, which offered them a real choice between alternatives and made their intentions to use alternatives relevant. Perhaps this result could also be explained by the fact that intentions were measured according to *alternative* travel modes as opposed to car use. In a study about healthy eating, Verplanken and Faes (1999) argued that the statistical insignificance of the expected intention-habit interaction was due to the different target behaviours for which they were measured. However, the results can also be read as supporting Fazio’s ideas that strong habits (which mean a higher grade of automaticity in belief activation in his terminology) should *enhance* the attitude-behaviour link (Fazio, Sambonmatsu, Powell, & Kardes, 1986).

A more detailed review of the results gives very interesting insights into the structure and status of the different processes and constructs. Personal norms show a comparatively strong influence on habits, but a weaker one on intentions. This is in line with the theoretical assumption that personal norms are related to an individual's value system and therefore have much larger temporal stability than an average intention, which is usually generated directly prior to a behavioural decision and therefore subject to far more change over time.[8] Thus, habits as a predictor of behavioural stability should tend to be more closely related to theoretically stable variables like norms. Furthermore, habits are assumed to be associated with a certain situation (Ouellette & Wood, 1998), which should result in a strong relation to situational aspects, assuming that the situation shows at least some stability (for a discussion and analysis of the influence of stable and unstable situations on habits see Klöckner & Matthies, 2009). The results precisely show this strong relationship between habits and situation (either directly related or filtered by PBC). It is also encouraging that habits obviously still have an independent effect on behaviour when a large set of other variables is included. This seems to contradict the assumptions of Bamberg et al. (2003) that the determination of behaviour by the “so called habit-construct” should disappear if all other possible sources of stability are controlled. However, some sources of stability not included in the study could possibly account for the remaining effect of habit. In this study, the effect of habit on behaviour is much weaker than reported on frequently shown behaviour in other studies (e.g. Ouellette & Wood, 1998). This indicates that the small but significant remaining effect in this study might be a better and more realistic approximation of the *real* habitual influence on behaviour when all confounding effects of stability in other variables are removed.

AN and AC are very closely related in several studies (e.g. Klöckner & Matthies, 2009; Matthies, Selge & Klöckner, in press), which is also the case in this one. The confirmatory factor analysis shows that a two-construct solution is viable. Nevertheless, the question seems to be whether or not the study participants truly differentiate between AN and AC, or if the feeling of a need for action only occurs in situations which simultaneously generate a feeling of responsibility for the consequences of this action. Therefore, AN and AC might be theoretically different constructs which are extremely difficult to differentiate empirically in the field. Perhaps a controlled manipulation of AN independently of AC (or vice versa) in the laboratory could provide greater insights into the structure of the activation stage of the NAM (Schwartz & Howard, 1981) implemented into the CADM in this paper. For the time being, it seems reasonable to model AN and AC as being independent but closely related constructs which both contribute to activating PN even if they fail to demonstrate independent impacts on PN in some cases. Rethinking the way AN and AC are operationalised also seems to make sense. Measuring AN on a more general level (e.g. as the awareness people have of global warming without specifying it to car use and its contribution) might help to separate the constructs.

While explaining the strengths of the results, one should also be aware of their possible flaws. First of all, the included objective situational constraints were by no means comprehensive. Car availability is not the only situational condition that makes car use possible or impossible. Road conditions, availability of parking space at the destination, traffic jams, etc. are other possible influences that could be recorded in future studies. Furthermore, situational influences should be measured independently of the participants' perception, e.g. through observation and not self-reporting, to truly separate objective and subjective situational influences. Not including attitudes as a predictor of intentions is another shortcoming of this study, which limits the comprehensiveness of the model. This does not affect the prediction of pro-environmental behaviour because attitudes are not a direct predictor of behaviour, but of intentions. Most likely, the relative importance of personal norms, social norms and perceived behavioural control would change if attitudes were included in the model. It is also likely that the amount of explained variation in intention would be higher. Furthermore, the overall fit of the model might change when attitudes are included. As discussed in the introduction, the demonstrated support for the CADM in the domain of travel mode choice does not necessarily mean that the CADM is a valid model for other domains of ecological behaviour. Thus, more testing in other domains is needed. Second, the model has to be tested on other populations, as the test sample for this study was limited to students and also suffered from a strong process of self-selection. As a result, the results must be carefully confirmed in other populations. This may even necessitate cross-cultural studies.

A major revision of the CADM should involve taking the dimension of time into account in the model. Normally, this is left out of action models. Human decision making, however, does not occur at an isolated point in time, but within a sequence of other decisions in similar and different situations which impact future decisions and the decision-making process. Locating habits in a time perspective is probably the easiest part: habits should be related to previous behaviours in similar situations (Wood, Quinn, & Kashy, 2002). Therefore, the situational stability and previous behaviour should be related to habits at a future point in time. On the other hand, habits should be influenced by former normative processes as well as situational conditions at an earlier point in time as they were established by repeatedly making the same decision. In return, habits should determine future behaviour because they "freeze" established behavioural patterns. Apart from the processes of establishing habits and making them relevant predictors of future behaviour which include the dimension of time, other relationships between past behaviour, future intentions and personal and social norms seem plausible. Intentions and norms determine behaviour. In turn, it is a well-established fact that behaviour also influences the way people see themselves (Bem, 1965). If we assume that behaviour feeds back on its psychological predictors, an analysis of mechanisms, how this influence works and if it is different for norms, habits, and attitudes should be one of the most interesting questions for future studies.

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Footnotes

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[2] Ajzen (1991) uses the term "subjective norms" instead of the term "social norms" we prefer to use in this paper. Both terms have been used more or less interchangeably in the literature. Theories based on the Norm Activation Model use the term "social norms", while ones in the tradition of the Theory of Planned Behaviour use the term "subjective norm". In order to avoid confusion between two different terms, we decided to only use the term "social norms". In our opinion, this term better reflects the theoretical content of the construct.

[3] Some authors, however (e.g. van Liere & Dunlap, 1978; Hopper & Nielsen, 1991), suggest another approach in which AN and AC are treated as mediating or moderating processes between personal norms and behaviour and therefore as proxies to behaviour. De Groot and Steg (2009) systematically analysed the relations and found little evidence for moderation.

[4] We are aware that there is an immense body of literature about the generation and the influence of choice sets in the domain of travel mode choice. We decided not to include this literature to reduce the complexity of the paper.

[5] It must be noted that the standard operationalisation of intention proposed by Icek Ajzen on his homepage (see http://www.people.umass.edu/aizen/pdf/tpb.measurement.pdf) does not capture the intention immediately before the behaviour is performed, but describes a more generalized intention for a given period of time (e.g. next week or next month). To produce comparable results to other studies that apply the TPB, we use this standard operationalisation in this paper even though we consider intentions to be more closely linked to behaviour.

[6] Equivalent models refer to alternative model structures with a mathematical perspective equivalent to the structure proposed here.

[7] Chi^2 based measures of model fit (e.g. RMSEA) are sensitive to model complexity (degrees of freedom). This “punishes” more complex models because it is harder to achieve a good model fit. Therefore, we decided to take a reasonable model fit of the complex model structure as a good enough sign that the model structure fits the data.

[8]Although intention in this study was measured on a comparatively general level (“in the next seven days”), the temporal stability of this “generalized” intention is still assumed to be much lower than the stability of norms, which remain unchanged for months and years. See also footnote 3.

Appendix

The following items were used as indicators of the latent constructs in the model:

Awareness of Need (AN, 3 items, Cronbach's alpha=.84)

AN1: Car use is an urgent problem for environmental protection.

AN2: I believe that using the car causes many environmental problems.

AN3: Driving a car contributes to climate change.

Awareness of Consequences (AC, 3 items, Cronbach's alpha=.84)

AC1: My personal car use affects the quality of life for future generations.

AC2: If I reduce my personal car use, I contribute to climate protection.

AC3: My personal decision to use the car has consequences for global ecological damage.

Personal Ecological Norm (PN, 3 items, Cronbach's alpha=.88)

PN1: Due to values important to me, I feel obliged to use the car as little as possible.

PN2: Due to my values/principles, I feel personally obliged to use environmentally friendly means of transportation such as a bike, bus or train.

PN3: The aspect of environmental protection in travel mode choice is solidly anchored in my value system.

Social Ecological Norm (SN, 3 items, Cronbach's alpha=.84)

SN1: People who are important to me expect that I will use environmentally friendly means of transportation.

SN2: People who are important to me insinuate that I should consider environmental protection when selecting a mode of travel.

SN3: People who are important to me support me when I use environmentally friendly means of transportation instead of the car.

Ecological Intention (INT, 2 items, Cronbach's alpha=.86)

INT1: My intention to use public transportation instead of the car for my frequent trips (university, shopping, leisure, work) in the next seven days is strong.

INT2: I intend to use public transportation instead of the car for my frequent trips (university, shopping, leisure, work) in the next seven days.

Perceived Behavioural Control (PBC, 2 items, Cronbach's alpha=.81)

PBC1: Circumstances force me to use the car on my frequent trips.

PBC2: It would be difficult to manage my frequent trips with environmentally friendly means of transportation.

Car Access

CA: How often do you have access to a car (1=never, 5=always)?

Response Frequency Measure (HAB1, 5 items, index score = number of times "car" was named in the items)

Assume you want to do the following things. Which travel mode are you most likely to use? Please answer spontaneously. (Habit strength equals the times “car” was chosen)

RFM1: Visiting a friend in a nearby town.

RFM 2: Taking a stroll in the city centre.

RFM 3: Visiting a pub in the evening.

RFM 4: Taking an excursion in nice weather.

RFM 5: Shopping for daily needs.

Self Report Habit Index (HAB2, 6 items, index score = mean score of the six items)

Taking the car for frequent trips is something that…

SRHI1: … gives me a strange feeling when I don’t do it.

SRHI2: … I do totally automatically.

SRHI3: … I do without thinking about it.

SRHI4: … is part of my routine.

SRHI5: … is typical for me.

SRHI6: … does not require any active thought.

Cronbach’s alpha of RFM and SHRI= .73

Tables

Table 1: Estimated Parameters of the Test of the Theory of Planned Behaviour (N=389).

	B	*S.E.*	*p*	*beta*	R^2
SN → SN1	1.00	-	-	.81	
SN → SN2	1.13	.07	<.001	.85	
SN → SN3	1.00	.07	<.001	.78	
INT → INT1	1.00	-	-	.86	
INT → INT2	1.04	.06	<.001	.88	
PBC → PBC1	1.00	-	-	.88	
PBC → PBC2	.82	.05	<.001	.78	
INT → BEH	-.06	.01	<.001	-.35	
PBC → BEH	.09	.01	<.001	.48	
BEH					.59
SN → INT	.34	.07	<.001	.24	
PBC → INT	-.64	.06	<.001	-.66	
INT					.54
SN ↔ PBC	-.38	.16	<.050	-.14	

Table 2: Model-fit Indices of all Tested Models (N=389).

		Chi^2	*df*	*p*	*d*	*RMSEA*	*CFI*	*SRMR*
TPB	*Overall Model*	21.72	16	.15	.02	.03	1.00	.02
	Measurement Model	20.72	15	.15	.02	.03	-	-
	Path Model	1.00	1	.32	-.00	-[1]	-	-
NAM	*Overall Model*	95.35	79	.10	.04	.02	1.00	.02
	Measurement Model	91.49	76	.11	.04	.02	-	-
	Path Model	3.87	3	.28	.00	.03	-	-
TPB	*Overall Model*	126.90	105	.07	.06	.02	.99	.02
&	*Measurement Model*	119.21	99	.08	.05	.02	-	-
NAM	*Path Model*	7.69	6	.26	.00	.03	-	-
CADM	*Overall Model*	210.16	151	.00	.15	.03	.99	.03
	Measurement Model	172.39	136	.02	.09	.03	-	-
	Path Model	37.76	15	.00	.06	.06	-	-

[1] RMSEA is not calculable for the path model because *d* is negative.

Table 3: Estimated Parameters of the Test of the Norm-Activation Model (N=389).

	B	*S.E.*	*p*	*beta*	R^2
PN → PN1	1.00	-	-	.84	
PN → PN2	1.01	.05	<.001	.87	
PN → PN3	.86	.05	<.001	.82	
AN → AN1	1.00	-	-	.81	
AN → AN2	1.00	.06	<.001	.83	
AN → AN3	.92	.06	<.001	.75	
AC → AC1	1.00	-	-	.77	
AC → AC2	1.04	.07	<.001	.80	
AC → AC3	1.11	.07	<.001	.84	
SN → SN1	1.00	-	-	.82	
SN → SN2	1.11	.07	<.001	.85	
SN → SN3	.99	.07	<.001	.73	
PBC → PBC1	1.00	-	-	.87	
PBC → PBC2	.83	.06	<.001	.78	
PN → BEH	-.02	.01	<.05	-.11	
PBC → BEH	.12	.01	<.001	.69	
BEH					.54
SN → PN	.41	.06	<.001	.34	
AN → PN	.22	.15	n.s.	.18	
AC → PN	.39	.16	<.05	.32	
PBC → PN	-.22	.04	<.001	-.26	
PN					.55
AC ↔ AN	1.49	.15	<.001	.86	
AN ↔ PBC	-.35	.16	<.05	-.14	

AC ↔ PBC	-.01	.15	n.s.	-.01
SN ↔ AN	.54	.12	<.001	.30
SN ↔ AC	.54	.11	<.001	.30
SN ↔ PBC	-.40	.16	<.05	-.15

Table 4: Estimated Parameters of the Test of the Integrated Theory of Planned Behaviour and Norm-Activation Model (N=389).

	B	*S.E.*	*p*	*beta*	R^2
PN → PN1	1.00	-	-	.84	
PN → PN2	1.02	.05	<.001	.87	
PN → PN3	.86	.05	<.001	.81	
INT → INT1	1.00	-	-	.86	
INT → INT2	1.03	.06	<.001	.88	
AN → AN1	1.00	-	-	.81	
AN → AN2	1.00	.06	<.001	.83	
AN → AN3	.92	.06	<.001	.75	
AC → AC1	1.00	-	-	.77	
AC → AC2	1.04	.07	<.001	.80	
AC → AC3	1.11	.07	<.001	.84	
SN → SN1	1.00	-	-	.81	
SN → SN2	1.12	.07	<.001	.85	
SN → SN3	1.00	.07	<.001	.73	
PBC → PBC1	1.00	-	-	.88	
PBC → PBC2	.82	.05	<.001	.78	
INT → BEH	-.06	.01	<.001	-.34	
PBC → BEH	.09	.01	<.001	.49	
BEH					.59
SN → INT	.20	.08	<.05	.14	
PN → INT	.25	.07	<.001	.21	
PBC → INT	-.60	.06	<.001	-.60	
INT					.57

SN → PN	.41	.06	<.001	.35	
AN → PN	.21	.15	n.s.	.17	
AC → PN	.39	.15	<.05	.32	
PBC → PN	-.22	.04	<.001	-.26	
PN					.56
AC ↔ AN	1.49	.15	<.001	.86	
AN ↔ PBC	-.35	.16	<.05	-.14	
AC ↔ PBC	-.03	.15	n.s.	-.01	
SN ↔ AN	.54	.11	<.001	.30	
SN ↔ AC	.54	.11	<.001	.30	
SN ↔ PBC	-.38	.16	<.05	-.14	

Table 5: Estimated Parameters of the Test of the Comprehensive Action Determination Model (N=389).

	B	*S.E.*	*p*	*beta*	R^2
PN → PN1	1.00	-	-	.83	
PN → PN2	1.02	.05	<.001	.87	
PN → PN3	.86	.05	<.001	.81	
INT → INT1	1.00	-	-	.86	
INT → INT2	1.03	.06	<.001	.87	
AN → AN1	1.00	-	-	.81	
AN → AN2	1.00	.06	<.001	.83	
AN → AN3	.92	.06	<.001	.75	
AC → AC1	1.00	-	-	.77	
AC → AC2	1.05	.07	<.001	.81	
AC → AC3	1.10	.07	<.001	.84	
SN → SN1	1.00	-	-	.81	
SN → SN2	1.13	.07	<.001	.85	
SN → SN3	1.00	.07	<.001	.73	
HAB → HAB1	1.00	-	-	.79	
HAB → HAB2	1.55	.10	<.001	.80	
PBC → PBC1	1.00	-	-	.87	
PBC → PBC2	.82	.05	<.001	.77	
INT → BEH	-.05	.01	<.001	-.25	
PBC → BEH	.04	.02	<.01	.24	
HAB → BEH	.08	.03	<.05	.20	
CA → BEH	.05	.01	<.001	.24	
BEH					.65

SN → INT	.19	.08	<.05	.13	
PN → INT	.27	.07	<.001	.23	
PBC → INT	-.62	.05	<.001	-.63	
INT					.60
SN → PN	.41	.06	<.001	.35	
AN → PN	.22	.15	n.s.	.18	
AC → PN	.39	.15	<.05	.32	
PBC → PN	-.21	.04	<.001	-.25	
PN					.54
CA → PBC	.83	.06	<.001	.66	
PBC					.44
PN → HAB	-.17	.03	<.001	-.30	
CA → HAB	.16	.03	<.001	.28	
PBC → HAB	.24	.03	<.001	.52	
HAB					.77
AC ↔ AN	1.49	.15	<.001	.86	
SN ↔ AN	.54	.11	<.001	.30	
SN ↔ AC	.53	.11	<.001	.30	
AN ↔ CA	-.13	.11	n.s.	-.07	
AC ↔ CA	.05	.11	n.s.	.02	
SN ↔ CA	-.36	.12	<.01	-.17	

Table 6: Standardised Total Effects on Behaviour, Intention, and Habit in the Comprehensive Action Determination Model (N=389).

	BEH	INT	HAB
INT	-.25***	-	-
PN	-.12***	.23***	-.30***
SN	.07***	.21***	-.11***
PBC	.53***	-.69***	.60***
HAB	.20*	-	-
CA	.65***	-.45***	.68***
AN	-.02[ns]	.04 [ns]	-.05 [ns]
AC	-.04*	.07*	-.10*

*** p<.001; ** p<.01; * p<.05; ns = not significant

Table 7: Estimated Parameters of the Test of the Comprehensive Action Determination Model Including Interaction Terms (N=389).

	B	*S.E.*	*p*
PN → PN1	1.00	-	-
PN → PN2	1.02	.05	<.001
PN → PN3	.86	.05	<.001
INT → INT1	1.00	-	-
INT → INT2	1.02	.06	<.001
AN → AN1	1.00	-	-
AN → AN2	1.00	.06	<.001
AN → AN3	.92	.06	<.001
AC → AC1	1.00	-	-
AC → AC2	1.05	.07	<.001
AC → AC3	1.11	.07	<.001
SN → SN1	1.00	-	-
SN → SN2	1.12	.07	<.001
SN → SN3	.99	.07	<.001
HAB → HAB1	1.00	-	-
HAB → HAB2	1.54	.10	<.001
PBC → PBC1	1.00	-	-
PBC → PBC2	.81	.05	<.001
INT → BEH	.03	.02	n.s.
PBC → BEH	.05	.02	<.01
HAB → BEH	.00	.04	n.s.
CA → BEH	.04	.01	<.05
INT x HAB → BEH	-.03	.02	<.05

INT x PBC → BEH	.01	.01	n.s.
INT x CA → BEH	-.02	.01	<.05
SN → INT	.18	.08	<.05
PN → INT	.27	.07	<.001
PBC → INT	-.63	.05	<.001
SN → PN	.41	.06	<.001
AN → PN	.25	.15	n.s.
AC → PN	.36	.15	<.05
PBC → PN	-.21	.04	<.001
CA → PBC	.83	.06	<.001
PN → HAB	-.17	.03	<.001
CA → HAB	.16	.03	<.001
PBC → HAB	.24	.03	<.001
AC ↔ AN	1.48	.15	<.001
SN ↔ AN	.53	.11	<.001
SN ↔ AC	.54	.11	<.001

Figures

Figure 1: General Sketch of the Comprehensive Action Determination Model.

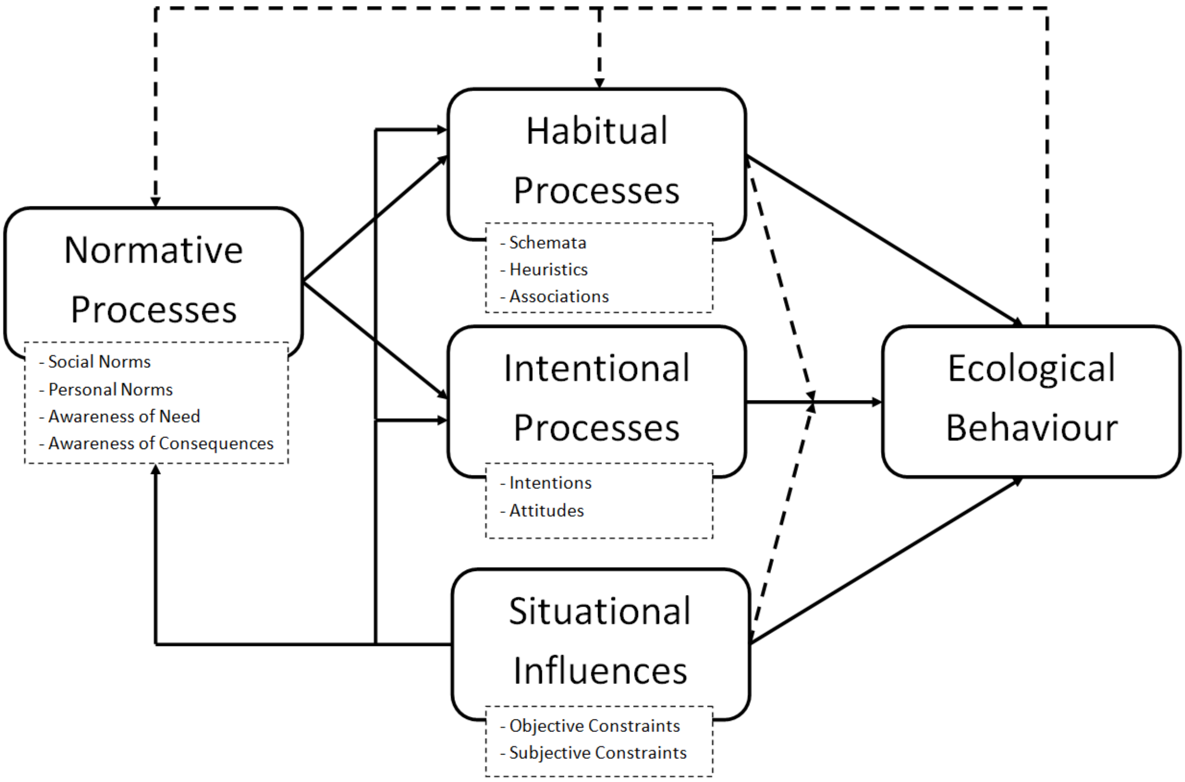

Figure 2: A Specified Version of the Comprehensive Action Determination Model.

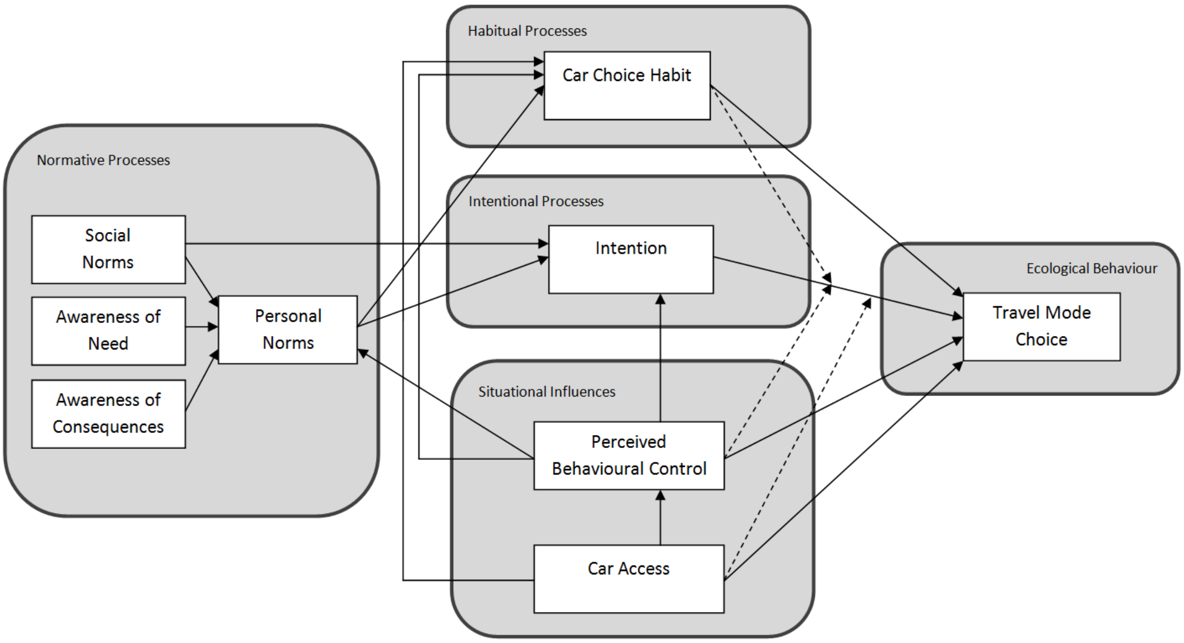

Figure 3: Results of the Structural Equation Model. Displayed Values are Standardised Path Coefficients and Explained Variations.

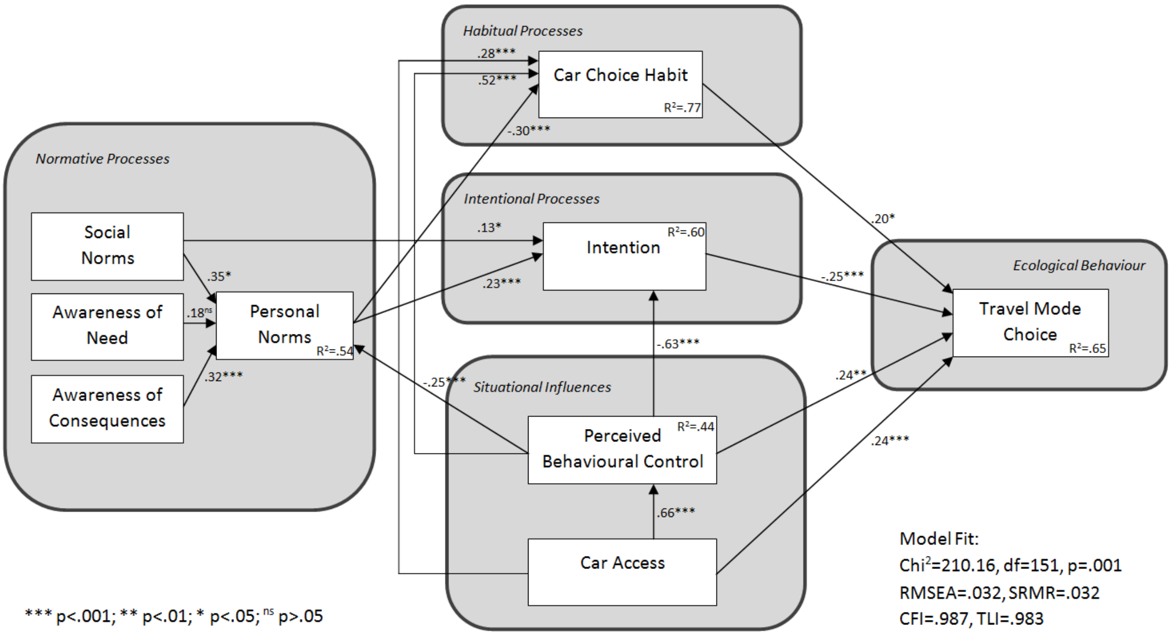

Figure 4: Interaction between the intention to use alternative travel modes and car use habits on car choice. The mean difference in the percentage of car use is displayed in the following groups: weak car choice habits and weak intentions to use alternative modes (n=37), weak car choice habits and strong intentions to use alternative modes (n=158), strong car choice habits and weak intentions to use alternative modes (n=158) and strong car choice habits and strong intentions to use alternative modes (n=36). Dichotomised factor scores for the latent constructs intention and habit were used to define the groups.

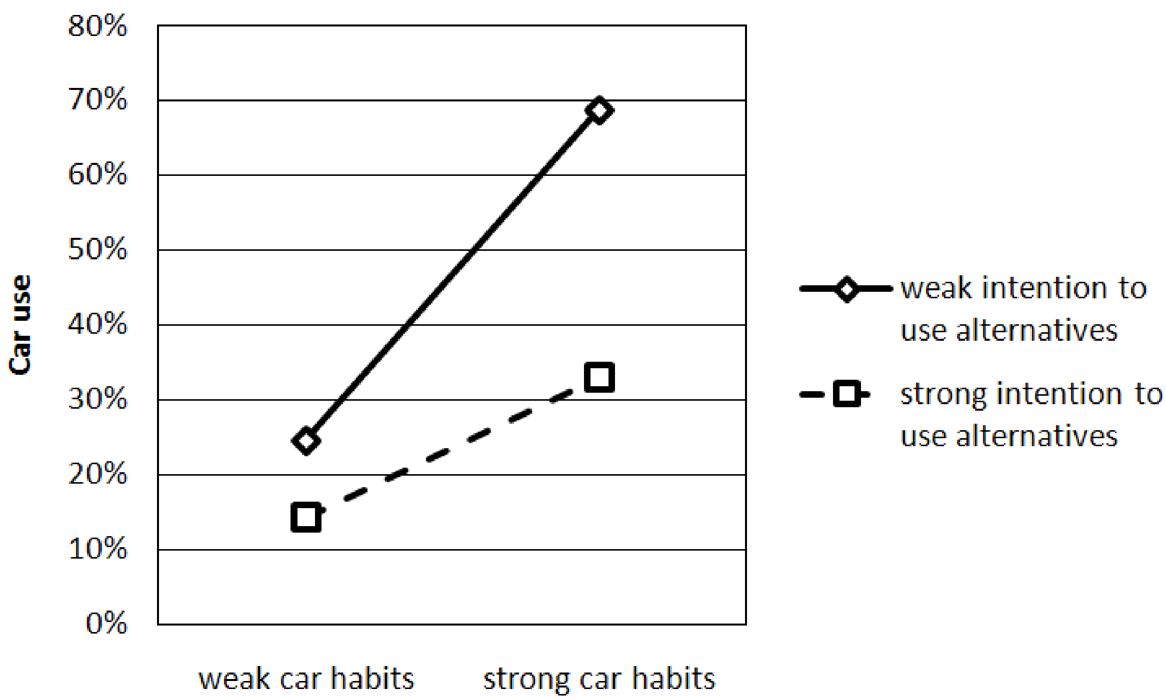

Figure 5: Interaction between the intention to use alternative travel modes and car access on car choice. The mean difference in the percentage of car use is displayed in the following groups: limited car access and weak intentions to use alternative modes (n=75), limited car access and strong intentions to use alternative modes (n=157), easy car access and weak intentions to use alternative modes (n=120) and easy car access and strong intentions to use alternative modes (n=37). Dichotomised factor scores for the latent constructs intention and car access were used to define the groups.